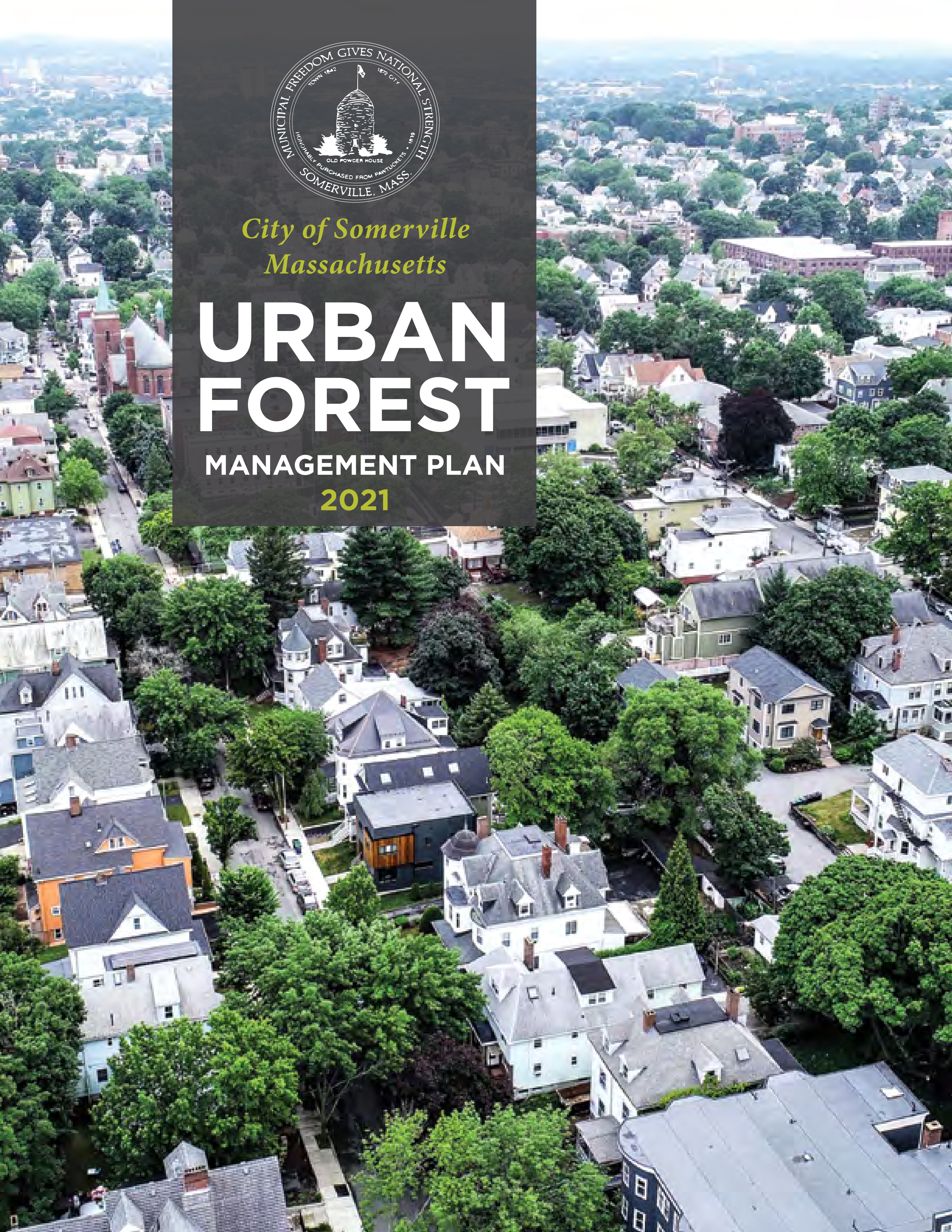
City of Somerville
Massachusetts

URBAN FOREST

MANAGEMENT PLAN

2021



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SOMERVILLE URBAN FOREST MANAGEMENT PLAN

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VISION STATEMENT

Somerville's vision for its trees is to create the best forest for a city, and the best city for a forest.

This Urban Forestry Management Plan (UFMP) serves as a guiding document for the expansion, preservation and maintenance of a healthy and diverse urban forest to maximize environmental, economic, safety and aesthetic tree benefits for the Somerville community today and in the future.

ACKNOWLEDGEMENTS

This Somerville Urban Forest Management Plan was made possible by grant funding from the Massachusetts Department of Conservation and Recreation in cooperation with USDA Forest Service and through its Urban and Community Forestry (U&CF) Grant Program. The U&CF Grant Program is designed to encourage communities to create and support long-term and sustained urban and community forestry programs throughout Massachusetts.

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All residents who read and gave thoughtful comments on prior drafts of this document

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MAYOR'S LETTER

It is my pleasure to release Somerville's first comprehensive Urban Forest Management Plan. Trees are an essential part of our community both for quality of life and for our environment. They provide shade, help to clean our air and stormwater, calm traffic, increase property values, and are a vital component of making Somerville the best place to live, work, play, and raise a family. Trees are also a crucial part of our urban ecosystem as they are a source of food and habitat for our city's pollinators and other wildlife.

Trees provide us with countless benefits, and we need to take proper care of them to help them survive in tough urban conditions. Regular tree maintenance will not only encourage proper growth and longevity, but also support public health and safety.

This Urban Forest Management Plan provides a data-driven approach to understanding the current conditions and needs of Somerville's urban forest, as well as detailed recommendations to grow our tree canopy. Not only does this Plan include an assessment of the city's complete public tree inventory and a canopy cover analysis of all public and private trees, but it also includes guidance for maintaining our urban forest, planting more trees, improving our urban forestry operations, and enhancing public engagement.

This Plan builds upon the important work and ideas provided in Somerville's Open Space and Recreation Plan (2016-2023), Somerville Climate Forward (2018), and SomerVision 2040. All of these plans call for the creation of an Urban Forest Management Plan and identify a need to increase the City's tree canopy. Now, with this Plan, we have a framework for growing a healthier urban forest.

The pages that follow provide us with an understanding of Somerville's urban forest today and a roadmap for how to continue to grow and improve it. As with all important things, it will take a village to make our urban forest the best that it can be. City staff and residents alike share an immense passion for Somerville's trees and, armed with this Plan, I am confident that together we can enrich our urban forest!

Joseph A. Curtatone
Mayor
City of Somerville

Somerville
Urban
Forestry
Committee

Urban Forestry Management Plan
Foreword from the Urban Forestry Committee
City of Somerville

The Urban Forestry Committee (UFC) held its first meeting in July 2019. The formation of the UFC came after recognizing that the city's Tree Preservation Ordinance called for a committee and in response to increasing public concern over the state of the urban forest after the removal of trees on Beacon Street and along the GLX corridor.

The following pages contain the City's newest Urban Forestry Management Plan. The development of this document is a critical step in the process of building and protecting Somerville's urban forest. This document lays the foundation necessary to develop and maintain tree plantings and other green spaces in our city over the next five to ten years. As with all Somerville's documents, this one will evolve over time according to science and our social needs.

Trees in our landscape provide monetary benefit by way of energy costs, health benefits, and crime reduction. They also provide ecological benefits through carbon sequestration, mitigating urban heat, and providing food and habitat for insects, birds, and other animals who underpin the very foundation of human existence. These benefits and how they are quantified are outlined in detail in the following pages. What is more difficult to quantify is the value of connecting and interacting with nature. Observing nature offers tremendous value: it connects community, provides respite from busy and stressful lives, and creates learning opportunities for our children. Learning about ecology, biodiversity, and the importance of healthy ecosystems can lead to more formalized study, investigative research and career choice. These, in turn, inform climate policy and create tools and structure for the protection of all wildlife.

The UFC recognizes the importance of the moment, how we need to modify our behavior if we are to meet the challenge of the climate crisis. We are dedicated to serving the community and helping to reach the goal of creating a sustainable and equitable pathway for planting, maintaining, and protecting our urban forest and green spaces. This includes creating pollinator corridors to support native insect populations, advocating for healthy soils, and championing biodiversity. The UFC is aware of the decimation of our local insect, bird and wildlife populations. The return of pollinators will be a crucial next step in the development of this plan. We must commit to converting to sustainable and ecological landscaping habits and using indigenous species in our public and private plantings. Although Somerville is only 4.1 square miles, we are confident that our actions will inspire communities throughout the Commonwealth.

Sincerely,

The Urban Forestry Committee
January 28, 2021

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EXECUTIVE SUMMARY

As part of the City's commitment to its urban forest, this Plan was developed by the City of Somerville's Public Space & Urban Forestry (PSUF) Division based on a tree inventory and other research conducted by its consultant, Davey Resource Group (DRG). Somerville's trees provide a wealth of benefits to our residents, such as providing shade, cleaner air and water, habitat for wildlife and pollinators, and safer streets, as well as increasing property values and improving people's quality of life. In addition to providing an overview of the existing state urban forest, this Plan creates a vision and road map for preserving and expanding our urban canopy. It includes specific recommendations for addressing short-term and long-term maintenance needs for inventoried public trees, as well as suggestions for improving urban forestry operations and public outreach.

STATE OF THE EXISTING URBAN FOREST

Canopy Cover

Current: 14.6%

Goal: 16%

An analysis of aerial imagery from 2018 reveals that Somerville's tree canopy covers 14.6% of the land area. Somerville aims to increase canopy cover to 16%, which will require preserving existing trees, and planting new trees on both public and private property.

Three Dominant Tree Species

Three species comprise a large percentage of the City's trees. A more diverse species distribution is desirable to assure biodiversity and health.

1036 Ash Trees

Threatened by Emerald Ash Borer

The 1036 Ash trees identified on public property (and an unknown number of ash trees on private property) are threatened by the invasive insect Emerald Ash Borer. The City is currently using an organic insecticide to treat City-owned ash trees that are healthy enough to treat. A modified strategy that includes additional removals and replacements is recommended, as well as an educational outreach campaign would help raise awareness of this pest.

44% Native

Approximately 44% of the inventoried trees are native to New England, whereas 16% of are invasive species as defined by the Massachusetts Prohibited Plant List. Increasing the proportion of native species and decreasing the proportion of invasive species in the population will be beneficial for the ecosystem.

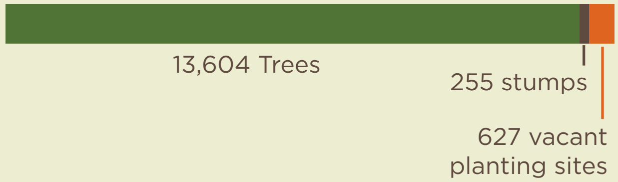
Somerville's street trees provide approximately

$1,047,466

in quantifiable annual ecosystem service benefits.

14,486 sites recorded

A total of 14,486 sites on publicly-owned land were recorded during the 2018 tree inventory: 13,604 trees, 255 stumps, and 627 vacant planting sites.



Municipal Tree Maintenance & Planting Recommendations

The many environmental and economic benefits that trees provide justify the time and money invested in planting and maintenance. Identified maintenance needs for the sites inventoried in 2018 include: tree removal (8% of inventoried sites), stump removal (2% of inventoried sites), tree pruning (64% of inventoried sites), young tree training (19% of inventoried sites), and tree planting (4% of inventoried sites). These needs can be divided into "priority" and "proactive" maintenance.

Priority Maintenance

Maintenance should be prioritized by addressing trees with the highest risk first. High and Moderate Risk trees should be removed or pruned immediately to promote public safety. Low Risk trees should be addressed after all elevated risk tree maintenance has been completed. Trees should be planted to mitigate removals and increase canopy cover.

REMOVAL

Total = 864 trees
High Risk = 11 trees
Moderate Risk = 200 trees
Low Risk = 653 trees
Stumps = 231

PRIORITY PRUNING

Total = 333 trees
High Risk = 8 trees
Moderate Risk = 325 trees

ROUTINE PRUNING CYCLE

Total = 7,593 trees
6-year pruning cycle
Prune ~1,265 trees per year

YOUNG TREE TRAINING CYCLE

Total = 2,483 trees
3-year cycle
Prune ~827 young trees per year

TREE PLANTING

Goal number of trees to plant
= at least 350 per year

Proactive Maintenance

PROACTIVE PRUNING

Somerville's urban forest will benefit greatly from proactive pruning cycles, including a three-year young tree training cycle and a six-year routine pruning cycle. Proactive pruning cycles improve the overall health of the tree population and may eventually reduce program costs by correcting defects in trees before they worsen. Based on inventory data, at least 827 young trees should be structurally pruned each year during the young tree training cycle, and approximately 1,265 trees should be pruned each year during a routine pruning cycle.

TREE PLANTING

Planting trees is necessary to maintain and increase canopy cover, and to replace trees that have been removed or lost to natural mortality (expected to be 1–3% per year) or other threats (for example, construction, invasive pests such as Emerald Ash Borer, or impacts from weather events such as ice, snow, storms, wind, drought and flooding). The City's goal is to plant at least 350 trees of a variety of species each year to offset these losses, increase canopy, and maximize benefits. The City should plant even more trees to increase the urban canopy over the long-term.

Municipal tree planting should focus on planting trees in currently available planting sites along the City-owned rights-of-way, replacing trees that are recommended for removal, as well as establishing new canopy in areas where there are gaps in the existing canopy. Filling in these gaps is very important to reduce the urban heat island effect and mitigate the impacts of climate change, and also to increase habitat connectivity for arthropods and other wildlife.

Tree planting efforts should work towards creating an even distribution of canopy across neighborhoods with different income levels/ racial diversity in order to promote environmental justice. A diversity of tree species should be planted, and the planting list in *Appendix D* offers smart choices for species selection. A high importance should be placed on planting native species as they better support native pollinators and other wildlife.

The City of Somerville recognizes that its urban forest is critical to ecosystem health and economic growth. Planning and action are central to promoting and sustaining a healthy urban forest.

Urban Forest Program Needs

Planned tree planting and a systematic approach to tree maintenance will help ensure a cost-effective, proactive urban forest program. Over the long term, investing in this program will promote public health and safety, improve tree care efficiency, and increase the economic and environmental benefits the community receives from its trees.

Adequate funding will be needed for the City to implement an effective tree management program. The estimated total cost for the first year of this seven-year program is $708,140. This total will decrease to approximately $626,400 for Year 7 of the program.

Somerville has many additional opportunities to improve its urban forestry program. Keeping the tree inventory up-to-date through database management is crucial for making informed management decisions and projecting accurate maintenance budgets. Being prepared for storm events will help ensure public safety and will allow City operations to return to normal more quickly after a storm. Increasing the operational efficiency and effectiveness of the urban forestry program and updating the ordinance and other policies will help to create a more robust urban forestry program. Furthermore, expanding public engagement will help to improve the health and expanse of the entire urban forest, including trees on private property.

The City is fortunate to have a significant tree canopy, dedicated staff and funding for tree management, and strong support for a safe and sustainable urban forest among City staff, residents, and public officials. This City has come a long way in the last few years toward improving its urban forest program, and together we can continue to make it even better!

FY 2021 $708,140

- 11 High Risk Removals
- 8 High Risk Prunes
- 114 Moderate Risk Removals
- 219 Moderate Risk Prunes
- YTT Cycle: 828 Trees
- 350 Trees Recommended for Planting and Follow-Up Care
- $60,000 for Ash Tree Treatments
- $75,000 for Storm Response and Resident Requests
- Newly Found Priority Tree Work (Removal or Pruning): Costs TBD

FY 2022 $718,855

- 86 Moderate Risk Removals
- 41 Low Risk Removals
- 106 Moderate Risk Prunes
- YTT Cycle: 828 Trees
- $100,000 for Routine Pruning of 1/6th of the Tree Population
- 350 Trees Recommended for Planting and Follow-Up Care
- $60,000 for Ash Tree Treatments
- $75,000 for Storm Response and Resident Requests
- Newly Found Priority Tree Work (Removal or Pruning): Costs TBD

FY 2023 $ 686,350

- 100 Low Risk Removals
- YTT Cycle: 827 Trees
- $100,000 for Routine Pruning of 1/6th of the Tree Population
- 350 Trees Recommended for Planting and Follow-Up Care
- $60,000 for Ash Tree Treatments
- $75,000 for Storm Response and Resident Requests
- Newly Found Priority Tree Work (Removal or Pruning): Costs TBD

FY 2024 $ 680,200

- 173 Low Risk Removals
- YTT Cycle: 828 Trees
- $100,000 for Routine Pruning of 1/6th of the Tree Population
- 350 Trees Recommended for Planting and Follow-Up Care
- $60,000 for Ash Tree Treatments
- $75,000 for Storm Response and Resident Requests
- Newly Found Priority Tree Work (Removal or Pruning): Costs TBD

FY 2025 $646,400

- 200 Low Risk Removals
- YTT Cycle: 828 Trees
- $100,000 for Routine Pruning of 1/6th of the Tree Population
- 350 Trees Recommended for Planting and Follow-Up Care
- $60,000 for Ash Tree Treatments
- $75,000 for Storm Response and Resident Requests
- Newly Found Priority Tree Work (Removal or Pruning): Costs TBD

FY 2026 $640,250

- 139 Low Risk Removals
- YTT Cycle: 827 Trees
- $100,000 for Routine Pruning of 1/6th of the Tree Population
- 350 Trees Recommended for Planting and Follow-Up Care
- $60,000 for Ash Tree Treatments
- $75,000 for Storm Response and Resident Requests
- Newly Found Priority Tree Work (Removal or Pruning): Costs TBD

FY 2027 $626,400

- YTT Cycle: 828 Trees
- $100,000 for Routine Pruning of 1/6th of the Tree Population
- 350 Trees Recommended for Planting and Follow-Up Care
- $60,000 for Ash Tree Treatments
- $75,000 for Storm Response and Resident Requests
- Newly Found Priority Tree Work (Removal or Pruning): Costs TBD

INTRODUCTION

The City of Somerville is home to more than 81,360 full-time residents (United States Census Bureau, 2019) who enjoy the beauty and benefits of their urban forest. The City's Public Space & Urban Forestry division and the Department of Public Works manage and maintain trees, stumps and planting sites on City-owned property, including in specified parks, public facilities, and along the street rights-of-way (a total of 12,285 trees, stumps, and planting sites). Funding for Somerville's Urban Forestry program comes from the City's municipal budget and federal funding.

Somerville, with consultant Davey Resource Group (DRG), conducted an inventory of public trees between June 2017 and January 2019 (for ease of interpretation the inventory will hereafter be referred to as the 2018 inventory). Somerville has been a Tree City USA community for 26 years. The requirements for being a Tree City USA include having a tree ordinance, maintaining a budget of more than $2 per capita for tree-related expenses, and celebrating Arbor Day. Past urban forestry projects have demonstrated a desire to improve the environment through higher levels of tree care and have earned the City six (6) Tree City USA Growth Awards.

Approach to Tree Management

The best approach to managing an urban forest is to develop an organized, proactive program using tools (such as a tree inventory and a tree management plan) to set goals and measure progress. These tools can be utilized to establish tree care priorities, build strategic planting plans, draft cost-effective budgets based on projected needs, and ultimately minimize the need for costly, reactive solutions to crises or urgent hazards.

This Urban Forest Management Plan considers the diversity, distribution, and general condition of the inventoried trees, and also provides a prioritized system for managing public trees. This comprehensive management plan includes the following sections:

Section 1:
The Importance of Trees in the City

This section of the Urban Forest Management Plan discusses the benefits of, and the importance of investing in, a healthy urban forest in Somerville.

- *Section 1.1: Somerville's Tree Canopy* presents the extent of the tree canopy cover across the city, and describes the benefits the canopy provides to the city's residents. A canopy cover goal is created based on the available planting space in the city.
- *Section 1.2: Somerville's Street Trees* summarizes the economic, environmental, and social benefits that the City's street trees provide to the community. This section presents statistics of an i-Tree Streets benefits analysis conducted for Somerville.

Section 2:
Somerville's Tree Inventory Data

This section summarizes the 2018 tree inventory data and presents trends, findings, and recommendations. This analysis of Somerville's tree inventory provides insight into the overall health of the City's trees and provides guidance for utilizing the tree inventory data for proactive, data-based management of Somerville's urban forest.

Section 3: Expand, Preserve, and Maintain

This section of the Urban Forest Management Plan provides details and recommendations for expanding the tree canopy through tree planting, performing maintenance on the City's tree population to encourage tree health and public safety, and preparing for current and potential issues that the City's trees may face, like pests and storms.

- *Section 3.1: Tree Planting Plan* provides guidelines for planting new trees in the city, including details on where to focus planting efforts, and best practices for species selection and planting techniques.

- *Section 3.2: Tree Maintenance Program* describes a seven-year tree maintenance program designed to reduce risk through prioritized tree removal and pruning, and to improve tree health and structure through proactive pruning cycles and other urban forest maintenance activities.

- *Section 3.3: Invasive Insect and Disease Management Strategy* provides strategies for managing pests and diseases that may impact the City's urban forest. Emerald Ash Borer is the main focus of this section as it is currently the most damaging and prevalent pest in Somerville.

- *Section 3.4: Storm Preparedness Plan* outlines policies and procedures to aid the City in mitigating, responding to, and recovering from an emergency or natural disaster in a timely manner. This is particularly important in the light of climate change, which is expected to increase storm frequency and severity.

Section 4: The Road Map

This Section of the Urban Forest Management Plan describes current practices and future needs for the City's urban forestry program in terms of operations, funding, policies, and public engagement. This Section should be used as a Road Map for the City to increase operational efficiency, identify additional funding avenues, better protect the cities trees, and advance outreach strategies.

- *Section 4.1: Operations Review* describes the existing urban forestry operations in the City, and suggests goals, guidelines, and specific improvements that, once adopted, will help standardize and optimize the urban forestry program.

- *Section 4.2: Funding Analysis* summarizes current funding level and sources, and compares these levels to the projected costs of completing tree removals, plantings, prunings and other maintenance activities at the suggested rate presented in *Section 3.2*.

- *Section 4.3: City of Somerville Tree Ordinance & Policy Review* assesses Somerville's Tree Preservation Ordinance and other tree management policies, and provides recommendations for improving and building upon these documents.

- *Section 4.4: Public Engagement* reviews current and potential strategies and partnerships for community engagement and resident involvement. Basic public engagement tools and strategies are provided as well as suggestions for specific outreach projects.

Section 5: Action Plan

The Action Plan coalesces all of the recommendations made throughout the Urban Forest Management Plan, and organizes them into short-term, medium-term, and long-term goals. The City aims to implement these strategies over the next 5 to 10 years.

SECTION 1

THE IMPORTANCE OF TREES IN THE CITY

Trees Matter

An urban forest is defined as all of the trees within a municipality or a community. This can include the trees along streets or rights-of-way, in parks and greenspaces, in forests, and on private property. The urban forest plays an important role in supporting and improving the quality of life in a city. As global populations continue to shift to urban areas and the climate continues to change, city dwellers are increasingly aware of the unique challenges of creating and maintaining sustainable environments for people and wildlife. Urban trees are now more important than ever. Trees do more than beautify and provide shade; trees contribute to a community's quality of life.Trees are integral parts of solutions to modern urban challenges and are a major component of urban infrastructure. When properly maintained, trees provide communities with abundant environmental, economic, and social benefits that far exceed the time and money invested in planting, pruning, protection, and removal. This section of the Urban Forest Management Plan discusses the benefits of, and the importance of investing in, a healthy urban forest in Somerville.

Temperature Moderation. The shade provided by trees and the water vapor emitted by tree leaves lower the ambient temperature. The temperature on tree-canopied streets can be 5-15 °F lower than on streets without trees (Miller 1997).

Reduced Energy Consumption and Lower Energy Costs. Trees moderate temperatures in the summer by providing shade and in the winter by acting as windbreaks. By moderating local environmental conditions, trees decrease energy consumption and help people to save on heating and cooling expenses (North Carolina State University 2012, Heisler 1986).

Wildlife Habitat. Trees provide shelter, food, and water for a variety of birds, insects, and small mammals. Connected urban greenways comprised of diverse shade and understory trees provide resources and habitat that help connect wildlife with fragmented urban forests.

Cleaner Air. Trees cleanse atmospheric pollutants (chemicals, particles, etc.), produce oxygen, and absorb carbon dioxide. Trees improve air quality by trapping and holding a significant percentage (up to 60%) of pollen, dust and smoke from the air (Coder 1996).

Reduced Asthma in Children. Cleaner air leads to better respiratory health outcomes for children. Studies have shown that children who live on tree-lined streets have lower rates of asthma (Lovasi 2008).

Prevention of Water Pollution. Aging sewers struggle to keep up with the amount of stormwater during heavy rainfall, which can lead to overflow and pollution of nearby waterways. Trees act as mini-reservoirs, helping to slow and reduce the amount of rainwater in storm drains. One hundred mature trees can intercept 100,000 gallons of rainfall per year (USDA Forest Service 2003).

Erosion Prevention. Trees, particularly tree roots, help stabilize hillsides by reinforcing soil shear strength (Kazutoki and Ziemer 1991).

Higher Property Values. Trees can increase residential property and commercial rental values by an average of 7%. Conversely, values can decline by as much as 20% for properties with no trees (Wolf 2007).

Successful Business Districts. On average, consumers will pay about 11% more for goods in shaded and landscaped business districts (Wolf 1998b, 1999, and 2003). Consumers also feel that the quality of the products is better in business districts having trees (Wolf 1998a).

Better Health. Studies show individuals with views of, or access to, greenspace tend to be healthier. Employees experience 23% less sick time and greater job satisfaction, and hospital patients recover faster with fewer drugs (Ulrich 1984). Trees have also been shown to have a calming and healing effect on ADHD adults and teens (Burden 2006).

Crime Reduction. Apartment buildings with medium to high levels of greenery have been found to have over 40% fewer crimes than apartment buildings without any trees (Kuo and Sullivan 2001a).

Stronger, More Connected Communities. Tree-lined streets can create stronger social ties. In one study, residents of apartment buildings with more trees reported they knew their neighbors better, socialized with them more often, had stronger feelings of community, and felt safer and better adjusted than did residents of more barren, but otherwise identical areas (Kuo and Sullivan 2001b).

Safer Streets. Traffic speeds and the amount of stress drivers feel are reduced on tree-lined streets, which also are likely to reduce road rage/aggressive driving (Wolf 1998a, Kuo and Sullivan 2001b).

Less Noise. Trees help reduce noise levels. A 100-foot wide densely planted tree buffer will reduce noise by 5-8 decibels (Bentrup 2008).

Improving School Performance. Among urban, low-income students, higher tree cover is linked to better school performance on standardized tests (Kuo et al. 2018).

Mitigating Pollinator Decline
Urban forests offer a unique opportunity for ecosystem restoration and pollinator health. Globally, pollinator populations are declining due to habitat loss and high pesticide use. Urban forests can provide habitat and safe passageway for our insects and wildlife (Hall et al. 2016, Theodorou et al. 2020).

1.1

Somerville's Tree Canopy

Assessment & Overview

The City of Somerville spans approximately 2,703 acres to the northwest of the city of Boston and is bordered to the northeast by the Mystic River. Somerville's tree canopy is a vital asset, which provides numerous benefits to city dwellers. By understanding the location of tree canopy throughout the City, municipal leaders can begin to make decisions about where to focus future planting efforts.

Canopy cover measures the amount of land area that is covered by trees, and is assessed by looking down at the ground from the sky (using flyover data from a plane or satellite). Canopy cover is an important metric for a city, as many of the benefits of trees are related to the amount of leaf area a tree provides. Estimates of certain environmental benefits of trees can be quantified using canopy cover data. Additional benefits can be calculated with on the ground information based on a tree inventory.

This section of the Urban Forest Management Plan (UFMP) provides details about the amount of canopy cover in Somerville through an Urban Tree Canopy (UTC) assessment (see *Appendix A* for methodology). The UTC is a broad analysis at the canopy scale which provides a valuable city-wide overview of tree cover. A more detailed analysis of the benefits that street trees provide, based upon Somerville's most recent tree inventory (see *Section 2: Somerville's Tree Inventory Data*), is found in *Section 1.2: Somerville's Street Trees*.

Somerville's UTC assessment determined the location and quantity of the current tree canopy across the entire city based on aerial imagery from 2018, and calculated ecosystem service benefits resulting from this canopy cover. The following pages provide an overview of the UTC process, the assessment results, and recommendations for tree planting and management strategies.

Urban Tree Canopy Assessment Methodology

The UTC assessment used a combination of data sources, tools, and analytical methods, including USDA aerial imagery, remote sensing technology, census data, locally supplied data, and other

scientific methods (see *Appendix A* for more details). Briefly, the UTC assessment was performed as follows:

- Existing tree canopy coverage across Somerville (including public and private land) was determined using aerial imagery. The ecosystem services provided by the current canopy were calculated using i-Tree Canopy and i-Tree Hydro (http://www.itreetools.org).

- An assessment of realistic locations for potential increases in canopy was then made by eliminating impervious areas and water bodies from possible planting areas.

- The potential planting areas were prioritized to provide a way for efficiently achieving canopy goals.

Canopy Cover Overview

The urban tree canopy (UTC) analysis identified five land cover types in Somerville based on 2018 aerial imagery: tree canopy, grass/low vegetation, impervious surfaces (concrete, buildings, and roads), bare soil, and bodies of water ("hydrology") (**Figure 1.1**).

Based on aerial imagery from 2018, **Somerville's tree canopy covers 14.6% of the city (just over 394 acres)**. In comparison to other cities in the region with available canopy cover data, Somerville has relatively low tree canopy cover (**Table 1.1**). The available area for tree canopy is much lower in Somerville than these other cities, which is primarily due to Somerville's higher

Figure 1.1. Somerville 2018 Land Cover

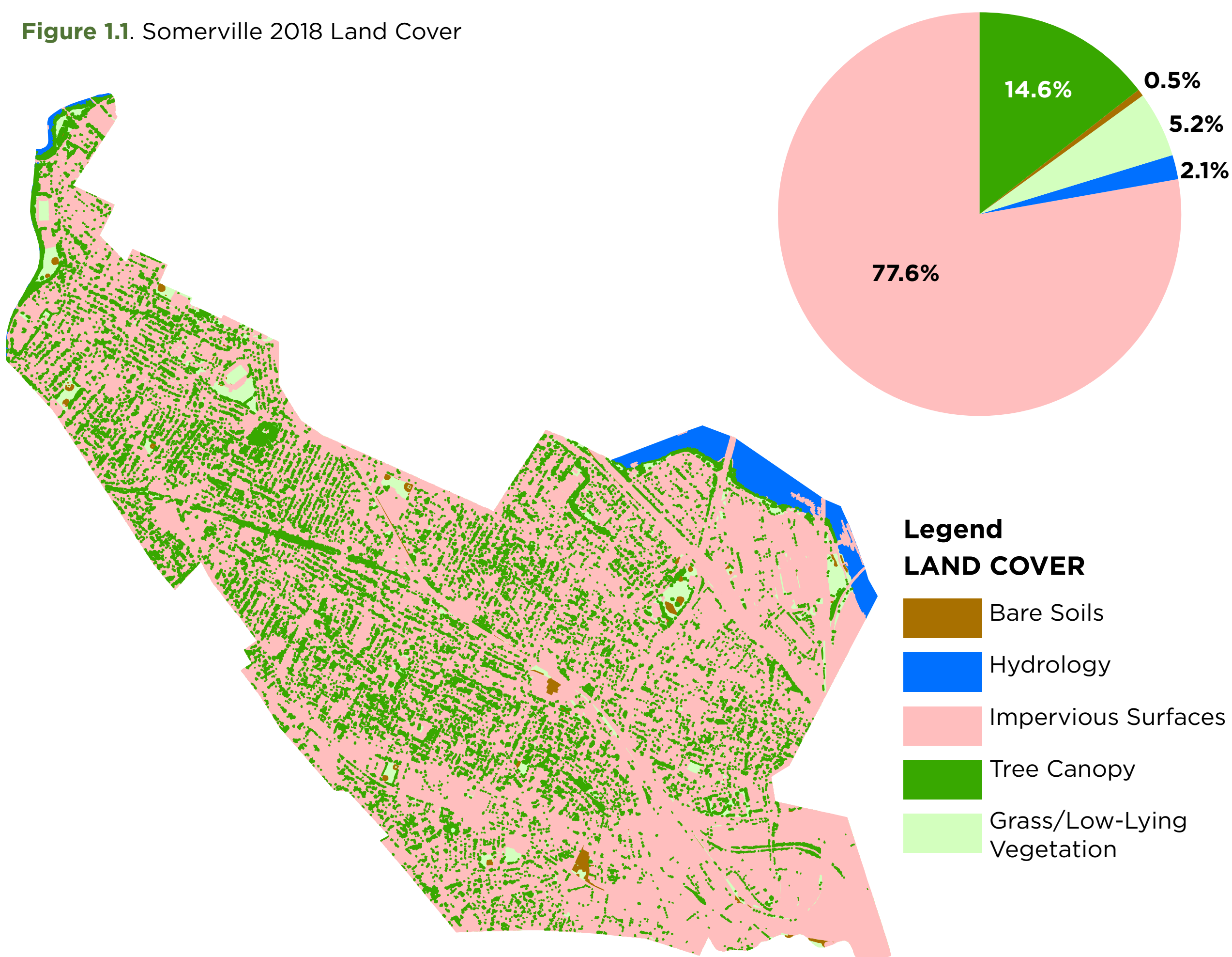


Table 1.1. Canopy Cover in Select New England Cities

	Canopy Cover	Study Area	Year Measured	Population Density (people/sq mi)
Somerville, MA	14.6%	4.2 mi^2	2018	19,893
Providence, RI	24.4%	18.8 mi^2	2015	9,402
Cambridge, MA	25.3%	7.1 mi^2	2018	16,469
Boston, MA	26.5%	48.9 mi^2	2019	13,841
Worcester, MA	40.8%	38.5 mi^2	2015	4,990

density and smaller size. Somerville is the most densely populated city in New England. Compared to Somerville, the larger cities listed in **Table 1.1** have lower percentages of impervious surfaces (buildings, roads, parking lots, etc.), and incorporate large areas of open space and natural/naturalized areas that Somerville does not have access to.

Canopy Cover Measurable Benefits

Various tree canopy assessment and analytical tools were used to quantify and value the ecosystem benefits of Somerville's tree canopy (including public and private trees) (*Appendix A*). These benefits value the trees' ability to store carbon, intercept and absorb stormwater, and clean the air. Whereas these particular benefits can be calculated from tree canopy data, more accurate benefits values can be calculated from data on individual trees. For a more detailed analysis of these and other ecosystem services provided by Somerville's street tree population, see *Section 1.2: Somerville's Street Trees*.

OVERALL BENEFITS

Overall, Somerville's existing canopy provides its residents with almost $283,869 annually in quantifiable benefits related to stormwater runoff reduction, air quality improvements, and carbon sequestration. On top of the annual benefits, the amount of carbon that has been stored over the lifetime of Somerville trees contributes an additional $2.2 million in benefits, bringing the collective benefit amount to $2.4 million. **Table 1.2** details the annual benefits provided by Somerville's tree canopy.

STORMWATER RUNOFF REDUCTION

Trees intercept rainfall by temporarily holing rainwater on leaves and bark, delaying that water from reaching the ground and moderating peak runoff quantities. Tree roots also directly absorb stormwater by consuming water stored in soil pores, thereby increasing the capacity of local soils to store rainwater. Trees in Somerville are able to intercept an impressive 4.36 million gallons of stormwater annually. Based on the U.S. Geological Survey 8-year annual average amount of rainfall in Somerville (an annual average of 54.7 inches between 2005 and 2012), the stormwater reduction rate equates to almost 11,052 gallons of stormwater reduction per acre of tree canopy. This important infrastructure service Somerville trees provide is valued at approximately $174,458.

AIR QUALITY IMPROVEMENTS

Trees absorb gaseous pollutants from the air through the stomata in their leaves. Every year Somerville trees remove huge amounts of pollution from the air, including over 240 pounds of carbon monoxide (CO), 4,160 pounds of nitrogen dioxide (NO2), 17,280 pounds of ozone (O3), 1,185 pounds of sulfur dioxide (SO2) and 2,160 pounds of dust, soot and other "particulate matter" (PM10) (**Table 1.2**). This equates to $21,248 worth of air quality improvements annually. Of these gaseous pollutants, the absorption of ozone pollution provides the greatest monetary benefit value to Somerville residents at $16,042. Reforestation efforts in and around urban areas have been shown to be one of the more cost effective and feasible methods for controlling dangerous ground level ozone, which is known to cause increases in respiratory and cardiovascular diseases and human deaths world-wide (Kroeger et al. 2014). However, it is important to note there are species-specific differences in air filtration and the emission of volatile organic compounds; thus, it is important to select high value species when the goal of a planting effort is to improve air quality. A list of suggested species is provided at the end of this section.

CARBON REDUCTION

Tree leaves absorb carbon dioxide (CO_2) from the atmosphere and turn it into energy through the process of photosynthesis. Carbon is then stored in the living tissues of trees over their lifetimes. The leaves of the trees in Somerville are calculated to absorb over 1,902 tons of CO_2 annually, which is valued at $88,162. Furthermore, the amount of carbon stored in the woody tissue of the living trees in Somerville over their lifetimes is calculated at almost 47,771 tons, which has a value of approximately $2.2 million. These two carbon sequestration avenues represent a total benefit value of $2.3 million. Carbon sequestration in urban environments like Somerville is an important tool for mitigating climate change.

OTHER ECOSYSTEM SERVICE BENEFITS

Trees provide additional important benefits to the people and wildlife of Somerville that are not monetarily quantifiable from tree canopy data. Some of these additional benefits can be calculated from tree inventory data. For details about the monetarily quantifiable ecosystem service benefits that street trees provide, please see *Section 1.2: Somerville's Street Trees*.

Table 1.2. Annual Benefits Provided by Somerville's Tree Canopy (All Public and Private Trees)

Benefit	Quantity	Value
Stormwater: Avoided Runoff	4,361,443 gallons	$174,458
Air Quality: Carbon Monoxide (CO) Removed	240 lbs.	$105
Air Quality: Nitrogen Dioxide (NO2) Removed	4,160 lbs.	$628
Air Quality: Ozone (O3) Removed	17,280 lbs.	$16,042
Air Quality: Sulfur Dioxide (SO2) Removed	1,185 lbs.	$52
Air Quality: Dust, Soot, Other Particles Removed (PM10)	2,160 lbs.	$4,422
Carbon Sequestered	1,902 tons	$88,162
Total Monetary Value		**$283,869**

Trends in Somerville Tree Canopy

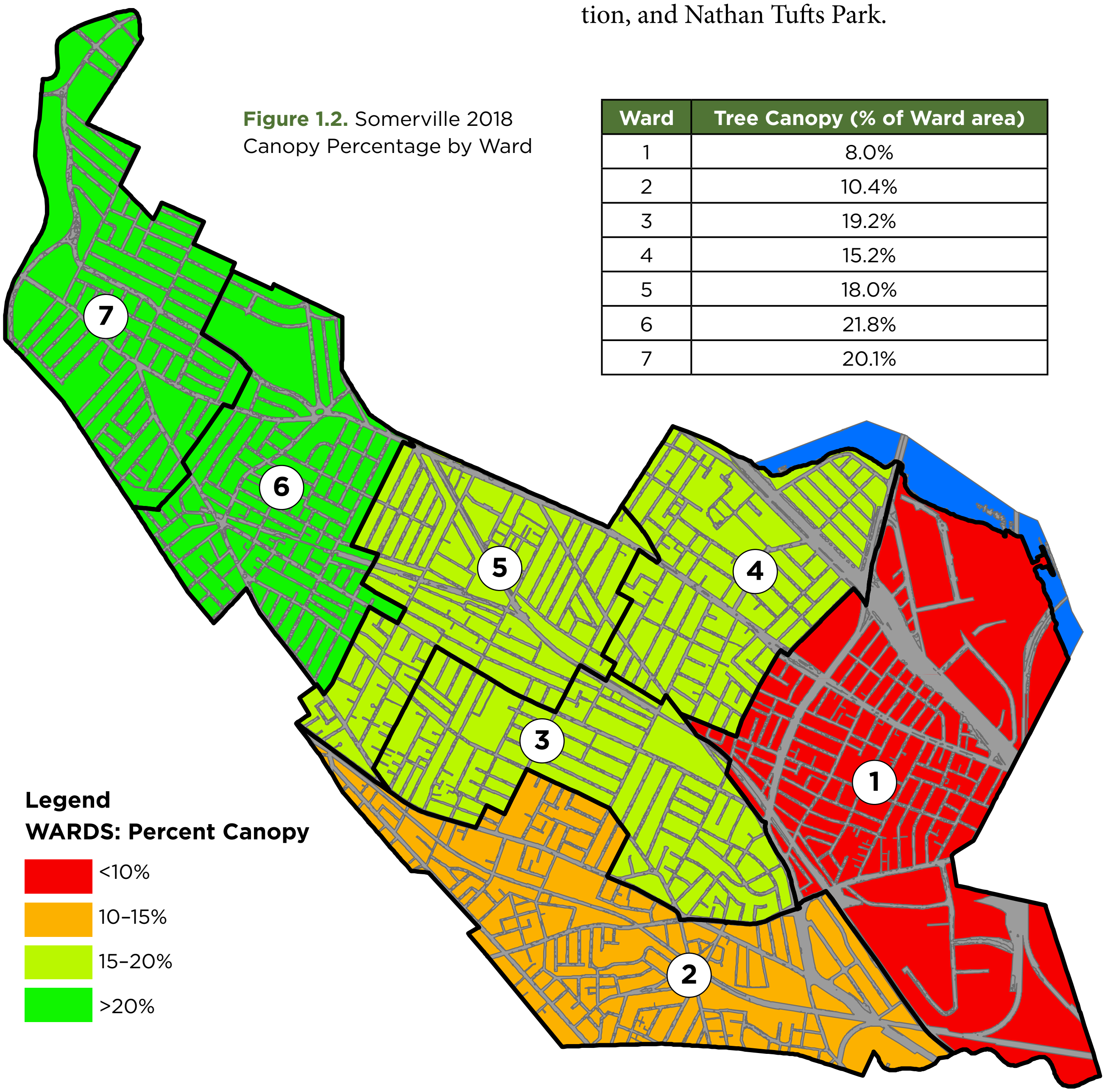
The following sections delve further into the tree canopy data to examine trends across the city. First, canopy cover is assessed by ward. Then, canopy cover is assessed by zoning classification. Finally, the extent of canopy cover in public land is compared to that of private land.

BY WARD

The City of Somerville is divided up into seven wards. Canopy cover varies by ward; the lowest canopy cover is in Ward 1, whereas Wards 6 and 7 have the most canopy cover (**Figure 1.2**). Ward 1 presently consists of industrial areas or previously industrial areas that have historically had little to no canopy. In some of these areas trees are being planted, but as the newly planted trees are still relatively small, they do not yet contribute significantly to the canopy cover. Wards 6 and 7 have some of the City's largest parks and open spaces that are covered by trees, including the Community Path, Alewife Brook Reservation, and Nathan Tufts Park.

Figure 1.2. Somerville 2018 Canopy Percentage by Ward

Ward	Tree Canopy (% of Ward area)
1	8.0%
2	10.4%
3	19.2%
4	15.2%
5	18.0%
6	21.8%
7	20.1%



BY ZONING CLASSIFICATION

Tree canopy coverage was analyzed by zoning classifications from the 2019 Somerville Zoning Ordinance. Eighteen zoning classifications were condensed into six broader categories: Residential Districts, Mid & High-Rise Districts, Commercial Districts, Civic Special District, Other Special Districts, and Rights-of-Way (ROW) (**Figure 1.3**; *Appendix A*). Resulting canopy coverage for each zoning class is shown in **Table 1.3**. Based on the 2018 tree canopy data and the 2019 zoning code, the highest percentages of tree canopy occurred in the Civic Special Dis-

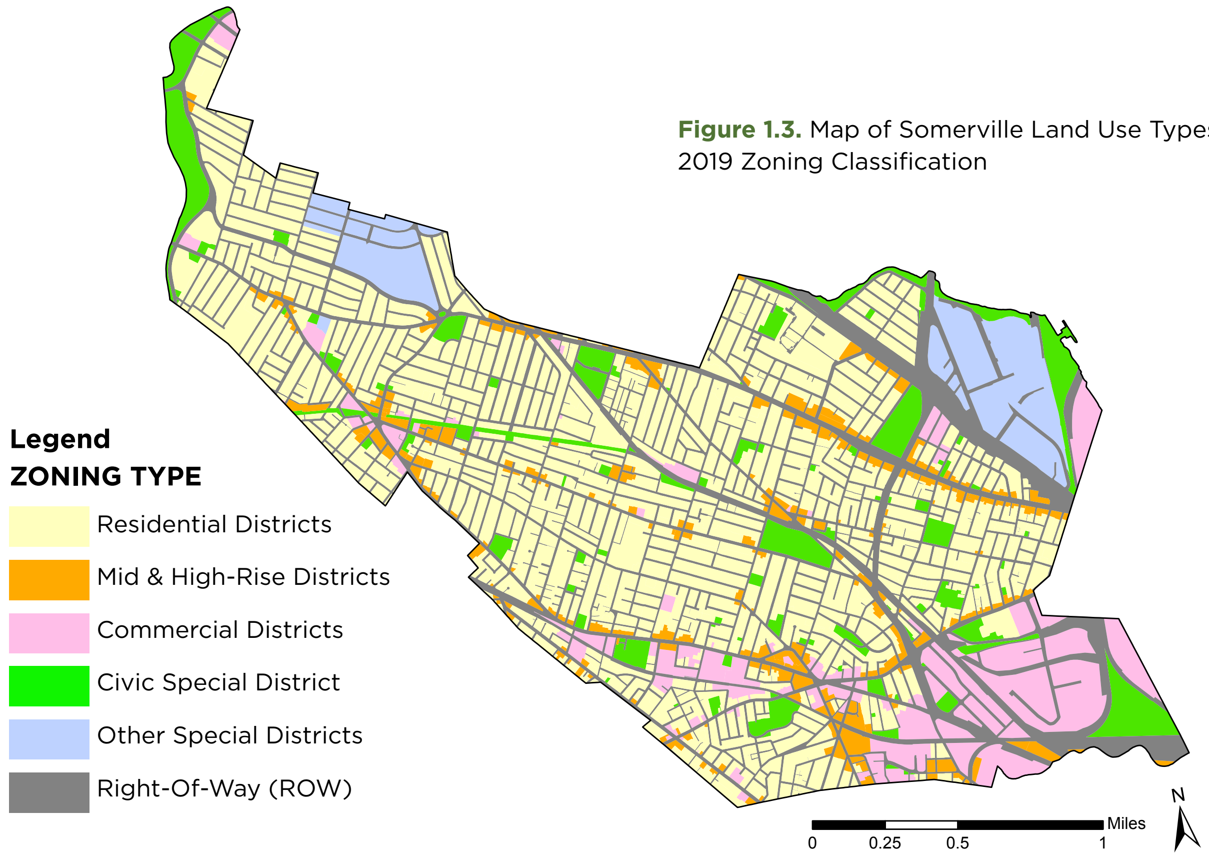


Figure 1.3. Map of Somerville Land Use Types Using 2019 Zoning Classification

Table 1.3. Amount of Tree Canopy and Potential Plantable Space in Somerville by Zoning Type

Zoning Type	Zoning Type Acreage	Percent of Study Area#	Acres of Canopy	Canopy Cover (% of City)	Acres of Potential Plantable Space	Potential Plantable Space (% of zoning type area)
Residential Districts	1210.8	46%	227.0	18.8%	35.2	2.9%
Mid & High-Rise Districts	128.3	5%	10.6	8.3%	3.6	2.8%
Commercial Districts	234.3	9%	8.2	3.5%	6.0	2.6%
Civic Special District*	213.3	8%	50.1	23.5%	29.0	13.6%
Other Special Districts	148.0	6%	12.2	8.2%	17.8	12.0%
Rights-of-Way (ROW)*	708.5	27%	84.5	11.9%	20.3	2.9%

*Indicates zoning types for which the land is primarily City-owned
#Total land area of the City is 4.1 square miles

Overall, Somerville's existing canopy provides its residents with almost $283,869 annually in quantifiable benefits related to stormwater runoff reduction, air quality improvements, and carbon sequestration. On top of the annual benefits, the amount of carbon that has been stored over the lifetime of Somerville trees contributes an additional $2.2 million in benefits, bringing the collective benefit amount to $2.4 million.

trict (23%), which includes parks and other civic spaces in the city. Residential Districts, which encompassed the largest and most predominant land use category (46% of the City), also had relatively high canopy cover (19%). Rights-of-Way, which encompassed 27% of the City, had 12% canopy cover.

Commercial Districts, which include industrial areas such as Brickbottom, contain the lowest percentage of tree canopy cover (3.5%). Recent research has demonstrated that business districts are more successful with tree canopies (Wolf 1998a, 1998b, 1999, and 2003), and thus focusing planting efforts in these areas would be useful, not only for the residents of the city, but also for the businesses. According to the UTC analysis, these Commercial Districts have 6 acres of plantable space available.

Mid & High-Rise Districts and Other Special Districts (which includes Tufts and Assembly Square) have only 8% canopy cover (**Table 1.3**). Other Special Districts and the Civic Special District (which includes parks and other civic spaces) have the highest percentages of potential plantable space. Residential Districts and the Civic Special District have the most acres of potential plantable space available (35.2 and 29.0 acres, respectively), followed by Rights-of-Way (20.3 acres) (**Table 1.3**).

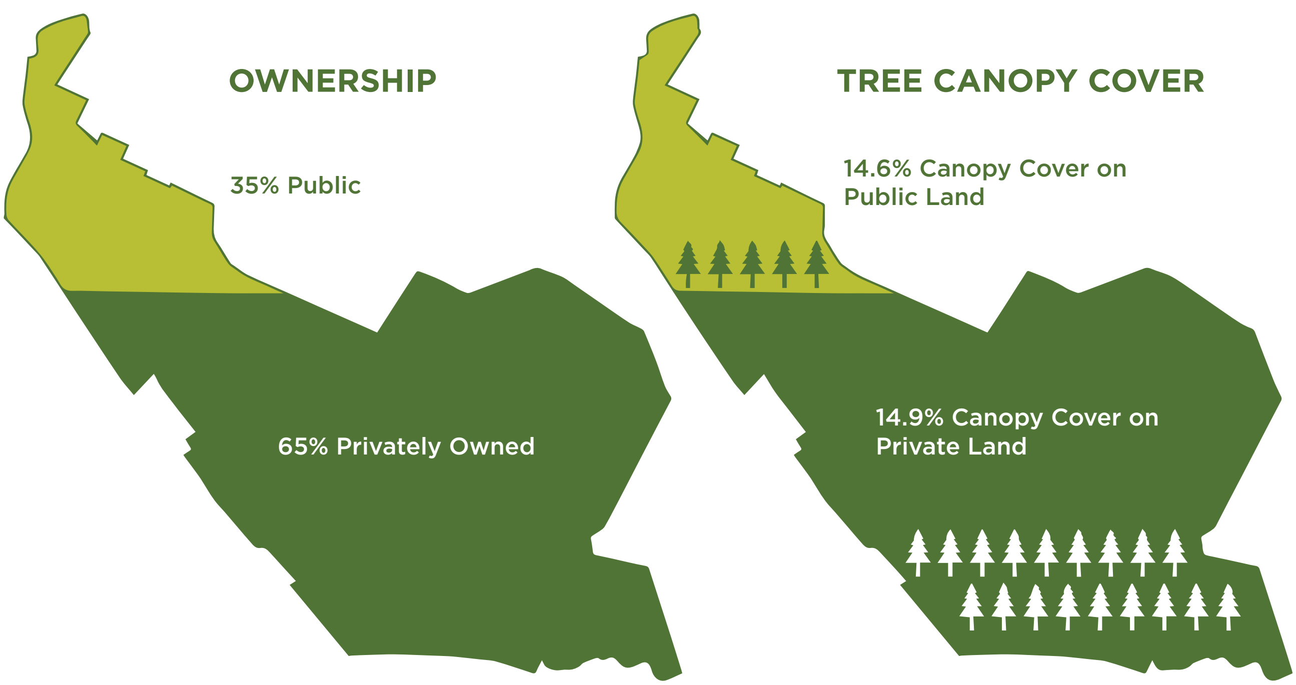
CANOPY COVER ON PUBLIC VERSUS PRIVATE LAND

Areas of the city that are largely City-owned (Civic Special Districts and Rights-of-Way) comprise 35% the land. Conversely, areas of the city that are largely privately-owned comprise 65% of the land. When comparing the publicly- and privately-owned land use categories, the distribution of tree canopy cover is roughly equal (14.6% and 14.9% canopy cover in publicly-owned and privately-owned land, respectively). As the majority of the land in Somerville is privately-owned, that means that the majority of tree canopy in the city is also privately-owned.

Additional plantable area in publicly controlled land totals 49 acres, which is 44% of the available plantable acres across the City of Somerville. The remaining 63 acres of plantable area in the City is on privately owned land, and accounts for 56% of the total available plantable land in the City. This indicates that while significant improvement to Somerville's tree cover can be made by planting on public property, the greatest opportunities for substantial and long-term canopy gains will come through planting efforts on privately-held lands.

Within privately owned land, the land use category with the highest acreage of potential plantable space is Residential Districts, with over 35 acres of potential plantable space. The land use category with the highest percentage of plantable area is Other Special Districts (which includes Tufts and Assembly Square), which has nearly 18 available plantable acres, and which presents an opportunity for a 12% increase in total canopy within that land use category.

When comparing land ownership and tree canopy, the distribution is roughly equal.



While significant improvement to Somerville's tree cover can be made by planting on public property, the greatest opportunities for substantial and long-term canopy gains will come through planting efforts on privately-held lands.

Urban Tree Canopy Goals

Clearly trees in Somerville provide many benefits, and to increase these benefits it is important to expand the canopy at every opportunity. Setting tree canopy and planting goals is an important step in the planning process as it provides metrics to measure performance throughout the coming years. It is essential to create realistic goals and a prioritized plan based on local issues and community values.

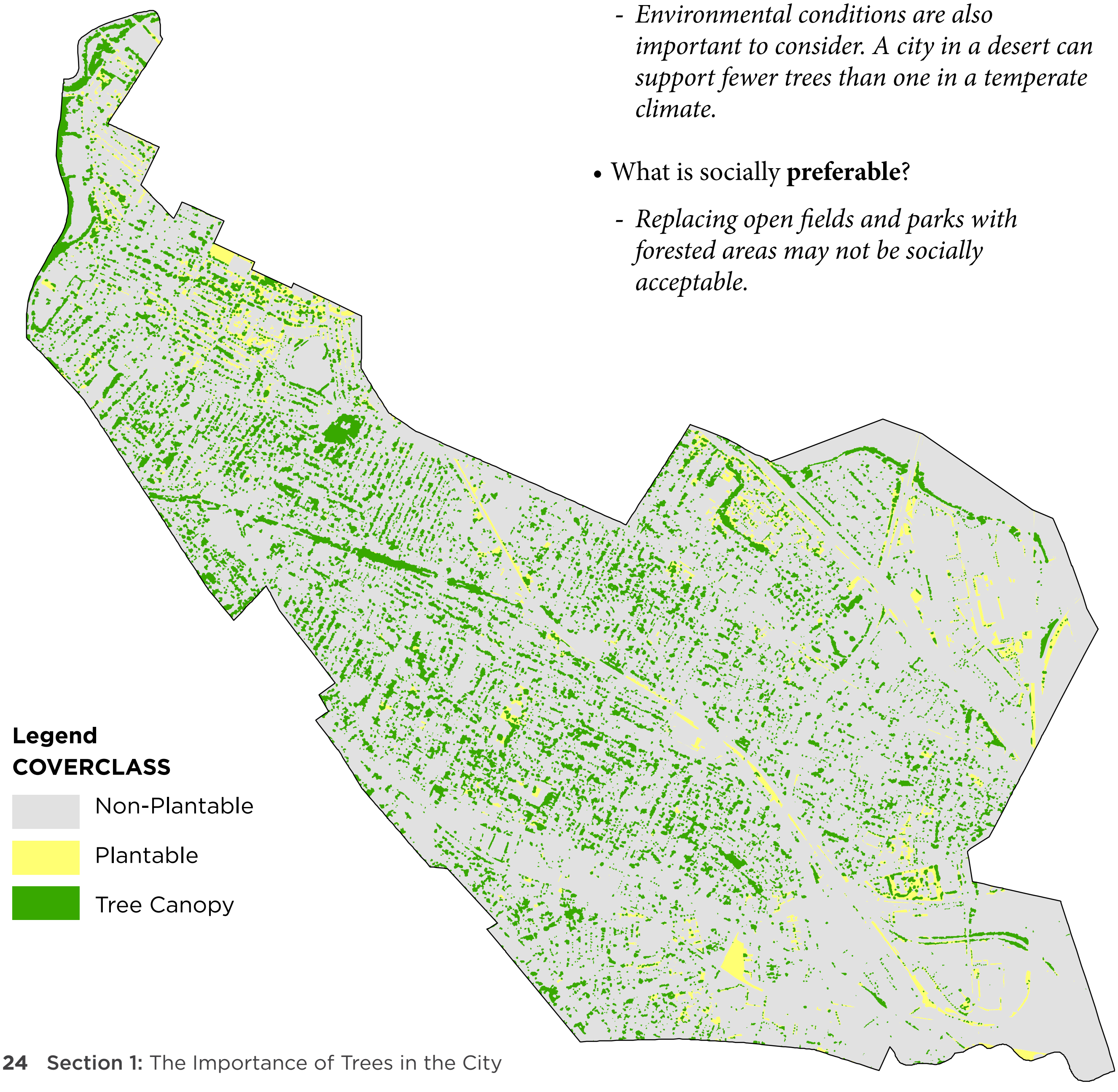


Figure 1.4. Somerville's Potential Plantable Area in Relation to Existing Tree Canopy. See *Appendix I* for Ward-specific maps.

PERCENT CANOPY COVER

What canopy percent to aim for?

The USDA Forest Service, in collaboration with the Davey Institute, has established recommendations for determining an urban tree canopy goal (Leff 2016). These recommendations are based on the following questions:

- What is physically **possible**?
  - *What lands can biologically support trees? If the area is already very densely developed there will be fewer opportunities to increase tree canopy cover.*
  - *Environmental conditions are also important to consider. A city in a desert can support fewer trees than one in a temperate climate.*
- What is socially **preferable**?
  - *Replacing open fields and parks with forested areas may not be socially acceptable.*

- What is the **potential** plantable space?
  - *A high percentage of existing commercial and industrial use will reduce available permeable areas for planting, but land cover can be changed if there are the resources and will to do so.*

Determining realistic and acceptable treecanopy goals for Somerville involves a multi-step process of answering the above questions and identifying an ideal canopy area, while also balancing the City's other community, economic and social goals.

How much canopy is physically possible in Somerville?

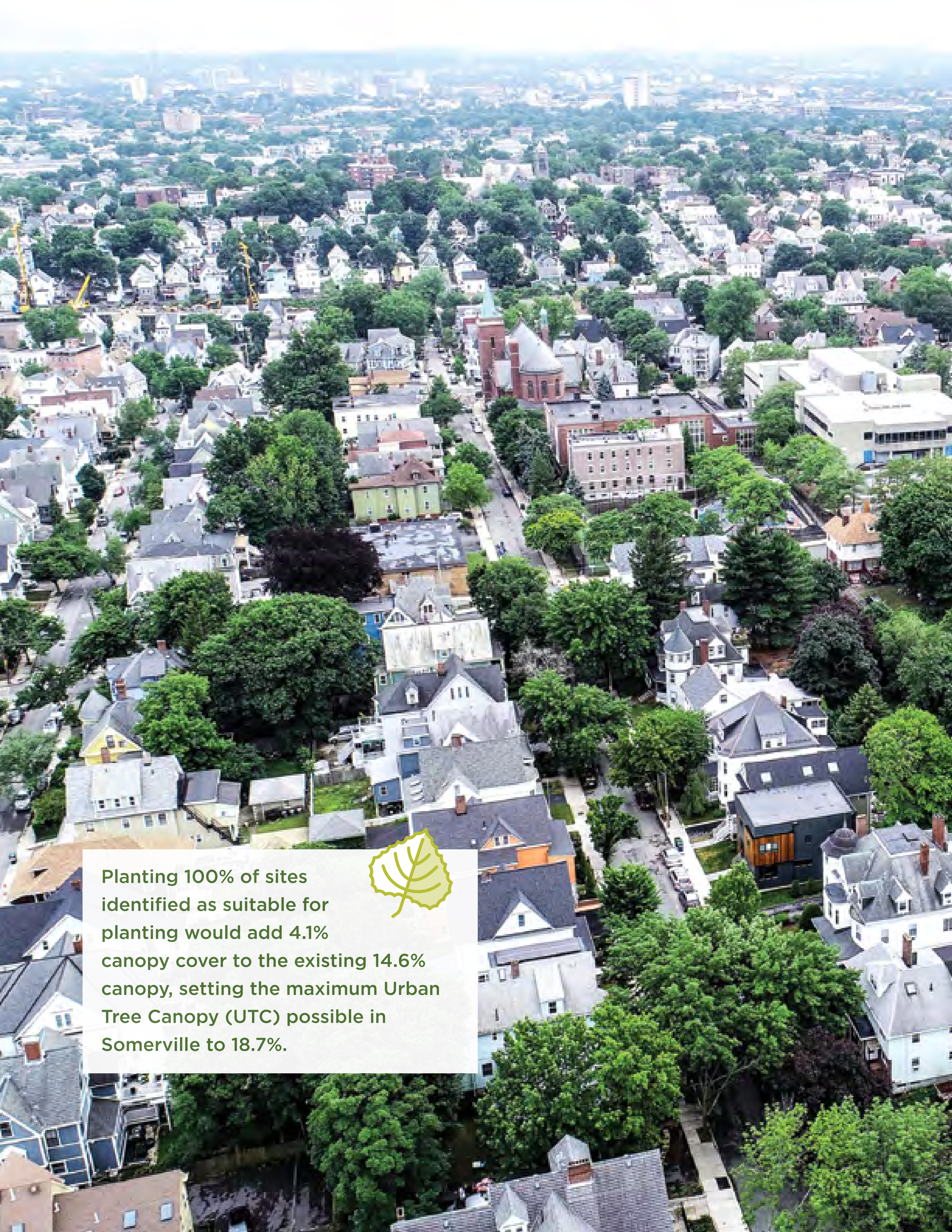
The level of possible canopy is determined by adding the existing canopy to the amount of available planting space in Somerville. This data, while theoretical, is important to have when setting realistic canopy goals. Analysis of available planting space involves more than simply assuming all pervious surfaces currently without trees (grass/low-lying vegetation or bare soil) are potential planting locations. Some pervious surfaces are not suitable for planting (ex. recreational fields, agricultural areas, programmed park areas, cemeteries, and some parts of the rights-of-way).

As a baseline, potential realistic plantable areas are determined by taking all of the pervious surface in the city and excluding those areas unsuitable for planting. The maximum canopy possible is then determined by calculating the resulting canopy if 100% of these suitable planting areas were indeed planted with the largest canopy-producing tree possible for that location. That canopy can then be added to the existing canopy to reach a maximum canopy percentage.

The UTC analysis has identified approximately 112 acres of land in Somerville (including public and private land) that could be planted with trees (**Figure 1.4**). Planting 100% of these sites would add 4.1% canopy cover to the existing 14.6% canopy, setting the maximum UTC possible in Somerville to 18.7%. Due to other competing land use needs across the city, a realistic canopy goal should be lower than this theoretical maximum canopy percentage.

Based on this analysis, the theoretical maximum UTC possible in Somerville is still lower than the current actual canopy cover of the other cities listed in **Table 1.1**. As explained above, Somerville is the most densely populated city in New England. Thus, expecting to reach the same canopy cover as other, less dense cities is unrealistic. To reach similar percentages of canopy as these other cities, Somerville would have to convert built and other impervious surfaces into tree canopy.

Nevertheless, not all impervious areas should be ruled out for planting, as trees can still be added in certain impervious locations (such as sidewalks and parking lot islands). Although a canopy analysis using the methodology described above cannot consider the multitude of factors that go into removing impervious surfaces for the purposes of planting, the City of Somerville should consider using these sorts of areas to increase its maximum tree canopy area in the long term. For example, the City could increase the number of trees planted along streets, and could consider requiring tree cover on surface parking lots.



Planting 100% of sites identified as suitable for planting would add 4.1% canopy cover to the existing 14.6% canopy, setting the maximum Urban Tree Canopy (UTC) possible in Somerville to 18.7%.

What should Somerville's canopy goals be?

Now that the maximum possible canopy has been theoretically identified, realistic canopy goals can be developed. The available land in Somerville must be shared among various stakeholders with various needs and interests. As the most densely populated city in New England, it is not realistic to suggest or recommend that all available pervious surfaces be completely planted. A determination of realistic local goals must be made based on what is spatially, economically, ecologically, and politically feasible for canopy across various land uses and wards. This will require input and support from the public, local leaders, and subject matter experts to set local goals that are based on local values, local environmental and quality of life goals, compliance with federal and local clean air and water regulations, economic development plans, and other community needs. Once realistic goals are determined, the City of Somerville and stakeholders can pursue those goals using policies, procedures, education, incentives, and various funding avenues.

When considering canopy goals, it is also important to consider the replacement of canopy that is being lost. Cities are difficult environments for trees to live in, and mortality rates of 1-3% per year are common. In addition, the invasive pest Emerald Ash Borer (EAB) has been identified in Somerville, which is known to infest all species of ash trees and cause a tree to die in a few short years. Although Somerville has a robust treatment program for public trees, the loss of privately-owned ash trees due to EAB must be considered. The number of privately-owned ash trees is unknown. However, as these trees succumb to the pest, tree replacement planting on a one-to-one ratio or greater is recommended.

CANOPY GOAL

Somerville's goal is to increase the tree canopy across the city. Increasing the city's canopy cover is a long-term goal that results from planting more trees and from promoting the growth and survival of trees that are currently in the landscape.

The City has set a goal of obtaining a canopy cover of 16% citywide, representing a 1.6% increase in canopy cover compared to the 2018 value of 14.6%. This goal is ambitious, but attainable. An increase of 1.6% canopy cover means that an additional 42.3 acres of Somerville's land needs to be covered by tree canopy.

How many trees do we need to plant to reach 16% canopy cover?

Planting trees is an important aspect of growing the canopy, but it can take decades for the full impact of tree planting to be seen and it is difficult to predict the impact of present day plantings on future canopy because a tree's canopy spread grows over time. For example, the average canopy spread for a newly planted 2-inch caliper tree is approximately 20 square feet at the time of planting. Depending on the species, it will take a tree approximately 10–30 years to reach maturity. The average canopy spread for a mature tree is 645 square feet (this also varies by species). Thus, although it would take over 92,000 new 2-inch caliper trees to increase the canopy cover in the city by 42.3 acres, it would only take approximately 2,850 mature trees to reach the same level of canopy cover. The actual number of trees needed to reach 16% canopy cover depends on the species that are planted and their rate of growth, as well as the rate of decline and removal for the current tree population.

Photograph credit, facing page: Victor Nascimento, City of Somerville

Steps for reaching canopy cover goal

It is complicated to determine the exact steps for achieving the 16% canopy cover goal, as there are various factors at play. In general, canopy cover expands through tree planting and tree growth, and canopy cover decreases through tree damage and decline as well as tree mortality and removal. Increasing the city's tree canopy to attain 16% canopy cover will require the involvement of City and its residents. To grow our tree canopy, we must focus on all of the following:

- Plant trees in public spaces and on private property.
- Plant trees in areas that are currently pervious (i.e. the potential realistic plantable areas) and in areas that are currently impermeable (i.e. along streets, in parking lots, etc.).
- Plant large-growing tree species wherever possible.
- Reduce tree loss by improving the maintenance of existing trees, protecting trees from construction, and preserving larger trees.

Variation by Ward

Current and potential canopy cover varies by Ward (**Figure 1.2, Table 1.4**). Planting efforts should focus on Wards 1 and 2, which currently have the lowest canopy cover. However, even if all of the potential plantable space in these two Wards is 100% planted, they will still only have between 12 and 13% canopy cover.

Measuring success

The City should continue to plant as many trees as possible on public property, and encourage tree planting and preservation on private property. The City should also improve maintenance and protection of existing trees to promote health and longevity. As change in canopy cover can take a long time, the City should plan to reassess canopy cover in 2028 (10 years after the current canopy cover analysis) to see how the urban forestry practices are impacting the canopy. This data should be used to assess the effectiveness of the interventions in this plan and to create new ones with the goal of increasing tree canopy.

Table 1.4. Amount of Tree Canopy and Potential Plantable Space in Somerville by Ward.

Ward	Ward Area (acres)	2018 Canopy Cover (acres)	2018 Canopy Cover (%)	Potential Plantable Space (acres)	Maximum Canopy Cover (%)*
1	642.9	51.4	8.0%	29.2	12.5%
2	434.5	45.0	10.4%	11.1	12.9%
3	298.8	57.4	19.2%	5.1	20.9%
4	296.0	45.0	15.2%	11.2	19.0%
5	316.4	56.9	18.0%	5.0	19.6%
6	319.3	69.5	21.8%	10.8	25.1%
7	335.4	67.5	20.1%	15.8	24.9%

*Calculated as the sum of 2018 Canopy Cover + Potential Plantable Space

Current Action Plan

The City of Somerville's current plan of planting an average of 350 trees per year on City-owned property and removing up to 145 trees per year that are dead, dying, or hazardous will result in a net gain of 205 trees per year, on average. By removing dead, dying, and hazardous mature trees (with an average estimated canopy spread of 645 square feet), and replacing them with young trees (with an average estimated canopy spread of 20 square feet), the canopy cover on City-owned property will likely show an initial drop over the next few years. However, as the newly planted young trees grow and mature over the coming decades, Somerville can expect canopy cover to increase within the City-owned areas. Currently the publicly-owned plantable area in Somerville covers 36 acres (or approximately 2,376 medium sized trees). At Somerville's current net rate of tree gain of 205 trees per year, it would take approximately 12 years to completely fill this plantable area. For more details on the City's tree planting and removal plans refer to *Section 3.1: Tree Planting Plan* and *Section 3.2: Tree Maintenance Program*.

As the rates of tree removal and tree planting on private property is unknown, it is unclear how the level tree canopy across the City will change in the future. Creating programs and policies that encourage tree maintenance and tree planting on private property would help to increase tree canopy levels across the city.

UTC Recommendations

Based on this UTC assessment, municipal leaders have set a goal of increasing the amount of tree canopy in Somerville to 16%. Reaching this urban tree canopy goal will be a challenge; however, establishing realistic goals for preserving existing canopy, planting new trees, and harnessing the maximum amount of ecosystem service benefits by planting large growing trees wherever possible are prudent, responsible, and rewarding endeavors.

In the future, Somerville can use this UTC data to explore and understand other patterns in the canopy data. For example, it may be interesting to explore how tree canopy cover relates to environmental problems such as flooding or excessive heat. Additionally, assessing how tree canopy cover varies in relation to the people who reside/work throughout the metropolitan area (socioeconomics and demographics) would provide useful insight for tree planting equity.

1.2
Somerville's Street Trees

Focusing in from a bird's eye view of Somerville's urban canopy to the trees growing along its public streets provides a more nuanced valuation of the city's trees. Street trees, Somerville's largest category of publicly-owned trees, are an important community resource and city infrastructure, whose value increases over time. As described at the beginning of *Section 1: The Importance of Trees in the City,* trees provide numerous benefits such as pollution control, energy reduction, stormwater management, property value increases, wildlife habitat, and aesthetics. Unlike other City infrastructure, as years pass the value of trees and their ability to "work" increases over time.

All of the services and benefits of trees in the urban and suburban setting were once considered to be unquantifiable. However, extensive scientific studies and practical research have led to the development of models that can confidently calculate the value of many ecosystem services using tree inventory information.

The Benefits of Somerville's Street Trees

TREE BENEFIT ANALYSIS

The ecosystem service benefits calculated here are more detailed than the benefits calculated from tree canopy cover in the Urban Tree Canopy (UTC) assessment (see *Section 1.1: Somerville's Tree Canopy*). Here, the tree benefit values for the City of Somerville's street tree population were calculated using the City's 2018 tree inventory data (see *Section 2: Somerville's Tree Inventory Data* for more details about the inventory) and the i-Tree Streets application. The tree inventory contains more detailed descriptions of each tree (species, size, etc.) than the urban tree canopy analysis. Thus, a larger variety of ecosystem service benefits can be calculated from the tree inventory, and the estimates are more accurate.

The i-Tree Streets model estimated that the 9,313 inventoried street trees provide a total annual benefit of $1,047,466. Essentially, this means that if the right-of-way trees in Somerville did not exist, it would cost the City an additional $1,047,466 to provide the same increase in property values, and the same amount of cooling to buildings, stormwater management, and air cleaning. On average, a single Somerville tree provides an annual ecosystem service benefit of $111.29.

I-TREE STREETS OVERVIEW

i-Tree Streets, a component of i-Tree Tools (https://www.itreetools.org/tools), analyzes an inventoried tree population's structure to estimate the costs and benefits of that tree population. The assessment tool creates an annual benefit report that demonstrates the value street trees provide to a community. These quantified benefits and the reports generated include:

Aesthetic/Other Benefits: Shows the tangible and intangible benefits of trees reflected by increases in property values (in dollars).

Stormwater: Presents reductions in annual stormwater runoff due to rainfall interception by trees measured in gallons.

Carbon Stored: Tallies all of the carbon dioxide (CO_2) stored in the urban forest over the life of its trees as a result of sequestration. Carbon stored is measured in pounds and has been translated to tons for this report.

Energy: Presents the contribution of the urban forest towards conserving energy in terms of reduced natural gas use in the winter (measured in therms [thm]) and reduced electricity use for air conditioning in the summer (measured in Megawatt-hours ([MWh]).

CO_2 **Carbon Sequestered:** Presents annual reductions in atmospheric CO_2 due to sequestration by trees and reduced emissions from power plants due to reductions in energy use. This is measured in pounds and has been translated to tons for this report. The model accounts for CO_2 released as trees die and decompose and CO_2 released during the care and maintenance of trees.

Air Quality: Quantifies the air pollutants (ozone [O_3], nitrogen dioxide [NO_2], sulfur dioxide [SO_2], particulate matter less than 10 micrometers in diameter [PM_{10}]) deposited on tree surfaces, and reduced emissions from power plants (NO_2, PM_{10}, volatile organic compounds [VOCs], SO_2) due to reduced electricity use in pounds. The potential negative effects of trees on air quality due to biogenic volatile organic compounds (BVOC) emissions is also reported.

IV **Importance Value (IV):** IVs are calculated for species that comprise more than 1% of the population. The i-Tree Streets IV is the mean of three relative values (percentage of total trees, percentage of total leaf area, and percentage of canopy cover) and can range from 0 to 100, with an IV of 100 suggesting total reliance on one species. IVs offer valuable information about a community's reliance on certain species to provide functional benefits. For example, a species might represent 10% of a population but have an IV of 25% due to its substantial benefits, indicating that the loss of those trees would be more significant than just their population percentage would suggest.

SOMERVILLE'S I-TREE STREETS INPUTS

The City of Somerville's 2018 tree inventory data (see *Section 2: Somerville's Tree Inventory Data*) were used in the i-Tree Streets program to calculate the ecosystem service benefits these trees provide to the residents of the city. The i-Tree assessment was performed only on right-of-way (ROW) data. Although the 2018 inventory also included trees in parks and other public spaces, these trees were excluded from the analysis because the ecosystem service values provided by the i-Tree Streets analysis are specifically calibrated for street trees. For example, the analysis calculates the amount of energy savings that a nearby tree provides to homes and other buildings through shading and windbreaks. As there are no buildings near park trees, the calculated benefits would not be accurate for trees in these areas.

In addition to tree inventory data, i-Tree Streets requires cost-specific information for the community's tree management program—including administrative costs and costs for tree pruning, removal, and planting. Regional data, including energy prices, property values, and stormwater costs, are required inputs to generate the environmental and economic benefits trees provide. When community program costs or local economic data are not available, i-Tree Streets uses default economic inputs from a reference city selected by USDA Forest Service for the climate zone in which your community is located. Any default value can be adjusted for local conditions. Somerville's analysis used the default regional economic inputs for these settings (see *Appendix B*).

i-Tree Tools software was developed by the U.S. Department of Agriculture, Forest Service (USDA FS) with the help of several industry partners, including The Davey Tree Expert Company. Learn more at www.itreetools.org.

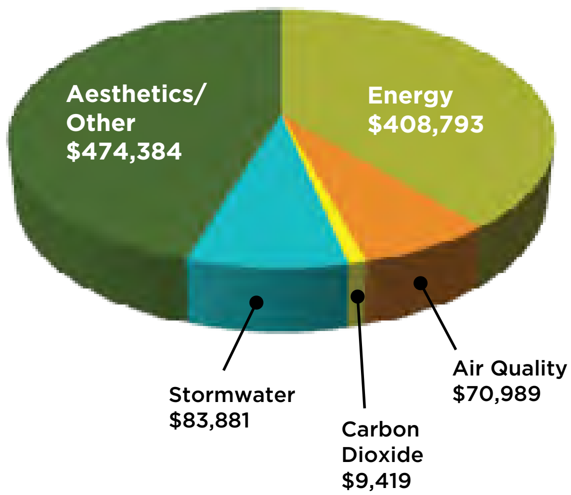
Annual Benefits

The i-Tree Streets model estimated that Somerville's 9,313 inventoried street trees provide a total annual benefit of $1,047,466. Essentially, this means that if the ROW trees in Somerville did not exist, it would cost the City an additional $1,047,466 to provide the same increase in property values, and the same amount of cooling to buildings, stormwater management, and air cleaning. On average, a single Somerville tree provides an annual ecosystem service benefit of $111.29.

Among all quantified ecosystem service benefits, the greatest value of the City's ROW trees comes from aesthetics and other tangible and intangible benefits trees provide that increase property values. These benefits account for 45% of the annual benefits that street trees provide. In addition to increasing property values, trees also play a major role in energy savings, which accounted for 39% of the annual benefits. These

Trees provide significant aesthetic value to the community. Additionally, the tangible services of trees provide quantifiable benefits that justify the time and money invested in planting and maintenance.

Figure 1.5. Total annual ecosystem service benefits provided by Somerville's street trees



energy savings occur both in the summer and the winter, because trees provide shade in the summer and act as windblocks in the winter. Stormwater management comprises an additional 8% of the annual benefits provided by Somerville's street trees. The City's street trees are estimated to intercept 10.5 million gallons of rainfall annually, which equates to a savings of $83,881 in stormwater management costs. Somerville's street trees also improve air quality, both by removing air pollutants from the air and by helping to reduce power plant emissions by reducing electricity use. Air quality improvements account for nearly 7% of the annual benefits the tree provide. Reductions in CO_2 are also important, but account for only 1% of the annual benefits these street trees provide.

Figure 1.5 summarizes the annual benefits and results for the entire street tree population. **Table 1.5** presents results for individual tree species from the i-Tree Streets analysis. The original i-Tree Streets reports can be found in *Appendix B.*

Table 1.5. Ecosystem Service Data for Somerville's Most Common Street Trees by Species

MOST COMMON TREES COLLECTED DURING INVENTORY		Number Trees in the ROW
Common Name	**Botanical Name**	
Norway maple[I]	Acer platanoides	1330
callery pear	Pyrus calleryana	1289
red maple[N]	Acer rubrum	1068
honeylocust[N]	Gleditsia triacanthos inermis	907
littleleaf linden	Tilia cordata	662
green ash[N]	Fraxinus pennsylvanica	654
Japanese zelkova	Zelkova serrata	481
London planetree	Platanus x acerifolia	420
cherry/plum	Prunus spp.	325
Japanese tree lilac	Syringa reticulata	236
kwanzan cherry	Prunus serrulata	203
northern red oak[N]	Quercus rubra	139
hybrid elm	Ulmus x	137
sweetgum[N]	Liquidambar styraciflua	126
white ash[N]	Fraxinus americana	122
pin oak[N]	Quercus palustris	104
hedge maple	Acer campestre	80
other street trees	~99 species	1,029
ROW Total	~116 species on the ROW	9,312

Percent of Total Trees	Canopy Cover	Total Rainfall Interception	BENEFIT PROVIDED BY STREET TREES							IMPORTANCE VALUE (IV)
			Aesthetic /Other	Storm-water	Carbon Dioxide Stored	Energy	Carbon Sequestered	Air Quality	Total Benefits	
(%)	(ft²)	(gal)	AVERAGE $/TREE							0–100 (higher IV = more important species)
14.1	1,014,340	1,677,944	48.49	10.09	13.02	53.40	1.49	9.46	135.96	15.07
13.7	744,830	1,412,916	88.80	8.77	4.98	36.47	1.21	7.39	147.62	12.82
11.3	438,140	964,713	46.37	7.23	3.47	31.41	0.61	5.09	94.17	9.76
9.6	1,037,136	1,616,115	65.78	14.25	9.19	72.06	1.42	12.49	175.20	14.46
7.0	462,989	807,623	30.54	9.76	9.87	49.69	0.94	8.27	109.06	7.50
6.9	582,636	1,028,458	48.10	12.58	5.70	62.87	1.21	11.01	141.46	8.96
5.1	322,920	596,739	77.02	9.92	4.58	56.03	1.10	9.01	157.66	5.57
4.5	321,578	550,456	44.35	10.48	5.19	53.25	1.05	8.48	122.81	5.00
3.5	70,694	102,285	11.07	2.52	3.67	18.38	0.42	2.86	38.92	1.80
2.5	27,249	37,128	9.25	1.26	0.67	10.19	0.20	1.53	23.08	1.07
2.2	37,058	52,205	10.46	2.06	2.23	15.64	0.33	2.41	33.14	1.05
1.5	155,622	283,087	46.90	16.29	20.68	66.14	1.65	11.66	163.32	2.24
1.5	25,606	54,830	57.90	3.20	0.93	14.96	0.35	2.34	79.67	0.87
1.3	44,508	75,821	34.80	4.81	1.78	27.27	0.49	3.22	72.36	0.97
1.3	84,080	151,972	44.71	9.97	5.01	48.91	0.93	8.47	118.00	1.41
1.1	61,478	115,933	50.42	8.92	10.22	34.95	1.01	6.17	111.69	1.10
0.8	20,544	31,788	19.81	3.18	2.76	19.94	0.46	3.24	49.39	0.48
12.0	468,834	925,143	33.05	6.06	4.93	27.05	0.63	4.91	76.63	9.85
100	5,920,243	10,485,157	50.40	8.91	6.88	43.43	1.00	7.54	118.16	100

I Invasive species in Massachusetts
https://www.mass.gov/service-details/massachusetts-prohibited-plant-list

N Native species in Massachusetts
https://plants.sc.egov.usda.gov/

Aesthetic & Other Benefits

Street trees provide important aesthetic and other benefits to residents such as slowing down traffic, and helping to create safer, more connected communities, all of which increase property values. The total annual benefit associated with these tangible and other intangible benefits that result in increasing property values was $474,384. The average benefit per tree equaled $50.40 per year.

Of the various species in the City's ROW, callery pear and Japanese zelkova contributed the most to the aesthetic/other benefits (**Table 1.5**).

Stormwater Benefits

Trees intercept rainfall, which helps lower costs to manage stormwater runoff (**Figure 1.6**). The inventoried ROW trees in Somerville intercept 10,485,157 gallons of rainfall annually (**Table 1.5**). On average, the estimated annual savings for the City in stormwater runoff management is $83,811.

Of all species inventoried, Norway maple contributed the most annual stormwater benefits (due to the large number of Norway maple trees in the inventory). The population of Norway maple (14% of ROW trees) intercepted approximately 1.7 million gallons of rainfall. On a per-tree basis, the highest values are provided by large trees with leafy canopies, such as honeylocust and northern red oak (which comprised 10% and 2% of the ROW population, respectively).

Figure 1.6: How trees reduce water runoff and soil pollutants

- Trees reduce stormwater runoff by capturing and storing rainfall in their canopy and releasing water into the atmosphere.
- Tree roots and leaf litter create soil conditions that promote the infiltration of rainwater into the soil.
- Trees help slow down and temporarily store runoff and reduce pollutants by absorbing nutrients and pollutants from soils and water through their roots.
- Trees remediate soil pollutants by stabilizing them or transforming them into less harmful substances.

Air Quality Improvements

The inventoried ROW tree population removes 14,333 pounds of air pollutants (including ozone, nitrogen dioxide, sulfur dioxide, and particulate matter) annually through deposition. The tree population is also estimated to avoid 8,594 pounds of power plant emissions annually through reduced electricity use.

Although trees do a great deal to absorb air pollutants, they also emit various biogenic volatile organic compounds (BVOCs) such as isoprenes and monoterpenes. These BVOCs can react in the air to form ozone, a harmful gas that pollutes the air and damages vegetation. The i-Tree Streets calculation takes these BVOCs into account when calculating the net air quality benefit the trees provide. The presence of some high BVOC emitter tree species in Somerville (including sweetgum, black gum, sycamore/London plane, and oak [Nowak 2000]) reduces the net air quality benefit of the inventoried population.

Using the annual per-tree values in **Table 1.5,** honeylocust, green ash, and northern red oak had the most impact on air quality, providing benefits ranging from $11.01 to $12.49 per tree.

Carbon Storage and Carbon Sequestration

During photosynthesis, trees absorb carbon dioxide (CO_2) from the atmosphere. This prevents CO_2 from reaching the upper atmosphere, where it can react with other compounds and form harmful gases like ozone, which adversely affects air quality. These trees also sequester some of the CO_2 during growth (Nowak et al. 2013) and store it in their tissues (ex. trunk, stems, roots).

The i-Tree Streets net carbon benefit calculation also takes into account the carbon emissions that are *not* released from power stations due to the heating and cooling effect of trees (i.e., conserved energy in buildings and homes). It also includes a calculation for emissions released during tree care and maintenance, such as driving to the site and operating equipment. Based on all of these factors, the net carbon benefit of the inventoried ROW trees in Somerville is approximately $9,419 per year.

Somerville's street trees store 9,810 tons of carbon (measured in CO_2 equivalents). This amount reflects the amount of carbon they have amassed during their lifetimes. Through sequestration and avoidance, 1,427 tons of CO_2 are removed from the atmosphere or prevented from being produced each year. On a per tree basis, silver maple provided the most carbon benefits, with each tree storing an average of $44.02 and sequestering a net average of $1.85 worth of carbon per year (*Appendix B*).

A common example of a natural biogenic volatile organic compounds (BVOC) is the gas emitted from pine trees, which creates the distinct smell of a pine forest.

Trees improve quality of life and help enhance the character of a community. Trees filter air, water, and sunlight, moderate local climate, slow wind and stormwater, shade homes, and provide shelter to animals and recreational areas for people.

Energy Benefits

Public trees conserve energy by shading structures and surfaces, which reduces electricity use for air conditioning in the summer. Trees also divert wind in the winter to reduce natural gas use. Based on the inventoried trees, the annual electric and natural gas savings are equivalent to 620 MWh of electricity and 228,644 therms of natural gas, which accounts for an annual savings of $408,793 in energy consumption citywide.

Norway maple contributed an average of $53.40 per tree to the annual energy benefits of the urban forest, but its contribution was mostly due to its dominance on the streets (**Table 1.6**). Other tree species, specifically honeylocust and northern red oak, contributed more to energy usage reduction on a per-tree basis. The annual value these trees provide exceeds $66 per tree, although they comprise only 9.6% and 1.5% of the population, respectively. The large leafy canopies of honeylocust and northern red oak are valuable because of the shade they provide, which reduces energy usage. Smaller trees inventoried, such as Japanese tree lilac and cherry/plum species, were found to have smaller reductions in energy usage on a per-tree basis.

Importance Value (IV)

The importance of a tree species to the community is based on its abundance in the ROW and its ability to provide environmental and economic benefits to the community. To calculate a species' IV value, the i-Tree Streets model takes into account the total number of trees of that species (percentage of the total street tree population),

Table 1.6. Energy Benefits of Specific Tree Species in Somerville (Norway maple, callery pear, honeylocust, and northern red oak).

***Acer plantanoides* (Norway maple)**	***Pyrus calleryana* (callery pear)**	***Gleditsia triacanthos inermis* (honeylocust)**	***Quercus rubra* (nothern red oak)**
14.1% of ROW	13.7% of ROW	9.6% of ROW	1.5% of ROW
107 MWh Electricity	78 MWh Electricity	103 MWh Electricity	14 MWh Electricity
39,849 thm Natural Gas	25,673 thm Natural Gas	36,148 thm Natural Gas	5,105 thm Natural Gas
$53.40 Average $/tree	$36.47 Average $/tree	$72.06 Average $/tree	$66.14 Average $/tree

and its total leaf area and canopy cover. The IV can range from 0 to 100, with an IV of 100 suggesting total reliance on one species. If IV values are greater or less than the species' percentage in the ROW, it indicates that the loss of that species may be more important or less important than its population percentage implies.

The i-Tree Streets assessment found that Norway maple has the greatest IV in the ROW population at 15.1 (**Table 1.5**), primarily because it comprises the largest percentage of the population (14.7% of the ROW). Although Norway maple is an invasive species in Massachusetts and is on the Massachusetts Prohibited Plant List (https://www.mass.gov/service-details/massachusetts-prohibited-plant-list), the high IV of Norway maple in Somerville indicates that the loss of this species would be economically detrimental to the City and its residents. The second highest IV was for honeylocust (14.5), followed by callery pear (12.8), and red maple (9.8) (**Table 1.5**). The IV of honeylocust is greater than callery pear, even though it is less abundant (9.6% versus 13.7% of the population). Species with larger canopies provide more environmental benefits to the community. Honeylocust is larger growing than callery pear, which explains its higher IV.

DISCUSSION & RECOMMENDATIONS

The i-Tree Streets analysis found that Somerville's right-of-way trees provide numerous environmental and economic benefits to the community. The aesthetic/other benefits provided by ROW trees were rated as having the greatest value to the community. The property value increase provided by trees is important to stimulate economic growth. In addition to increasing aesthetics and property values, trees manage stormwater through rainfall interception, provide shade and windbreaks to reduce energy usage, and store and sequester CO_2. Even though these environmental benefits were not found to be as great as the aesthetic/other benefits, they are noteworthy. In Somerville, 9,313 ROW trees absorb over 10.48 million gallons of rainfall annually, reducing runoff during storm events. While air quality is impaired by the number of high BVOC-emitting trees, this effect can be offset in the future by smart tree-planting efforts. Some of the highest BVOC producing species are sweetgum, black gum, sycamore/London plane, oak, poplar, black locust, and willow. Conversely, some species that produce very low levels of BVOCs and actually help lower ozone levels are mulberry, cherry, linden, and honeylocust.

The i-Tree Streets analysis demonstrated that Norway maple is the most influential tree along Somerville's ROW. If this species were lost to Asian longhorned beetle (*Anoplophora glabripennis*) or other threats, it would be a significant loss for the community.

To increase the benefits the urban forest provides, the City should plant young, large-statured tree species that are low emitters of BVOCs wherever possible. Leafy, large-stature trees consistently created the most environmental and economic benefits. **The following list of tree species are recommended for improving air quality (Bell and Wheeler 2006):**

- *Betula nigra* (river birch)
- *Celtis laevigata* (sugar hackberry)
- *Fagus grandifolia* (American beech)
- *Metasequoia glyptostroboides* (dawn redwood)
- *Tilia cordata* (littleleaf linden)
- *Tilia x europea* (European linden)
- *Tilia tomentosa* (silver linden)
- *Ulmus americana* (American elm)
- *Ulmus procera* (English elm)

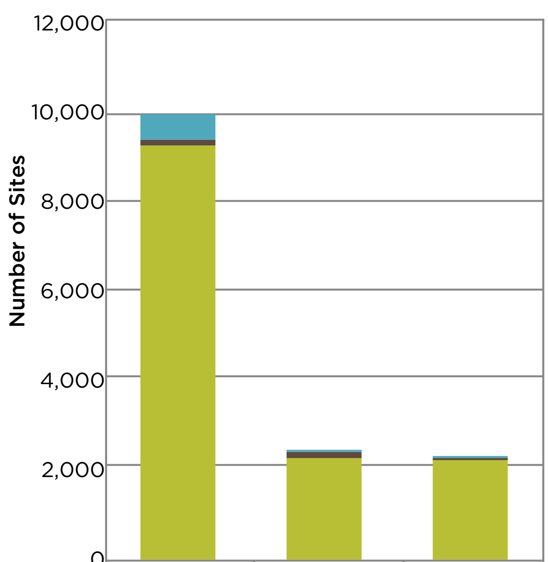
For a comprehensive planting plan for the City, see *Section 3.1: Tree Planting Plan*. See *Appendix D* for additional tree species recommendations.

River Birch at Ed Leathers Park in Somerville.

SECTION
2

SOMERVILLE'S TREE INVENTORY DATA

Somerville's trees provide numerous benefits to the City's residents, as described in *Section 1: The Importance of Trees in the City*. In order to better plan for, manage, and protect the urban forest, it is important to understand exactly what species of trees are growing in the city, where trees are located, and the site conditions that Somerville's trees are surviving in. This data is crucial for making decisions about the planning and care of a healthy tree canopy. It can be also used to educate City officials and residents toward a better understanding of the urban forest.



	Street	City Open Space	State Land
Vacant Sites	567	3	57
Stumps	105	126	24
Trees	9,313	2,171	2,120

Figure 2.1. Sites assessed during the Somerville 2018 tree inventory.

2018 SOMERVILLE TREE INVENTORY

From June 2017 through January 2019, City staff worked with arborists from Davey Resource Group (DRG) to inventory and assess trees, stumps, and currently available planting sites across all areas of Somerville's public property, including along the street "rights-of-way" (ROW), in all City-owned parks, in the areas around public buildings, and in State-owned open spaces. For simplicity, this inventory is hereafter referred to as the "2018 tree inventory". The 2018 tree inventory is the City's first comprehensive tree inventory since 2009 (Davey Resource Group, 2009). A total of 14,486 sites were assessed during the inventory: 13,604 trees, 255 stumps, and 627 vacant planting sites (planting sites were only inventoried on what was currently available along the ROW). Of the 14,486 sites collected, 69% were collected along the street ROW, 16% were collected in City-owned open spaces (parks and public buildings), and the remaining 15% were collected in State-owned property. **Figure 2.1** provides a detailed breakdown of the number and type of sites inventoried. Note that 37% of the open space in Somerville is City-owned, 51% is State-owned, and 12% is Privately-owned (City of Somerville, 2017).

INVENTORY DEFINITIONS & METHODOLOGY

A "tree" is defined as a perennial woody plant that can grow more than 20 feet tall. Characteristically, it has one main stem, although many species may grow as multi-stemmed forms. A "street tree" is further defined as a tree growing within the public right-of-way (ROW). The right-of-way is defined as a strip of land generally owned by a public entity over which facilities, such as highways, railroads, or power lines, are built. The street trees may be growing in sidewalks, tree lawns or parkways, islands, or medians. A "city open space tree" is defined as a tree growing in a City-owned park or public space, or on City-owned property such as municipal building lots or other facilities.

ISA Certified Arborists inventoried trees along street ROW and in community parks to collect information about trees that could be used to assess the state of the urban forest.

The inventory also included trees on State-owned land (including State-owned parks, public space, and rights-of-way). For the purpose of managing trees, sometimes the information about trees on State-owned land will be excluded from the management plan details as the City has no jurisdiction over what is done in these State-owned areas.

See *Appendix C* for a complete list of the City-owned open spaces and State-owned lands that were inventoried as well as additional details on data collection and site location methods.

Tree Inventory Assessment

Assessment Criteria

Recognizing trends in the tree inventory data can help guide short-term and long-term management planning. Data analysis and professional judgment were used to make generalizations about the state of the inventoried tree population. In this plan, the following criteria and indicators of the inventoried tree population were assessed:

- ***Species Diversity***, the variety of species in a specific population, affects the tree population's ability to withstand threats from invasive pests and diseases. Species diversity also impacts tree maintenance needs and costs, tree planting goals, and canopy continuity.

- ***Species Origin*** indicates whether the species is native to Massachusetts. Species that are native to an area tend to support more native pollinators and wildlife which helps to balance the ecosystem. Invasive species are particularly prolific non-native species that can significantly disrupt the ecosystem.

- ***Diameter Size Class Distribution***, the statistical distribution of a given tree population's trunk-size class, is used to indicate the relative age of a tree population. The diameter size class distribution affects the valuation of tree-related benefits as well as the projection of maintenance needs and costs, planting goals, and canopy continuity.

- ***Condition***, the general health of a tree population, indicates how well trees are performing given their site-specific conditions. General health affects both short-term and long-term maintenance needs and costs as well as canopy continuity. Condition was further separated out in the inventory by canopy condition (full leaf area to dead), and wood condition (strong/no decay to dead). These condition ratings were then combined to create an overall condition of the health of the tree.

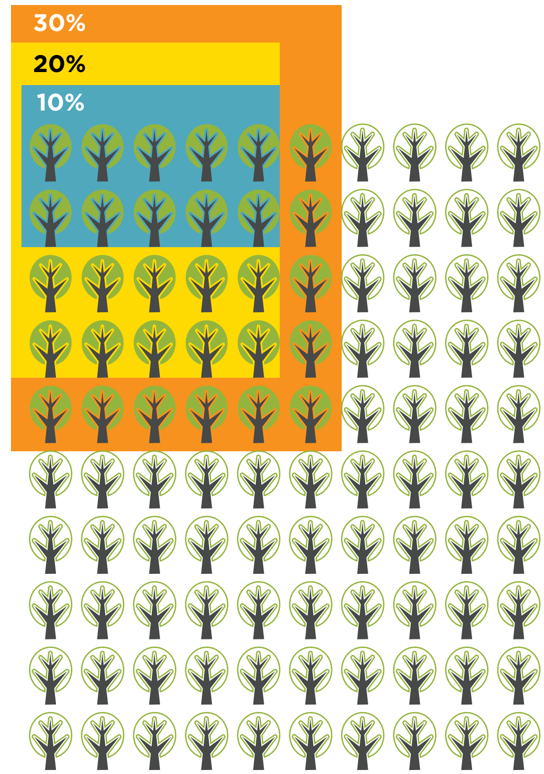
- ***Other Observations*** include the analyses of other types of inventory data that provide insight into past maintenance practices and growing conditions; such observations may affect current maintenance practices and future management decisions. Examples of "Other Observations" include infrastructure conflicts, growing space type, and site observations.

- ***Further Inspection*** indicates whether field observations led to a conclusion that a particular tree requires additional inspection, such as a Level III risk inspection in accordance with *ANSI A300, Part 9* (ANSI 2011), or periodic inspection due to particular conditions that may cause the tree to be a safety risk and, therefore, hazardous.

Species Diversity

Species diversity affects maintenance costs, planting goals, canopy continuity, wildlife habitat, and the City's ability to respond to threats from invasive pests or diseases. Low species diversity (large number of trees of the same species) can lead to severe losses in the event of species-specific epidemics, such as the devastating results of Dutch elm disease (caused by *Ophiostoma novo-ulmi*) throughout New England and the Midwest (see **Box 2.1**).

The best practice for the composition of an urban forest tree population is to follow the **"10-20-30 Rule"** for species diversity. This rules states that a single species should represent no more than 10% of the urban forest, a single genus no more than 20%, and a single family no more than 30% (Richards, 1983).



The 10-20-30 rules states that a single species should represent no more than 10% of the urban forest, a single genus no more than 20%, and a single family no more than 30%

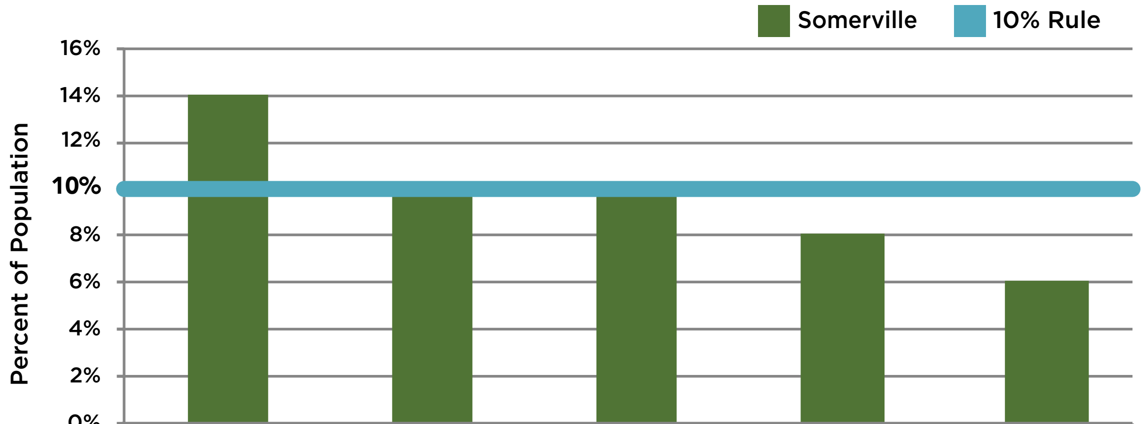
FINDINGS

Figure 2.2 uses the 10% Rule to compare the percentages of the most common species identified in the tree inventory (which is not a comprehensive analysis of the city's true biodiversity as the inventory did not include trees on private property). *Acer platanoides* (Norway maple) exceeds the recommended 10% maximum for a single species in a population, comprising 14% of the inventoried tree population. Additionally, *Pyrus calleryana* (callery pear), and *Acer rubrum* (red maple) are at the 10% threshold.

Figure 2.3 uses the 20% Rule to compare the percentages of the most common genera identified in the inventory. *Acer* (maple) comprises 28% of the inventoried tree population, thus exceeding the recommended 20% maximum for a single genus.

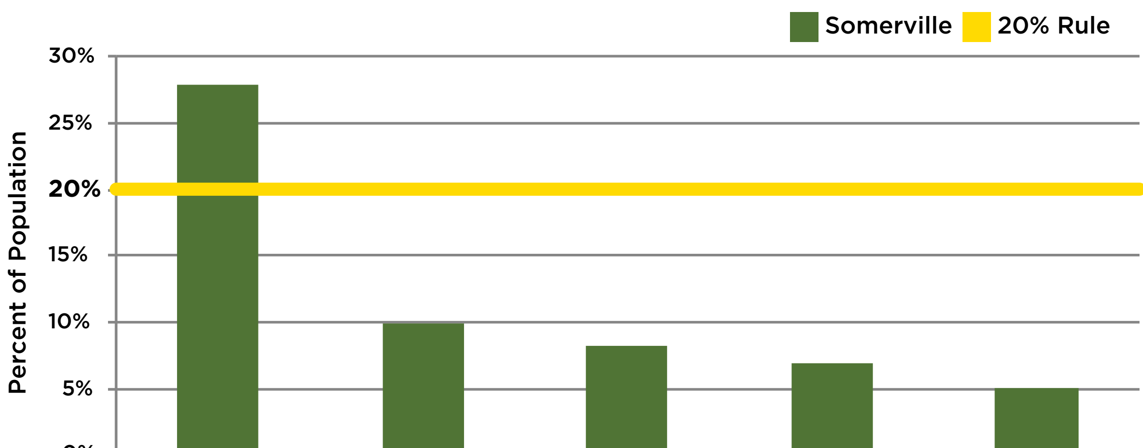
Figure 2.4 uses the 30% Rule to compare the percentages of the most common families identified in the inventory. No family of trees exceeds the recommended 30% maximum. However, *Aceraceae* (maple family) is approaching this threshold as it currently comprises 28% of the inventoried tree population. The other most common families in the inventory include *Rosaceae* (rose family), *Fabaceae* (legume family), *Oleaceae* (olive family), and *Ulmaceae* (elm family).

Figure 2.2. Five most abundant species of the inventoried population compared to the 10% Rule.



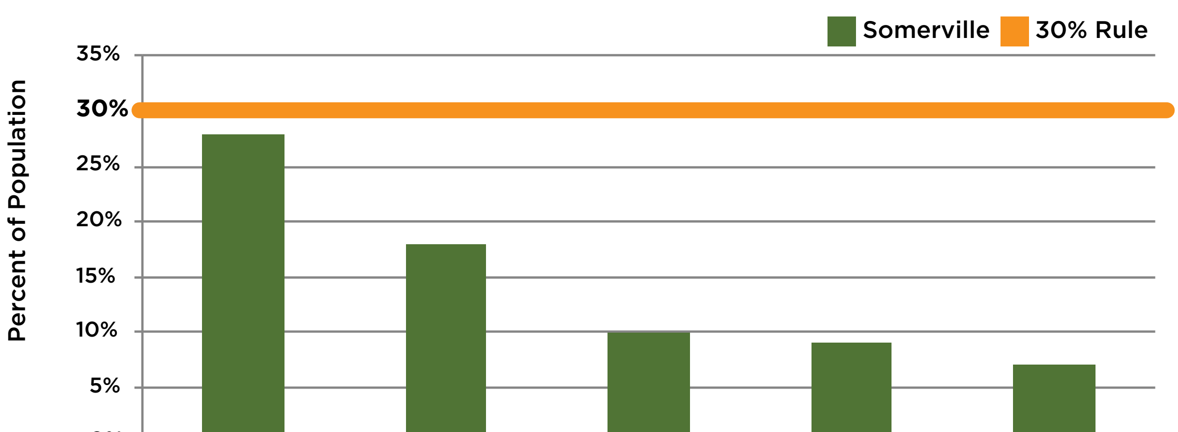
	Norway maple *Acer platanoides*	callery pear *Pyrus calleryana*	red maple *Acer rubrum*	honeylocust *Gleditsia triacanthos inermis*	littleleaf linden *Tilia cordata*
Somerville	14%	10%	10%	8%	6%

Figure 2.3. Five most abundant genera of the inventoried population compared to the 20% Rule.



	Acer spp. (maple)	*Pyrus* spp. (pear)	*Gleditsia* spp. (honeylocust)	*Fraxinus* spp. (ash)	*Prunus* spp. (cherry)
Somerville	28%	10%	8%	7%	5%

Figure 2.4. Five most abundant families of the inventoried population compared to the 30% Rule.



	Aceraceae (maple family)	*Rosaceae* (rose family)	*Fabaceae* (legume family)	*Oleaceae* (olive family)	*Ulmaceae* (elm family)
Somerville	28%	18%	10%	9%	7%

BOX 2.1

Dutch Elm Disease

Due to the spread of Dutch elm disease in the 1930s, combined with the disease's prevalence today, massive numbers of *Ulmus americana* (American elm), a popular street tree in New England cities and towns, have perished (Karnosky 1979). Several communities were stripped of most of their mature shade trees, creating a drastic void in canopy cover. Many of these communities have replanted to replace the lost elm trees. Ash and maple trees were popular replacements for American elm in the wake of Dutch elm disease. Unfortunately, some of the replacement species for American elm trees are now overabundant, causing a new biodiversity concern. Emerald ash borer (EAB, *Agrilus planipennis*) and Asian longhorned beetle (ALB, *Anoplophora glabripennis*) are non-native invasive insect pests that attack some of the most prevalent urban shade trees and certain agricultural trees throughout the country.

This Elm tree at Prospect Hill Park was one of the last remaining American Elm trees in the City. It was diagnosed with Dutch Elm Disease in 2019 and treated to help it survive for as long as possible. Sadly, it succumbed to the disease in 2020 and was removed.

DISCUSSION & RECOMMENDATIONS

Acer platanoides (Norway maple) dominates the streets and parks of Somerville. It was overplanted in the past because it tolerates urban conditions well and grows quickly. This is a biodiversity concern not only because its abundance in the landscape makes it a limiting species, but also because it can out-compete other trees and make it difficult for other plants to establish. In 2005 Norway maple was characterized as an invasive species in the State of Massachusetts, and it is thus banned from import, sale, or trade (https://www.mass.gov/massachusetts-prohibited-plant-list).

Pyrus calleryana (callery pear) and *Acer rubrum* (red maple) are also abundant in the City, and thus future planting of these species should be limited. Similar to Norway maple, callery pear was heavily planted in the past due to its tolerance of urban conditions, as well as the beautiful white blossoms it produces in the spring. However, due to the poor canopy structure that often results in large limb breakage, the City has not planted callery pear trees for a number of years.

Continuing to plant a diversity of tree species is an important objective that will ensure Somerville's urban forest is sustainable and resilient to future invasive pest infestations.

The City should severely limit the number of maple trees it plants. The City's tree population contains an overabundance of trees in the maple genus, primarily due to the high abundance of Norway maple and red maple. Maple trees are susceptible to the invasive species ALB and potentially the invasive species spotted lanternfly (*Lycorma delicatula*) (see *Section 3.3: Invasive Insect and Disease Management Strategy*). The planting of *Acer* (maple) should be limited to minimize the potential for loss in the event that ALB or spotted lanternfly threaten Somerville's urban tree population.

A species-diverse tree canopy has many benefits

Saves money | **Improves canopy health** | **Reduces infestations** | **Increasess resilience**

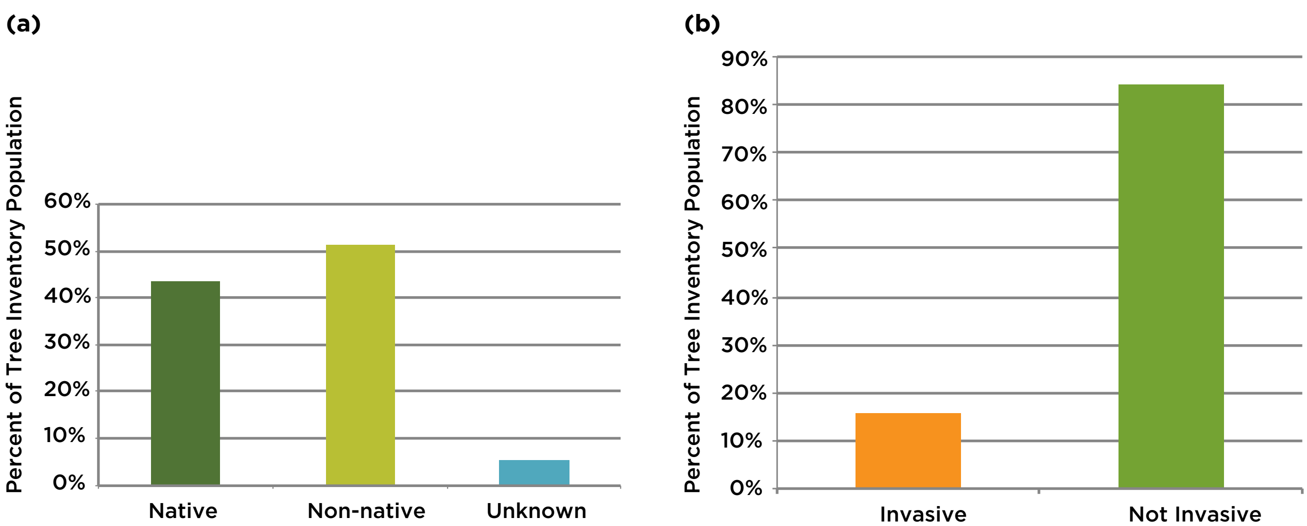
Species Origin and Invasive Species

Species origin and whether or not the species is invasive are also important aspect of species diversity that impacts the ecosystem at large. A native plant species is defined as "a plant that is a part of the balance of nature that has developed over hundreds or thousands of years in a particular region or ecosystem" (United States Department of Agriculture, n.d.). The term "native" should always be used with a geographic qualifier, such as "native to New England". Species native to an area are uniquely adapted to environments that mimic pre-contact conditions. One of the most important benefits of native species is that they create habitat for native birds, pollinators, and wildlife. In this way, native species are proven to increase and protect biodiversity. It is important to note, however, that Somerville's urban environment is very different from the environment prior to European settlement, and thus not all of the species that are native to New England are able to thrive in the city. Nativity is one of many considerations in the City's broader sustainability goals, but non-native species are also important components of the urban forest that work to increase species diversity and improve resilience to pests and climate change.

An invasive plant species is defined as "a plant that is both non-native and able to establish on many sites, grow quickly, and spread to the point of disrupting plant communities or ecosystems" (United States Department of Agriculture, n.d.). Because invasive species are aggressive colonizers, they can inhibit the growth and development of other species. It is important to note that there are many non-native species that are also not invasive.

The City of Somerville aims to have a healthy proportion of native tree species and to move towards eradicating the number of invasive species in its urban forest. In Massachusetts it is illegal to import, sell, or trade species identified as invasive, as reported on the Massachusetts Prohibited Plant List (https://www.mass.gov/service-details/massachusetts-prohibited-plant-list). However, some of the species listed on the Prohibited Plant List were heavily planted in the past, before they were identified as invasive.

Figure 2.5 Percent of the Tree Inventory that is native or non-native to New England (a), and percentage that is invasive to Massachusetts (b).



FINDINGS

Approximately 44% of the trees in the inventory are native to New England, while 51% of the trees are not native to this area (**Figure 2.5**). Approximately 5% of the trees could not be identified to species, and thus their origin is unknown.

Six of the tree species in the inventory are listed as invasive species on the Massachusetts Prohibited Plant List (https://www.mass.gov/massachusetts-prohibited-plant-list), including *Acer platanoides* (Norway maple), *Ailanthus altissima* (tree of heaven), *Robinia pseudoacacia* (black locust), *Acer pseudoplatanus* (sycamore maple), *Rhamnus cathartica* (common buckthorn), and *Phellodendron amurense* (Amur corktree). These six invasive species account for nearly 16% of the tree inventory.

DISCUSSION & RECOMMENDATIONS

Nearly half of Somerville's trees are native to New England. As increasing the percentage of native species that are planted will be beneficial for native birds, pollinators, and wildlife, the City should continue to plant native species in areas where they can survive and thrive.

Nativity is one of many considerations in the City's broader sustainability goals, but ultimately the most important factor in species selection is choosing the right tree for the right place. The urban environment is a particularly challenging place for a tree to grow, and it is essential to choose an appropriate plant for the physical conditions of a site. Because of human intervention, the characteristics of cities—in everything from temperature, soil structure and conditions, air pollutants, salt use, and maintenance regimes—bear little resemblance to the environments in which native species evolved, and these urban conditions create many challenges for trees and plants. Under certain circumstances such as sidewalk tree wells, difficult median strips, compact spaces, areas containing poor soils and/or extreme microclimates, and areas with little or no maintenance, only the strongest of plants can survive. See *Section 3.1: Tree Planting Plan* for more information about tree planting and species selection.

Additionally, climate change will result in a shift in the suitability of certain species to our region. The change in local climatic conditions with climate change is expected to occur faster than plants can naturally disperse or evolve. Species that cannot move or evolve fast enough are susceptible to die-off and even. To help reduce the impact of climate change on species extinctions as well as helping to ensure long-term plant success, foresters, managers, and ecologists should consider utilizing assisted species migration or assisted range expansion, thereby planting species currently classified as non-native and which are currently at the edge of their climatic tolerance zones (USDA Forest Service, 2015).

See *Appendix D* for a recommended tree species list for planting.

Diameter Size Class Distribution

Analyzing the diameter size class distribution provides an estimate of the relative age of the city's tree population and offers insight into maintenance needs and practices.

The inventoried trees were categorized into the following diameter size classes: young trees (0–8 inches DBH), established trees (8.1–17 inches DBH), maturing trees (17.1–24 inches DBH), and mature trees (greater than 24 inches DBH).

These four size class categories were chosen so that the population could be analyzed according to Richards' ideal distribution (Richards, 1983). Richards proposed an ideal diameter size class distribution for street trees based on observations of well-adapted trees in Syracuse, New York. Richards' ideal distribution suggests that an ideal tree population would have an abundance of newly planted and young trees, and lower numbers of established, maturing, and mature trees. In this ideal distribution, the largest fraction of trees (approximately 40% of the population) should be young (less than 8 inches DBH), while the smallest fraction (approximately 10%) should be in the large-diameter size class (greater than 24 inches DBH). This ideal distribution correlates to good population stability, where younger trees will grow and fill in as replacements for mature trees at the end of their life cycle. Other population distributions that include a higher proportion of maturing and mature trees would result in higher ecosystem service benefits (Morgenroth et al. 2020). Managing the urban forest to increase the proportion of maturing and mature trees would require more tree maintenance, additional risk assessments, and an increased need to remove hazardous and dead or dying trees.

FINDINGS

Figure 2.6 compares the diameter size class distribution of Somerville's inventoried tree population (separated by City-owned and State-owned trees), to the ideal distribution proposed by Richards (Richards, 1983). The distribution of City-owned trees tends towards the ideal, but with slightly more trees in the smaller diameter size classes (3% more young trees and 13% more established trees than the ideal distribution), and slightly fewer trees in the larger diameter size classes (9% fewer maturing trees and 7% fewer mature trees than the ideal distribution). Compared to the City-owned trees distribution, the distribution of State-owned trees aligns even more closely with the ideal distribution.

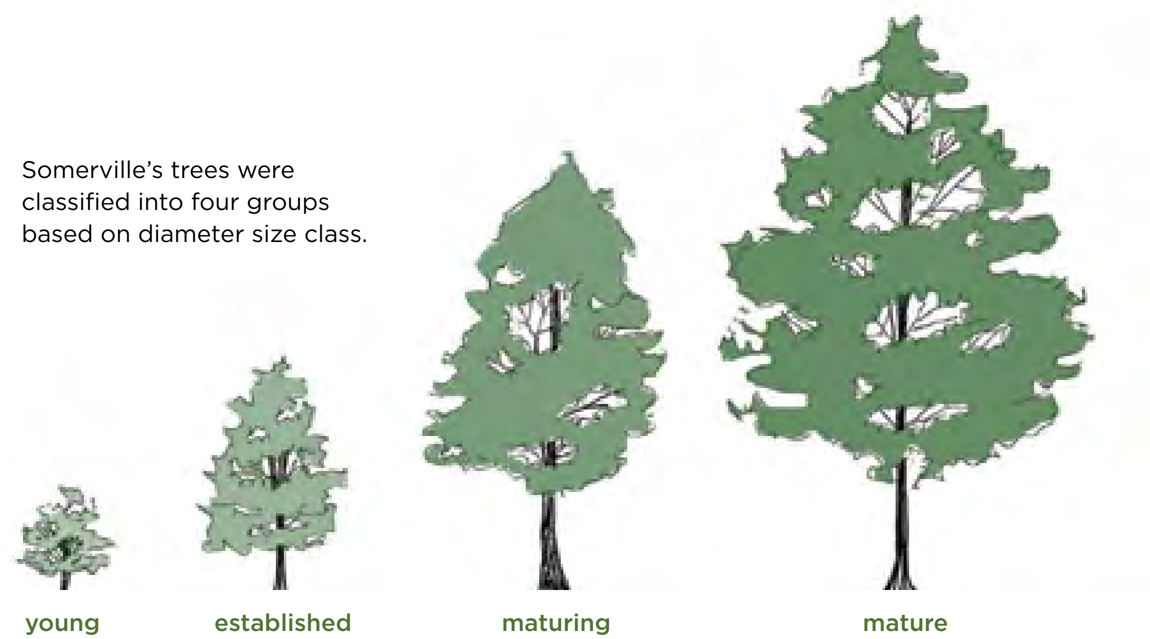
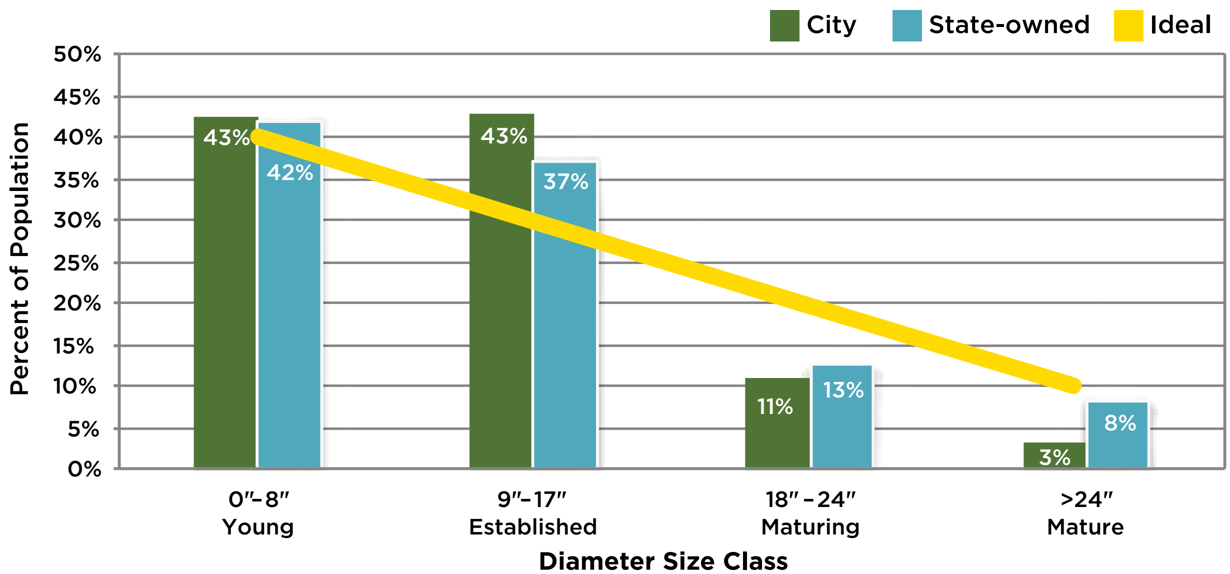


Figure 2.6. Comparison of diameter size class distribution for the inventoried trees to the ideal distribution, separated by City-owned (ROW and open spaces) and State-owned populations.



DISCUSSION & RECOMMENDATIONS

One of Somerville's objectives is to have an ideal distribution of trees at the street, park, and city-wide levels. Somerville's public tree population has too few maturing and mature trees, which indicates that the distribution is skewed. The City should promote tree preservation and proactive tree care to ensure the long-term survival of the older trees. See *Section 3.2: Tree Maintenance Program* and *Appendix F* for more information on risk assessment and priority maintenance. The City should also support a strong planting and maintenance program to ensure that young, healthy trees are in place to fill in gaps in tree canopy and replace older declining trees. Tree planting and tree care will allow the distribution to normalize over time. See *Section 3.1: Tree Planting Plan* and *Appendix E* for planting suggestions and information on species selection for planting sites.

Planting trees is necessary to increase canopy cover and replace trees lost to natural mortality (expected to be 1%–3% per year) and other threats (for example, invasive pests or impacts from weather events such as storms, wind, ice, snow, flooding, and drought). Planning for the replacement of existing trees and identifying the best places to create new canopy is critical.

Tree Condition

Urban trees grow in extremely challenging conditions. In addition to withstanding varied environmental conditions and pest damage, urban trees encounter a variety other factors that can impact their health. Many trees are growing in small tree wells which limits water and nutrient availability, soil compaction and hardscape features can impact root health, vehicles can cause damage to trunks and canopies, and branches can be excessively pruned for utility, pedestrian, or building clearance. Understanding the condition of a tree provides insight into its current health and stability, and is useful in determining if corrective management actions to improve vitality are warranted.

The condition of individual trees was identified based on methods defined by the International Society of Arboriculture (ISA). The condition assessment considered several factors for each tree, including:

- root characteristics
- branch structure
- trunk, canopy, and foliage condition
- the presence of pests

The condition of each inventoried tree was rated as Good, Fair, Poor, or Dead. The canopy and wood condition of each inventoried tree was assessed separately, and each tree's overall condition was calculated as an average of the two scores. If a tree's classification landed in-between two categories, it was assigned the lower of the two categories.

Comparing the condition of the inventoried tree population with relative tree age (or size class distribution) can provide insight into the stability of the population. Since tree species have different lifespans and mature at different diameters, heights, and crown spreads, actual tree age cannot be determined from diameter size class alone. However, general classifications of size can be extrapolated into relative age classes. The relative age categories are the same as the relative size categories described in Diameter Size Class Distribution – young, established, maturing, mature.

FINDINGS

Figures 2.7 and **2.8** illustrate the general health and distribution of trees relative to their condition.

Most of the inventoried City-owned and State-owned trees were recorded to be in Fair or Good condition, with a slightly higher percentage of City-owned trees in Good condition and a slightly higher percentage of State-owned trees in Fair condition (**Figure 2.7**).

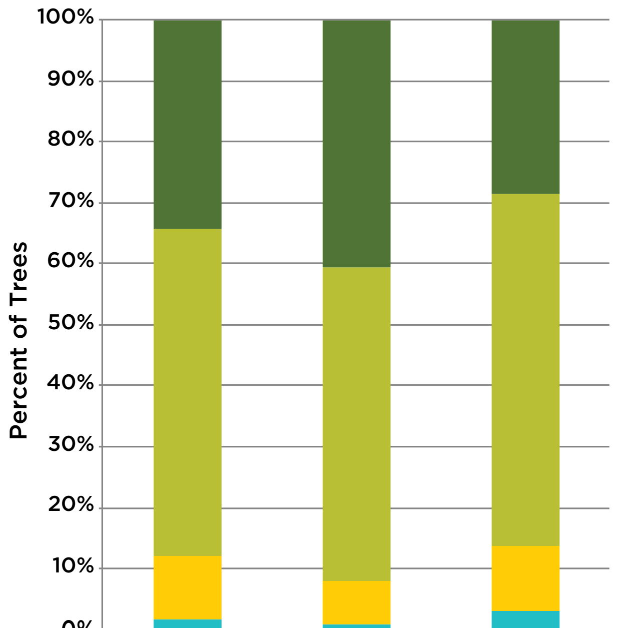
The condition rating of trees by size class (relative age) indicates growing condition as well as how trees were managed over time. **Figure 2.8** illustrates that most of the young City-owned trees were found to be in Good condition, whereas most of the established, maturing, and mature City-owned trees were found to be in Fair condition. Only City-owned trees (both street trees and open space trees) were used in this analysis because the City has no jurisdiction over the management of State-owned trees.

DISCUSSION & RECOMMENDATIONS

The condition of Somerville's inventoried tree population is typical for an urban population. The data analyses provide the following insight into historical maintenance practices and maintenance needs:

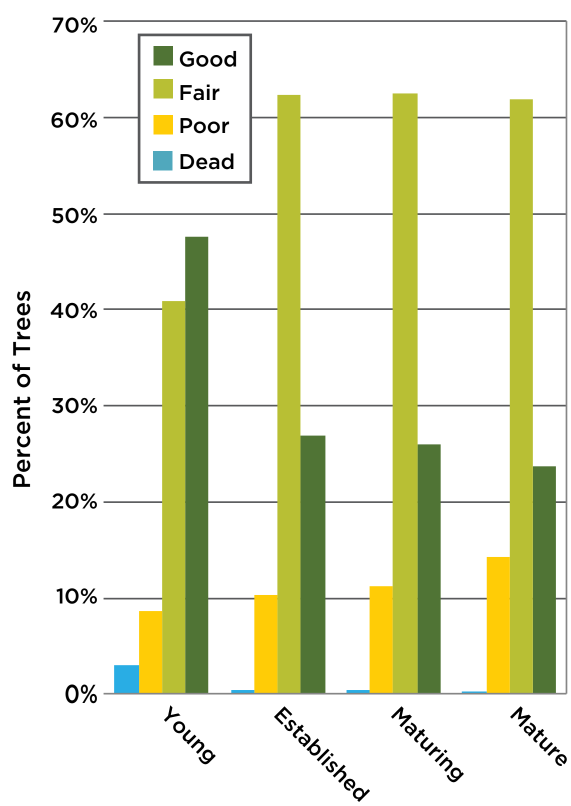
- The similar trends in condition for street and open space trees reflect both the growing conditions and past management practices. In Somerville, street trees have historically had more maintenance than park trees, while park trees are growing in better conditions. These differences lead to both groups having a majority of trees in Fair condition.

Figure 2.7. Condition of inventoried trees.
Note that due to rounding, the City open spaces category totals 99% instead of 100%.



	City streets (ROW)	City open spaces	State-owned
Good	34% (3205 trees)	40% (879 trees)	28% (604 trees)
Fair	54% (4991 trees)	51% (1118 trees)	58% (1223 trees)
Poor	10% (963 trees)	7% (158 trees)	11% (229 trees)
Dead	2% (154 trees)	1% (16 trees)	3% (64 trees)

Figure 2.8. Condition of City-owned trees by relative age.



- Dead trees and some trees in Poor condition should be removed because of their failed health; these trees will likely not recover, even with increased care. In appropriate areas where they will not present a hazard, poor and dead trees or stumps can be kept to provide wildlife habitat.

- The health of younger trees rated in Fair or Poor condition may improve over time with interventions such as watering, fertilizing and/or mulching, and structural pruning. Pruning should follow the standards in *ANSI A300 (Part 1)* (ANSI 2008). The City began a "Young Tree Training Program" in 2019 to address structural pruning needs of the City's younger trees.

- Poor condition ratings among mature trees were generally due to visible signs of decline and stress, including decay, dead limbs, sparse branching, or poor structure. These trees will require corrective pruning, regular inspections, and possible intensive plant health care to improve their vigor. Some of these trees are unlikely to recover and should be removed because they pose a danger to people or property.

- Implementing a proactive maintenance program that takes a holistic approach to tree health will help improve the condition of Somerville's trees. This type of program is based on identifying and correcting deficiencies in a tree's structure before they become a problem. The City's "Young Tree Training Program" and "Parks Tree Health Program" take a proactive maintenance approach. This approach should be extended to the ROW and other City-owned trees.

Proper tree care practices are needed for the long-term general health of the urban forest. Following guidelines developed by ISA and those recommended by *ANSI A300 (Part 6)* (ANSI 2012) will ensure that tree maintenance practices ultimately improve the health of the urban forest. For a more in depth review of Somerville's maintenance practices and needs please refer to *Section 3.2: Tree Maintenance Program* and *Section 4.1: Operations Review.*

Site Observations

Additional observations were recorded during the tree inventory to further describe a tree's growing location and/or site conditions. These conditions can affect the overall health of a tree and/or influence maintenance needs. Site observations recorded during the inventory include:

- ***Root flare*** (also called trunk flare)–This is the lower part of the trunk of a tree, where the trunk meets the roots. The presence of a root flare indicates that the tree was planted at the proper depth and relates to the health of structural roots.
- ***Girdling root*** (also called strangling root)–This is a root that is growing on top of or around another root or the trunk itself. As a girdling root grows, it encircles the other root or trunk, cutting off the supply of water and nutrients to that portion of the tree. Thus, a girdling root can impact the health and long-term survivability of a tree.
- ***Sidewalk condition***–The presence or absence of new sidewalks around each tree was recorded. New sidewalks around a tree well may indicate the sidewalk was replaced because the tree roots were lifting or cracking it. In addition, it is possible that some roots were cut during sidewalk replacement, which could impact tree health, longevity, and stability.
- ***Ground maintenance***–The need for maintenance at the ground level was recommended if the area around the tree had a sufficient amount of weeds or suckers (small branch offshoots around the base of the tree).

The tree above has no visible root flare, indicating it was planted too deep.

The tree above has been planted correctly and the root flare can clearly be seen.

This tree has two girdling roots that are wrapping themselves around the trunk and other roots. As these girdling roots continue to grow they will eventually choke off the supply of water and nutrients to the rest of the tree, and will cause the tree to die.

FINDINGS

Root Flare: The majority of the inventoried trees in Somerville have a visible root flare (76% of City-owned trees, and 94% of State-owned trees). Trees that do not have a visible root flare were planted to deep or buried by excess soil after planting, and are likely to decline and/or have shorter lifespans. This is because the root collar stays damp, which makes it susceptible to insects and disease. Also the rate of oxygen and carbon exchange in the roots declines, causing the roots to suffocate and decay. Trees that are planted too deep are susceptible to having girdling surface roots, and these roots can cause canopy decline and/or weak spots in the trunk.

Girdling Root: Girdling roots were observed on 19% of City-owned trees. Girdling roots can decrease the lifespan of a tree. At the time of the inventory, 8% of the City-owned trees that had girdling roots were recommended for removal (168 trees).

Girdling roots can result from planting a tree too deep, from growing a tree in limited space, or from piling mulch up around the trunk of the tree (i.e., mulch volcano). In some cases, trees that arrive from the nursery have circling roots (due to being container grown or balled and burlaped) which can become girdling roots. These roots should be pruned before the tree is planted, or if they are particularly bad the tree should be rejected from the nursery.

Depending on the location and size of the girdling root, it may be able to be corrected by either moving it or severing it.

Sidewalk condition: New sidewalks surrounded 20% of City-owned trees. Five percent of the City-owned trees with new sidewalk surrounding them were recommended for removal (111 trees). New sidewalk around a tree may negatively impact tree health if the installation of the sidewalk resulted in roots being crushed or severed. Alternatively, new sidewalk around a tree could also be beneficial to a tree if it resulted in a larger tree well opening.

Note the color changes of the sidewalk. The lighter gray color of the sidewalk is where the sidewalk has been replaced.

This photograph is a good example of root damage that can occur when a sidewalk is replaced. Some roots were cut and others were stripped when the old sidewalk was removed. This is an issue because these critical, anchoring roots have now been damaged and may not recover.

Table 2.1. Site Observations for City-owned Trees

Observations	Positive, Negative, or Risk Factor	Number of Trees	Percent of City-owned trees
Visible Root Flare		8,677	75.6%
Girdling Root		2,222	19.4%
Sidewalk Condition (New Sidewalk)		2,320	20.2%
Ground Maintenance Needed		1,206	10.5%
Total Number of City-owned Trees		**11,484**	-

Table 2.2. Site Observations for State-owned Trees

Observations	Positive, Negative, or Risk Factor	Number of Trees	Percent of State-owned trees
Visible Root Flare		1,999	94.3%
Girdling Root		242	11.4%
Sidewalk Condition (New Sidewalk)		17	0.8%
Ground Maintenance Needed		93	4.4%
Total Number of State-owned Trees		**2,120**	-

Ground maintenance: At the time of the inventory, 10% of the City-owned trees needed to have the area around them maintained by pruning off suckers or weeding. These weeds and suckers can block a sidewalk path, take nutrients away from the tree, and can be unsightly. Certain species (e.g. callery pear, linden) are more prone to growing suckers.

A summary of the site observations for City-owned trees is presented in **Table 2.1** and a summary of the site conditions for State-owned trees is presented in **Table 2.2**.

DISCUSSION & RECOMMENDATIONS

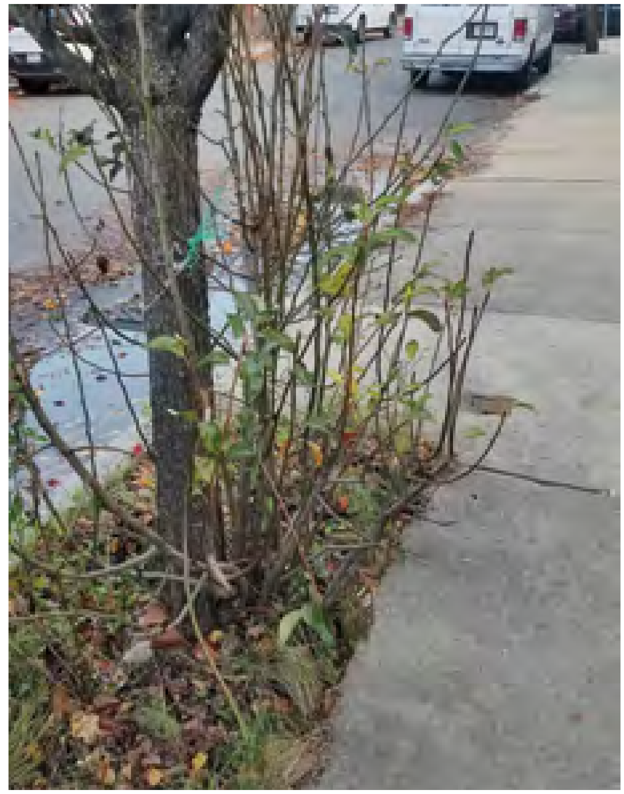
Site conditions and maintenance can impact a tree's health and long-term survival. The following recommendations will help to provide each tree with its best chance of success:

- Ensure trees are planted at correct depth and that root flare is visible at the time of planting. For those trees that are already in the landscape, consider replanting the trees with no visible root flare if they are small enough. Otherwise, if possible, carefully scrape away the soil from around the trunk until the root flare is visible.

- Unless slated for removal, trees noted as having girdling roots should be inspected to determine if corrective actions are possible and warranted. Where indicated, the corrective actions should be undertaken. If the girdling roots cannot be corrected and tree condition worsens, removal may be required.

- Sidewalk repairs are often necessary to ensure the sidewalks remain accessible. When performing sidewalk repair/replacement it is important to work around the existing roots, particularly the structural roots, instead of cutting them. Cutting structural roots not only reduces the ability of the tree to acquire sufficient water and nutrients, but can also cause the tree to become unstable.

This callery pear needs ground level maintenance to remove the suckers growing out of the base of the tree.



- Performing ground level maintenance on trees that have numerous suckers growing out of their base or which are surrounded by excessive weeds can help to increase tree vitality while also improving accessibility and the tree's appearance.

- Young trees that were staked or had other temporary hardware were noted (398 City-owned trees). Staking should only be installed when necessary to keep trees from leaning (windy sites) or to prevent damage from pedestrians and/or vandals. Stakes should only be attached to trees with a loose, flexible material. Installed hardware that has been attached to any tree for more than one year, and hardware that may no longer be needed for its intended purposes, should be inspected and removed as appropriate.

Infrastructure Conflicts

In an urban setting, space is limited both above and below ground. Trees in this environment may conflict with infrastructure such as buildings, sidewalks, and utility wires and pipes, which may, in turn, pose risks to public health and safety.

Existing or possible conflicts between trees and infrastructure recorded during the inventory include:

- ***Overhead Utilities***—The presence of overhead utility lines above a tree or planting site was noted; it is important to consider these data when planning pruning activities and selecting tree species for planting.

- ***Hardscape Damage***—Trees can adversely impact hardscape, which affects tree root and trunk systems, as well as pedestrian accessibility. The inventory includes tree-related damage that has caused curbs, sidewalks, and other hardscape features to lift or crack.

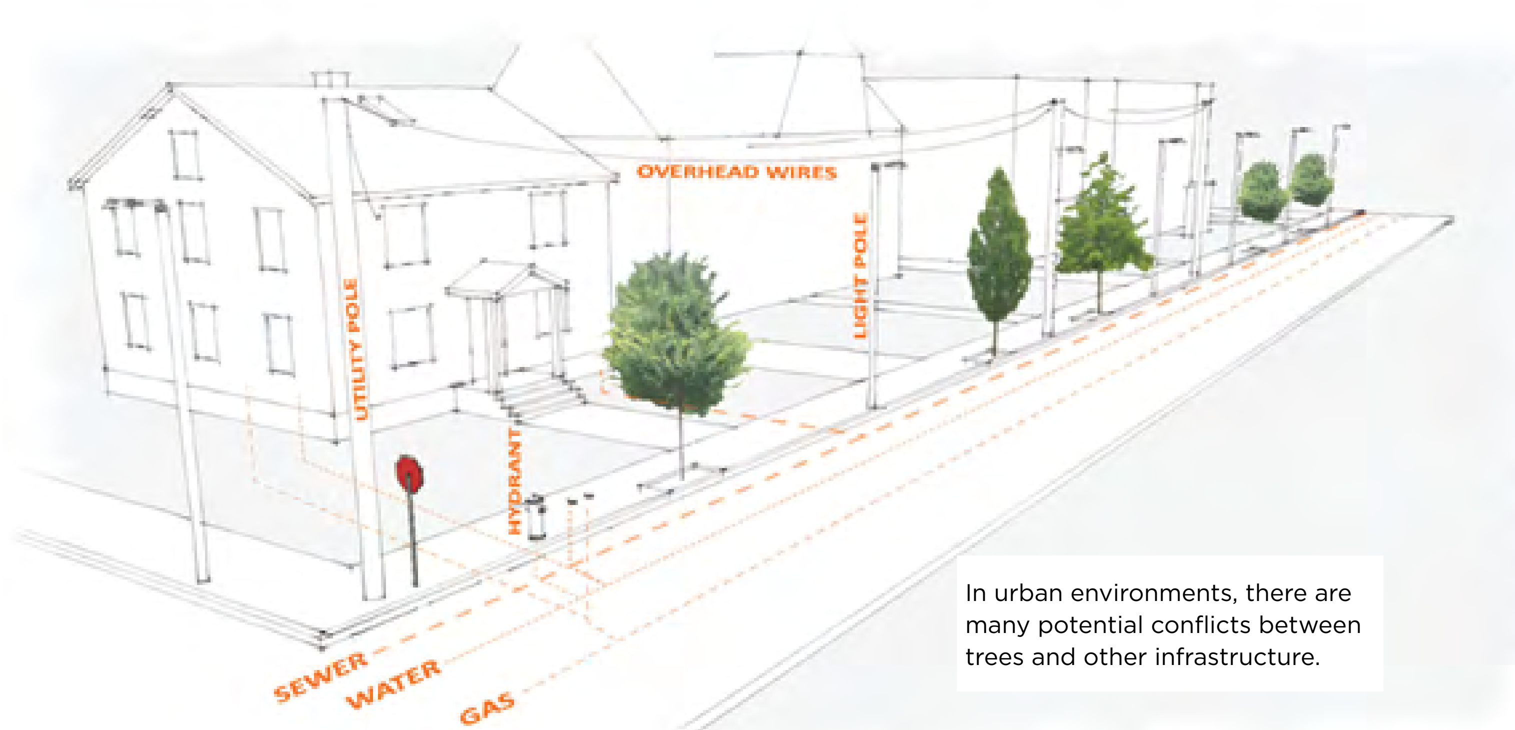
These data should be used to schedule pruning and plan repairs to damaged infrastructure.

The information about trees conflicting with overhead utilities is helpful when working with Eversource's vegetation management crews. The City of Somerville has a good relationship with Eversource, and they work together to ensure trees are not overly pruned but are still safe and remain clear from the powerlines. To limit hardscape damage, trees should be planted in growing spaces where adequate above ground and below ground space is provided. In urban sites this can be difficult as there are many possible conflicts, but maximizing the amount of growth space and choosing the correct type of tree for the available space greatly reduces these issues.

FINDINGS

There were 4,269 trees in the complete inventory with utility lines directly above, or passing through, the tree canopy. Of those trees, 729 were directly touching the lines (**Table 2.3**).

There was hardscape damage surrounding 16% of the tree population (**Table 2.4**). Hardscape damage included sidewalk slabs that were raised 1 inch or more and curbing that was pushed out 1 inch or more.



In urban environments, there are many potential conflicts between trees and other infrastructure.

Table 2.3. Trees Conflicts with Overhead Utility Infrastructure

Conflict	Presence	Number of Trees	Percent
Overhead Utilities	Present and Conflicting	729	5.36%
	Present and Not Conflicting	3,540	26.02%
	Not Present	9,335	68.62%
Total		**13,604**	**100%**

Table 2.4. Trees and Hardscape Damage

Conflict	Presence	Number of Trees	Percent
Sidewalk Deflection Greater Than or Equal to 1 inch	Yes	2,229	16.38%
	No	11,375	83.62%
Total		**13,604**	**100%**

This Japanese zelkova along Broadway is causing significant uplift of the sidewalk.

DISCUSSION & RECOMMENDATIONS

Tree canopy should not interfere with vehicular or pedestrian traffic, nor should it rest on buildings or block signs, signals, or lights. Pruning to avoid clearance issues and raise tree crowns should be completed in accordance with *ANSI A300 (Part 9)* (ANSI, 2011). Minimum clearance distance guidelines are as follows: 14 feet over streets; 8 feet over sidewalks; and 5 feet from buildings, signs, signals, or lights.

Planting small-growing trees within 20 feet of overhead utilities, medium-size trees within 20–40 feet of overhead utilities, and large-growing trees 40 feet or more from overhead utilities will help improve future tree conditions, minimize future utility line conflicts, and reduce the costs of maintaining trees under utility lines.

Tree roots can damage hardscape when they do not have sufficient space to grow. Damage should be fixed readily to ensure the sidewalks are accessible, but care should be taken to ensure tree roots are not severed in the process. When planting in hardscape such as sidewalks, it is important to give the tree enough growing room above ground. Guidelines for planting trees among hardscape features are as follows: give small-growing trees at least 3–5 feet, medium-growing trees at least 6–7 feet, and large-growing trees 8 feet or more between hardscape features. In most cases, this will allow for the spread of a tree's trunk taper, root collar, and immediate larger-diameter structural roots. For more planting recommendations please refer to *Section 3.1: Tree Planting Plan*.

Growing Space Type

A tree's health and longevity can be influenced by the type of space it is growing in and the area available for root development. Growing space data was collected during the tree inventory, including the type and size of the space. Growing space size was recorded as the minimum width and length of the available growing space, and growing space types were categorized as follows:

- ***Island***—surrounded by pavement or hardscape (for example, parking lot divider)
- ***Median***—located between opposing lanes of traffic
- ***Natural Area***—areas that do not appear to be regularly maintained purposefully
- ***Open/Restricted***—open sites with restricted growing space on two or three sides
- ***Open/Unrestricted***—open sites with unrestricted growing space on at least three sides
- ***Raised Planter***—in an above-grade or elevated planter
- ***Tree Lawn/Parkway***—located between the street curb and the public sidewalk
- ***Unmaintained Area***—urban areas that do not appear to be regularly maintained
- ***Well/Pit***—growing space that is at grade level and surrounded by sidewalk

FINDINGS

The most prevalent growing space types among all of the trees in the inventory were well/pit (63% of trees) and open/restricted (23% of trees) (**Table 2.5**).

Table 2.5.
Number of Trees in Each Growing Space Type

Growing Space Type	Number of Trees	Percent
Island	37	0.3%
Median	243	1.8%
Natural Area	37	0.3%
Open/Restricted	3141	23.1%
Open/Unrestricted	635	4.7%
Raised Planter	27	0.2%
Tree Lawn/Parkway	925	6.8%
Unmaintained Area	22	0.2%
Well/Pit	8537	62.8%
Total	**13,604**	**100%**

DISCUSSION& RECOMMENDATIONS

The ultimate size of a tree and how vigorously it grows depends on various factors such as species, soil quality, and water availability. Trees that have more soil available to them tend to grow larger and be more robust, so having appropriate growing space is important. To prolong the useful life of street trees, the minimum dimensions of tree wells or tree lawns should be 3 x 6 feet for small-growing tree species, 3 x 8 feet for medium-size tree species, and 3 x 10 feet for large-growing tree species. The useful life of a public tree ends when the cost of maintenance exceeds the value contributed by the tree. This can be due to increased maintenance required by a tree in decline, or it can be due to the costs of repairing damage caused by the tree's presence in a restricted site.

This pin oak along Alewife Parkway needs further inspection. There is a weak attachment with a crack forming. This tree may need to be cabled/braced, or removed. An ISA Certified Arborist should perform the additional inspection.

Further Inspection & Monitoring

This data field indicates whether a particular tree requires further inspection, such as a Level III risk inspection in accordance with *ANSI A300, Part 9* (ANSI, 2011), or periodic inspection due to particular conditions that may cause it to be a safety risk and, therefore, hazardous. If a tree was noted for further inspection, City staff should investigate as soon as possible to determine corrective actions. The City's primary concern is in removing any hazards to people or property.

FINDINGS

In the inventory, 1,021 City-owned trees were recommended for further inspection. Of these trees, 145 were recommended for multi-annual checks, 835 for insect/disease monitoring, and 41 for a Level III assessment (*ANSI A300, Part 9* (ANSI, 2011)). Of the 835 trees recommended for insect/disease monitoring 95% of these trees are ash trees, and 3% are American elms.

DISCUSSION & RECOMMENDATIONS

An ISA Certified Arborist or a Massachusetts Certified Arborist should perform additional inspections of the trees that need multi-annual checks and Level III assessments. If it is determined that these trees exceed the threshold for acceptable risk, the defective part(s) of the trees should be corrected or removed, or the entire tree may need to be removed.

The ash trees and elm trees should be closely monitored due to the presence of the invasive insect emerald ash borer (EAB) and the fungal disease Dutch Elm Disease (DED). Only three inventoried ash trees showed possible symptoms of EAB at the time of the inventory. These specific trees should be monitored closely. If signs of EAB manifest, the tree should be removed and the site should be inspected for potential replacement. See *Section 3.3: Invasive Insect and Disease Management Strategy* for more details on the City's ash tree treatment and monitoring program.

Potential Threats from Pests

Insects and diseases pose serious threats to tree health. Awareness and early diagnosis are essential to ensuring the health and continuity of the City's street and park trees. *Section 3.3: Invasive Insect and Disease Management Strategy* and *Appendix G* provide more detailed information about some of the current potential threats to Somerville's trees, including the emerald ash borer (EAB).

This white ash tree along Elm Street needs to be re-inspected for emerald ash borer (EAB). There is a small D-shaped borer hole, which looks similar to those created by EAB. The City may want to have a tree health specialist inspect this tree.

Many pests target a single species or an entire genus. The inventory data were analyzed to provide a general estimate of the percentage of trees susceptible to some of the known pests in Massachusetts (see **Figure 2.9**). It is important to note that **Figure 2.9** only relates to the public trees that were inventoried. Many more trees throughout Somerville, including those on private property, may be susceptible to these invasive pests.

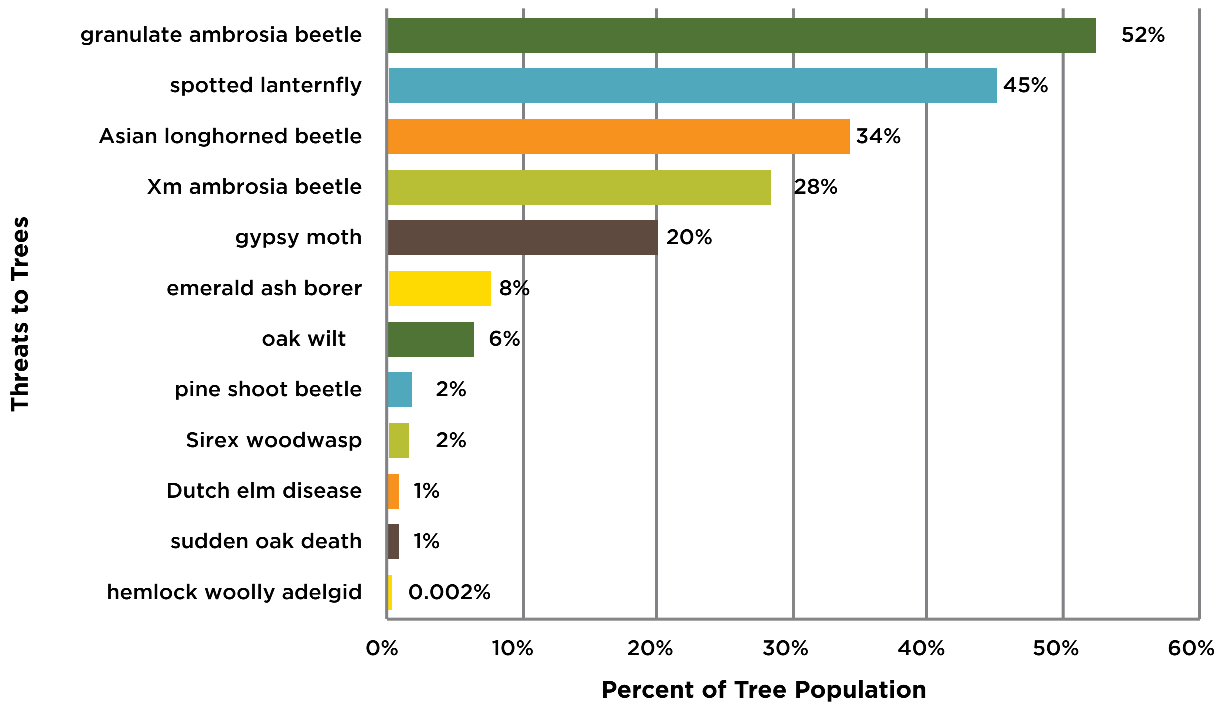
FINDINGS

Granulate ambrosia beetle (*Xylosandrus crassiusculus*) and spotted lanternfly (*Lycorma delicatula*) pose the biggest potential threats to a large percentage of the trees in the complete inventory (52% and 45%, respectively). These pests have not yet been detected in Somerville, but if they were detected, the City could see severe losses in its tree population.

Granulate ambrosia beetle's range is typically in the Southeast. However, it was found in Oregon and Virginia in 1992, and in Indiana in 2002 (Cole 2008). With climate change inducing more stress on trees, and causing hardiness zones to change, this pest is a potential threat to Somerville's trees. See *Appendix G* for more details about the Granulate ambrosia beetle.

Spotted lanternfly (*Lycorma delicatula*) is an invasive insect native to China. It was first discovered in Pennsylvania in 2014, and has since spread into New Jersey, Maryland, Delaware, and Virginia. While there are no known infestations in Massachusetts, this insect has been found in multiple counties in neighboring states. Spotted lanternfly prefers the host tree-of-heav-

Figure 2.9. Potential impact of insect and disease threats to all inventoried trees. Percent of at-risk tree population is based on species that are predicted to be susceptible to a given threat.



en (*Ailanthus altissima*), but it feeds on a wide range of fruit, ornamental, and woody trees, as well as agricultural crops (such as apples, peaches, grapes, and hops). Spotted lanternfly is discussed in greater detail in *Section 3.3: Invasive Insect and Disease Management Strategy*.

Also of particular note is the impact of emerald ash borer (EAB) on Somerville's trees. EAB has been recently found in Somerville. One EAB beetle was found on a trap in 2018, and 25 EAB beetles were found on traps in 2019. Although the majority of the 1,034 publicly-owned ash trees that were inventoried did not yet show signs or symptoms of infestation, once EAB is found it spreads quickly. The City's healthy ash trees are being proactively treated with an organic insecticide to help protect them from EAB. The unknown number of private trees that were not part of this inventory may be an additional concern. See *Appendix G* and *Section 3.3: Invasive Insect and Disease Management Strategy* for more information about EAB and Somerville's ash tree management strategy.

DISCUSSION & RECOMMENDATIONS

Somerville should be aware of the signs and symptoms of potential infestations and should be prepared to act if a significant threat is observed in its tree population or in a nearby community. An integrated pest management plan should be established. The plan should focus on identifying and monitoring threats, understanding the economic threshold, selecting the correct treatment, properly timing management strategies, recordkeeping, and evaluating results. Most of this information for key pests is provided in *Section 3.3: Invasive Insect and Disease Management Strategy*, including recommendations for managing the ash tree population and mitigating EAB.

SECTION
2

Tree Inventory Data Conclusions

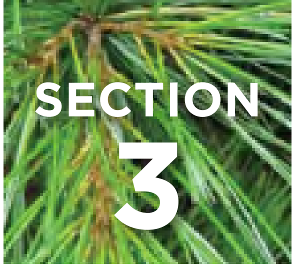
The data presented in the 2018 Somerville Tree Inventory is crucial to the City's Urban Forestry Program and to promoting the value of the urban forest among residents and elected officials. For each assessment criterion listed in the *Tree Inventory Assessment*, the "Discussion & Recommendations" section illuminates the data-based issues and needs that the City should address in policies and procedures moving forward. For example:

- Tree inventory data can be used to support necessary priority and proactive tree maintenance activities as well as tree planting and preservation initiatives (see *Section 3: Expand, Preserve & Maintain*).

- Species data can guide tree species selection for planting projects with the goals of improving species diversity and limiting the introduction of invasive pests and diseases.

- Outreach efforts can use the data found here to educate stakeholders on the issues that Somerville's trees face. For example, residents can be informed about threats to urban trees (such as granulate ambrosia beetle, emerald ash borer, and spotted lanternfly). Various avenues for outreach are described in *Section 4.4: Public Engagement*.

The inventory data presented here is a valuable tool for proactive, data-based management of Somerville's urban forest and it serves as the basis for the formulation of the short-, mid- and long-term goal setting outlined in the *Section 5: Action Plan.*



EXPAND, PRESERVE, AND MAINTAIN

Trees are an important asset providing numerous benefits to the inhabitants of Somerville (see *Section 1: The Importance of Trees in the City*). The City's urban forest encompasses a complex network of trees, site conditions, and maintenance requirements (see *Section 2: Somerville's Tree Inventory Data*). Understanding this system is important for proper decision-making regarding species selection, tree planting practices, and maintenance needs. At the same time, the complexity of these issues must not deter the goals of preserving our present day trees, proactively caring for our youngest trees, and expanding the urban forest in the future.

Like many cities across the country, Somerville faces a number of challenges brought on by aging infrastructure combined with continued growth and development. Add to this the threat of tree loss and the obstacles trees encounter when growing in an urban environment, and the challenges compound. Moreover, some residents view trees negatively because they can present a safety hazard to people and property, they sometimes conflict with utilities, and because of the work required to maintain the trees and dispose of leaves and other litter. Urban forest managers must also consider how the physical constraints of the urban environment impact tree health as well as how climate change is influencing the survivability of trees. Managing the urban forest is a complex task, in which the recommendations of experts, the needs of residents, the pressures of local economics and politics, the concerns for public safety and liability issues, the physical aspects of trees, as well as current and emerging ecological concerns, and the forces of nature and severe weather events must all be simultaneously balanced.

The City of Somerville must carefully consider each specific issue and balance these pressures with a local knowledge and an understanding of trees and their needs. If a balance is achieved, Somerville, with its unique and attractive qualities as a place to live, will grow stronger and the health and safety of its trees and residents will be maintained.

This section of the Urban Forest Management Plan provides details and recommendations for expanding the tree canopy through tree planting, performing maintenance on the City's tree population to encourage tree health and public safety, and how to best prepare for current and potential issues that the City's tree may face, like pests and storms.

Managing the urban forest is a complex task, in which the recommendations of experts, the needs of residents, the pressures of local economics and politics, the concerns for public safety and liability issues, the physical aspects of trees, as well as current and emerging ecological concerns, and the forces of nature and severe weather events must all be simultaneously balanced.

3.1
Tree Planting Plan

At present, the Urban Forestry Division aims to increase its planting to at least 350 trees per year -- a 16% increase from recent years. Based on current staffing levels, the goal of 350 trees per year is ambitious, yet realistic (see *Section 4.1: Operations Review*), and would require only a modest increase in funding (see *Section 4.2: Funding Analysis*). While achieving this goal would result planting more trees per year than the Urban Forestry Division has planted in 9 of the last 10 years (**Figure 3.1**), it is important to note that increasing the capacity to plant *even more* trees in the future would be a crucial way to increase canopy in the long term.

Historically, additional trees have been planted on City property through park renovation and construction projects, capital improvement projects, and streetscape projects (**Figure 3.1**). The City expects to continue planting additional trees throughout the city through these types of projects, and these trees would be counted above and beyond the 350 trees per year goal for the Urban Forestry Division.

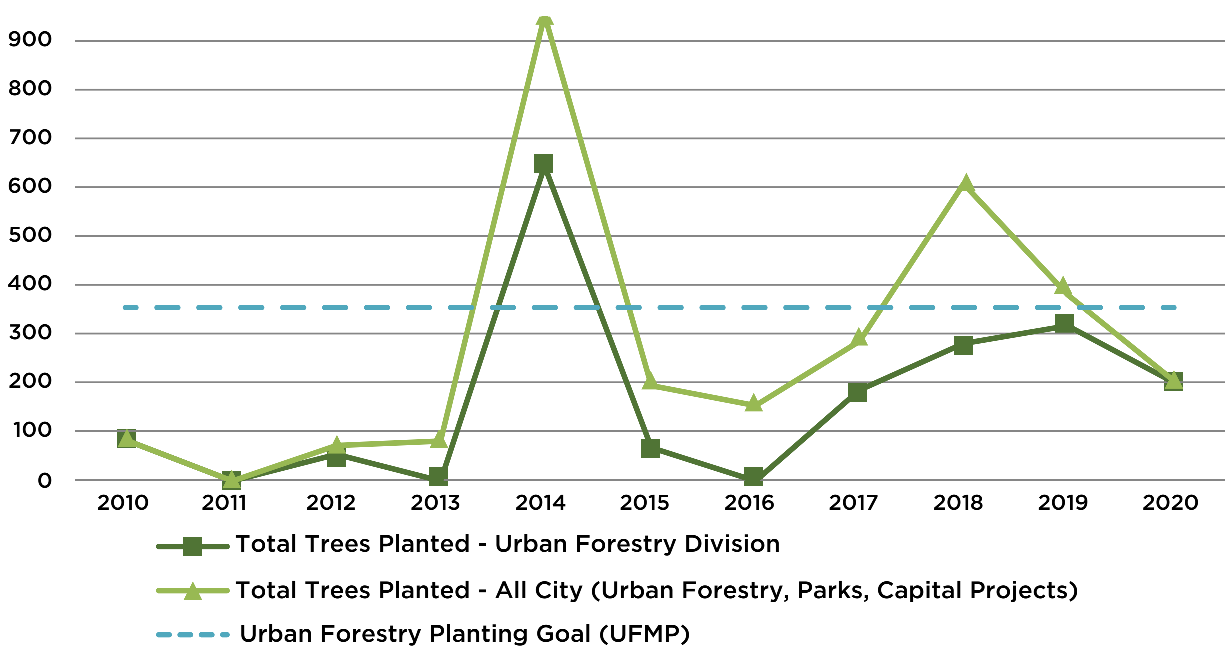


Figure 3.1. Number of trees planted on City-owned property between 2010 and 2020.
The amount of planting in 2020 was lower than expected because of the COVID-19 pandemic.

Developing an Effective Public Tree Planting Program

An effective tree planting program address three main questions: where to plant, what to plant, and how to plant? It is important to develop an overall planting strategy where the initial planting efforts are concentrated on streets and areas with the greatest need for improvement. Tree species and planting location designations are significant components of a municipal tree care program because of the long-term impact of these decisions.

Success of a continuing tree planting program will be judged by the health of the trees after planting and the amount of money spent on planting and maintaining the new trees. With a small amount of planning, healthy trees with greater life expectancy can be established with minimal up-front investment and relatively minor maintenance costs.

This *Tree Planting Plan* provides guidelines for the implementation of an organized and comprehensive tree planting strategy that results in the prioritization of tree planting locations and the expansion of Somerville's urban tree canopy. Information on suitable planting locations in the City is provided, along with general recommendations on choosing suitable trees for each site.

The scope of this Tree Planting Plan includes:

- **Where to plant**: Provides a brief description of the type of currently available planting sites in the City, as well as a prioritization of planting areas throughout the City based on current canopy cover and other environmental and demographic parameters.
- **What to plant**: Recommendations for making practical decisions in species selection related to species diversity, site restrictions, and functionality of the urban forest.
- **How to plant**: Recommendations for tree planting strategies in order to maximize investments in the purchasing, planting, and maintenance of new trees by meeting industry standards (such as ANSI, and the Society of Municipal Arborists).
- **Tree care after planting**: Recommendations for how to care for newly planted trees to improve tree health and longevity.

Many of the key elements for a successful tree-planting program described below are based upon the exceptional reference, *Principles and Practice of Planting Trees and Shrubs* by Gary Watson and E. B. Himelick (1997).

Where to Plant

There are numerous opportunities to plant more trees on public property in the City of Somerville. Historically, the locations of new tree plantings on City-owned rights-of-way in Somerville have been based on constituent requests (*e.g.* 311), the replacement of dead or dying trees (where feasible), and project-specific plantings (*e.g.* streetscape improvement projects). With the 2018 tree inventory, City officials now also know the exact location of additional planting sites that are available throughout the city. Moreover, the development of a prioritization scheme based on canopy data allows the City to begin significant tree planting efforts in high priority areas of the City.

CURRENTLY AVAILABLE PLANTING SITES

Somerville's 2018 public tree inventory (see *Section 2: Somerville's Tree Inventory Data*) identified a total of 567 currently available planting sites along the City-owned rights-of-way (ROW). Sites designated as currently available planting sites included open tree wells with no trees in them, locations that recently had a tree but where the tree was removed and paved over with asphalt, and other locations that were currently open and not yet planted but which had an appropriate amount of open space (*e.g.* in a tree lawn or naturalized area, median, island, etc.).

Stocking

Somerville's 2018 tree inventory shows the City's potential street tree population is 9,985 trees, which includes 9,313 existing trees (93%), 567 vacant planting sites (6%) and 105 stumps (1%) (see *Section 2: Somerville's Tree Inventory Data*). Based on these inventory values, the City of Somerville's ROW is 93% stocked. "Stocking" is a traditional forestry term used to measure the density and distribution of trees. In this case it means that, of the total number of available planting sites identified in the tree inventory along the public ROW, 93% currently have a tree present. Note that this value only considers the currently available planting areas along the street ROW, and not impervious surfaces that could become planting locations. Moreover, this value does not incorporate potential planting locations in parks or other civic spaces.

Of the 9,313 existing ROW trees in the inventory, 864 trees were recommended for removal (see *Section 3.2 Tree Maintenance Program*). These recommended removals represent a future increase in total number of potential planting sites. An important benchmark in maintaining a sustainable urban forest is to keep it at least 90% stocked, such that no more than 10% of the existing planting sites remain vacant. The City should make every effort to budget for tree planting in the future to maintain the urban forest at least 90% stocked and to continue increasing its canopy.

Full Stocking Potential

Full tree stocking can be an elusive goal, since mortality of young and old trees continually make more planting sites available. Nevertheless, working toward full stocking can help make other less glamorous aspects of urban forestry, such as tree removals, more palatable.

With a current stocking level of 93%, the City is well on its way towards achieving full tree stocking of the currently available planting sites. This means that the City is in a position to seek out new areas that would be appropriate for planting, both by turning previously impervious surfaces into pervious planting areas, and by planting in areas that were not identified in the tree inventory process. The Urban Forestry Division often creates new tree wells to plant trees (which also increases number of available planting sites), many of which are driven by resident requests. A full tree stocking program would be proactive, and would involve plantings beyond those requested by homeowners. High priority planting areas are identified in the canopy analysis below.

With a total of 567 vacant sites, the City would reach its full stocking potential in under two years following the desired planting schedule of 350 trees per year. This estimate assumes that no trees are removed, no new streets or tree wells are added, and all of the new plantings survive.

A more accurate formula for determining the planting rate to reach full stocking comes from the textbook *Urban Forestry: Planning and Managing Urban Greenspaces* by Robert W. Miller (1997) and is written as:

$$N = \frac{R + (V/G)}{S}$$

Where:

N = number of trees to be planted annually

R = number of trees to be removed annually

V = existing vacant sites

G = years remaining to achieve full stocking

S = assumed planting survival rate

For example, Somerville has 567 available planting sites scattered throughout its existing ROW. Assuming that 145 trees per year will be removed (this number is based on the average number of Priority Maintenance Removals in Years 1 through 6 of the program as demonstrated in *Section 3.2 Tree Maintenance Program*) and the planting survival rate over that period is 80% (Miller, 1997), the City could achieve full stocking in less than 5 years if it follows its current planting plan of 350 trees per year:

$$N = \frac{145 + (567/5)}{0.80} = 322 \text{ trees/year}$$

It should be noted that not all trees removed can be replaced in the same location due to utility/space conflicts. In these instances a new planting location will need to be chosen for a tree.

PRIORITIZED PLANTING LOCATIONS BASED ON TREE CANOPY DATA

Planting locations throughout the city were identified and prioritized as part of the urban tree canopy analysis (*Section 1.1: Somerville's Tree Canopy*). Potential planting locations included all viable areas of the City that were classified as grass/open space and bare ground in the urban tree canopy analysis (*Appendix A*). All potential planting sites were not treated equally as some sites were considered to be more suitable than others. To identify and prioritize planting potential, an analysis was performed that included various environmental and demographic variables, including proximity to hardscape, canopy fragmentation, floodplain proximity, soil permeability, slope, soil erosion factor (K-factor), urban heat island index, and proximity to bus routes and bike lanes. In addition, planting potential was prioritized in Environmental Justice areas (which include parameters of income, minority populations and English language isolation) and where there are vulnerable populations (elderly housing, schools, child care and medical centers). For more details on how the analysis was performed, see *Appendix A*.

A priority level ranging from Very Low to Very High was assigned to each of the potential planting locations (**Figure 3.2**). While available planting sites may ultimately be planted over the next several decades, the trees that are planted in the next several years should be planned for areas in most need, and where they will provide the most benefits and return on investment. Note that this planting location analysis covered the entire city, regardless of property ownership. Many of the high-priority planting locations are on Privately-owned or State-owned land. The City should encourage tree planting in these areas while also spearheading planting on City-owned land.

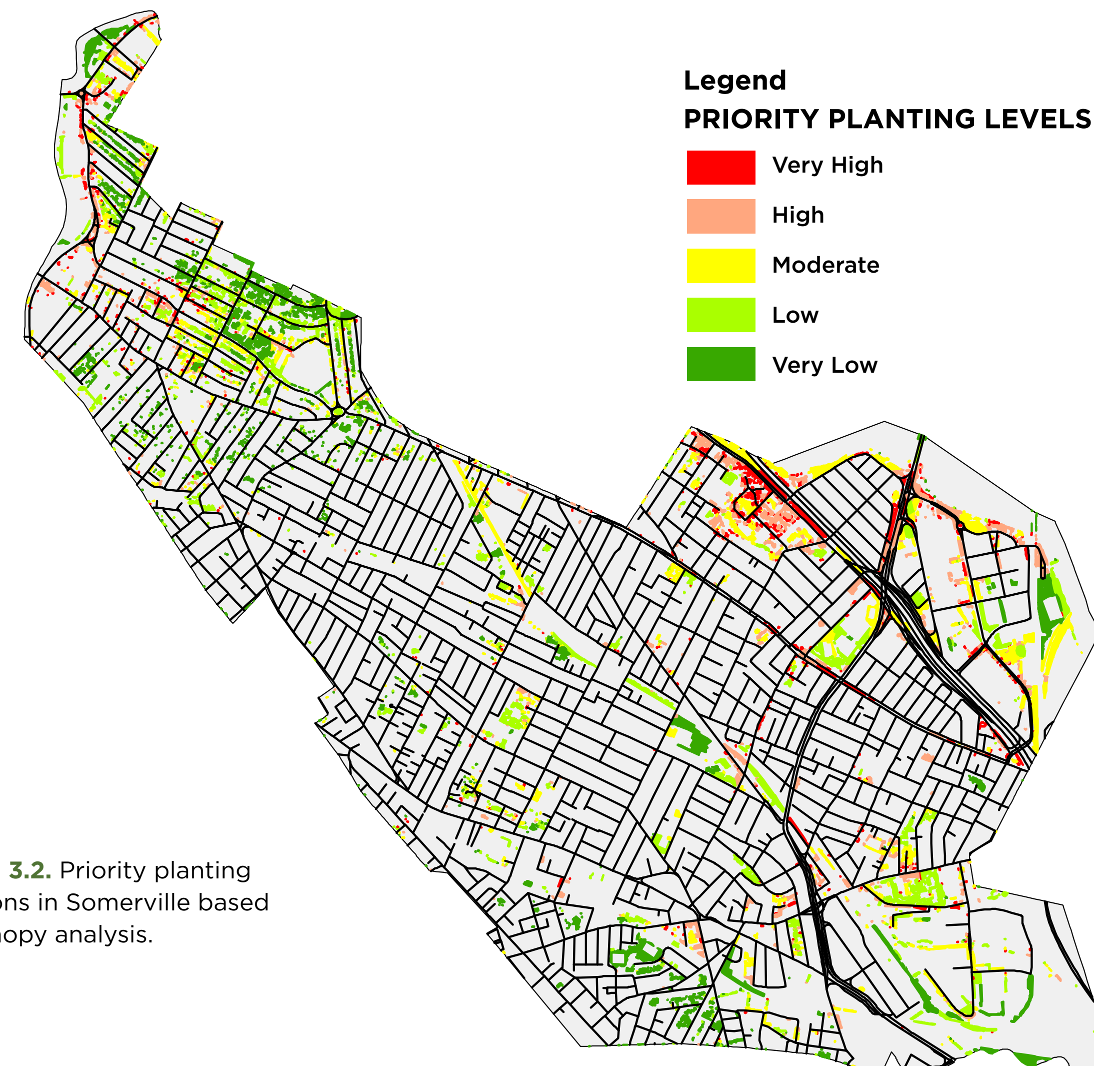


Figure 3.2. Priority planting locations in Somerville based on canopy analysis.

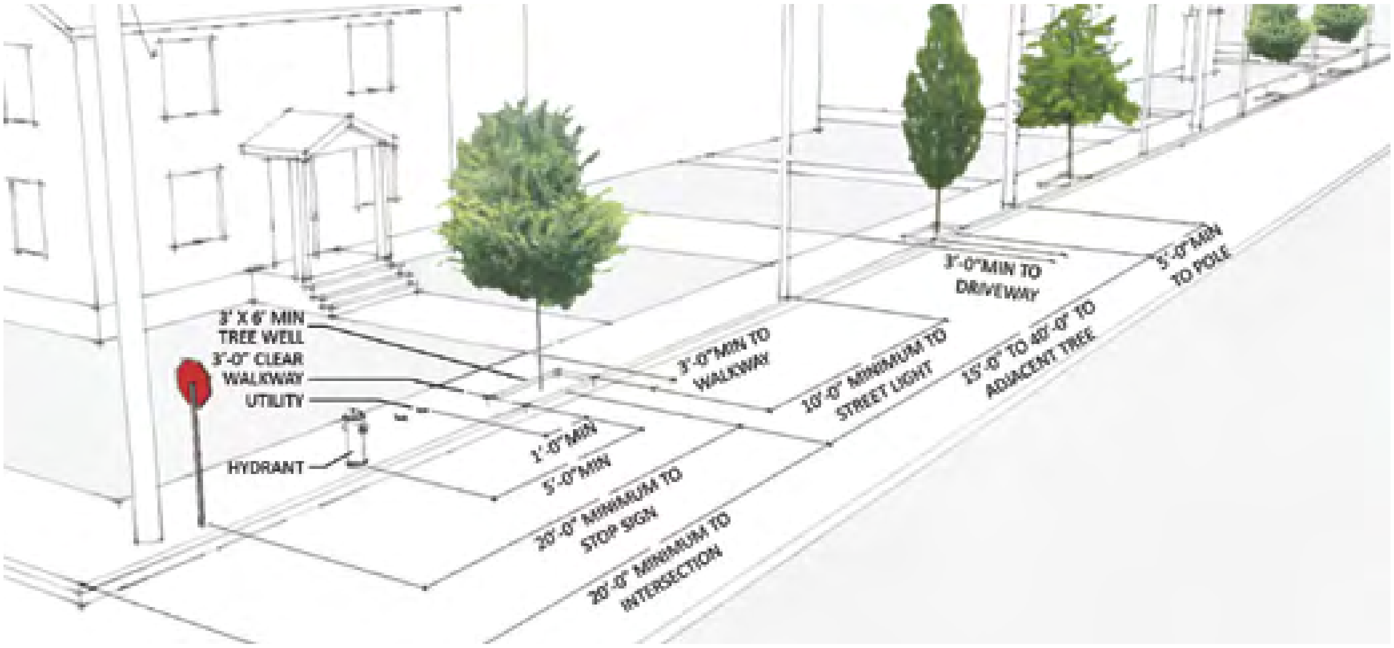


Figure 3.3. Tree planting parameters for new trees in existing sidewalks in Somerville.

TREE PLANTING PARAMETERS

Trees are an important part of City, but they must coexist with various other aspects of the built environment. To provide ample space for a growing tree while also maintaining public safety and protecting other City infrastructure, the City uses the following *minimum* guidelines when choosing new planting locations:

- New tree wells in *existing* sidewalks provide a minimum of 18 square feet of open soil (ex. a 3' x 6' tree well).

- New tree wells in *new* sidewalks must provide a minimum of 36 square feet of open soil (ex. a 6' x 6' tree well), and at least 1,000 gross cubic feet of soil value space for each tree, providing any soil volume under paved surfaces through suspended pavements or structural cells (Somerville Zoning Ordinance 2019).

- To reduce infrastructure conflicts and maintain visibility and access to important public safety features, trees must be planted a minimum of:
    - *20 feet away from any intersection, crosswalk, or stop sign;*
    - *5 feet away from any fire hydrant or utility pole;*
    - *10 feet from any streetlight;*
    - *3 feet from any driveway or walkway; and*
    - *1 foot away from any underground utilities (ex. gas and water).*

- The width of the sidewalk must also be taken into account, as per American with Disabilities Act (ADA) regulations a 3 foot sidewalk with must remain.

- Trees must be spaced out in such a way that they have room to grow. Small trees are spaced at least 15 feet on center (i.e., measured trunk to trunk), medium trees are spaced 25-30 feet on center, and large trees are spaced 40 feet on center.

These guidelines are summarized in **Figure 3.3**.

TREE PLANTING DESIGNS

Tree plantings greatly add to the aesthetic appeal of neighborhoods, historic districts, commercial areas, and industrial areas alike. The impact of new tree plantings is bolstered when specific design considerations are taken into account.

Planting in business districts is useful to increase the beauty and attractiveness of those areas. Research has shown that people pay more for products in landscaped business districts, and that people feel the quality of products is better in business districts with trees (Wolf 1998a, 1998b, 1999, and 2003). Although the way people shop has changed with the use of cell phones, tree selection for business and shopping areas should consider the benefit of shoppers being able to view storefronts, as well as the need to provide shade, safe passage, and clean sidewalks for visitors. Tree canopies should be open, as in *Nyssa sylvatica* (black tupelo), and the branching habit must be high enough to allow pedestrians to walk comfortably beneath the trees. Other options are tall, narrow, upright growing (fastigiate) species, such as Regal Prince Oak (*Quercus x warei* 'Long'). These trees provide beauty, a look of uniformity, and a formal appearance to the shopping district.

Tree plantings in residential areas can be selected to complement the existing types of trees growing on each street and block (such as large growth-habit trees or flowering tree species) or can be selected to begin to develop a uniform look for a given street. It is important to keep species diversity in mind when developing any type of tree planting design. Often, in older neighborhoods, one side of the street has utility lines, which precludes the use of large trees. The primary aesthetic role that street tree plantings can play in a residential neighborhood is to visually link individual homes into a unified landscape. It is this unified quality that makes older neighborhoods with large, mature trees so attractive in many communities. Either formal or informal planting schemes are appropriate for neighborhood streets. In most instances, medium or large trees, spaced so that their canopies overlap, are desirable.

In locations where a tree may not be appropriate to plant, other types of vegetation can be considered, such as vegetative walls, vines, and support structures that offer alternative vertical green space. A better functioning ecosystem will also include native meadows and understory plants.

What to Plant

The City must determine which tree species will be planted in each specific site. The phrase **"right tree, right place"** is the most important concept in planting. Many factors must be considered in choosing a species for a site that maximizes the health and survivability of the tree, and the benefits provided by that tree. Trees in urban environments must withstand particularly challenging conditions, such as high temperatures, drought, flooding, air pollution, soil salt, and limited growing space both above and below ground. Trees have different characteristics suitable for different landscapes, sites and microclimates. It is recommended that all characteristics be recognized, including, but not limited to, the desired function (e.g., seasonal flowering, shade canopy, wind resistance), mature size and shape for the intended location, soil conditions, root structure, maintenance requirements, potential pest problems, and survivability in the face of climate change. Equally important to selecting the right tree is choosing the right spot to plant it. Blocking an unsightly view or creating shade may be a priority, but it is important to also consider how a tree may impact existing structures and utilities as it grows taller, wider, and deeper. For example, if the tree's canopy, at maturity, will reach overhead utility lines, it is best to choose another tree or a different location. Taking the time to consider location before planting can prevent power disturbances and improper utility pruning practices.

RIGHT TREE, RIGHT PLACE

Trees in urban environments must withstand particularly challenging conditions, such as high temperatures, drought, flooding, air pollution, soil salt, and limited growing space both above and below ground. It is recommended that all characteristics be recognized, including, but not limited to:

- ❑ Desired Function (e.g., seasonal flowering, shade canopy, wind resistance)
- ❑ Mature Size and Shape for the intended location
- ❑ Soil Conditions
- ❑ Root Structure
- ❑ Maintenance Requirements
- ❑ Potential Pest Problems
- ❑ Survivability in the face of climate change

Growing space type and size dictates which species are suitable for any given planting site. In Somerville's 2018 tree inventory, the length and width (measured in feet) of the growing space for each of the currently available planting locations was recorded, as well as the presence of all overhead utility lines (including, but not limited to, power, telephone, and cable lines). Of the available planting sites, 100 were designated as "large", meaning that they are suitable for large growth habit trees (3' x 10' or greater grow space size and no overhead wires). In addition, there were 130 "medium" sites (at least 3' x 8' growing space and no overhead wires) and 337 "small" sites (at least 3' x 6' growing space and/or has wires overhead) in the inventory. Regardless of the available growing space size, all locations with overhead wires present were designated as "small" planting sites. **Figure 3.4** shows the distribution of the vacant planting sites by appropriate mature tree size. This distribution is typical for a dense community like Somerville.

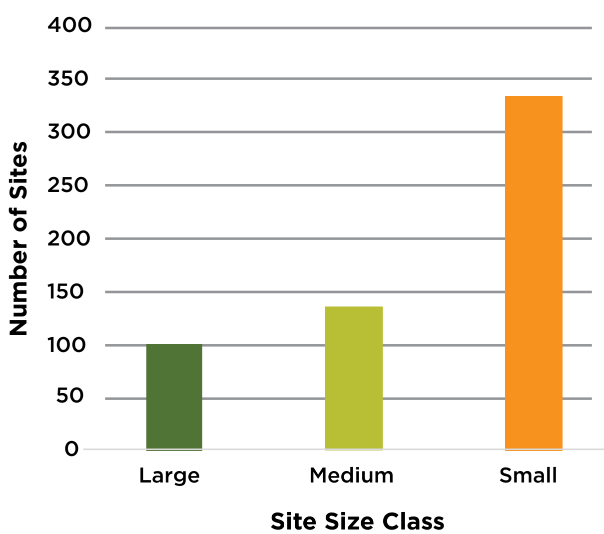


Figure 3.4. Potential planting sites along the City-owned right-of-way, by size class.

Historically, there has been some mismatch of tree species selection with available planting sites in Somerville. There are some large growing trees under power lines, and there are some small growing trees planted in sites suitable for larger trees. Large trees in small spaces can damage sidewalks and curbs, require severe pruning for overhead utility lines and street clearance, and often have a much shorter service life due to the restricted growing area. Small trees in large spaces limit the use of mature shade trees on public streets. It is well known that larger growing trees provide the most environmental and economic benefits, and appropriate areas to plant them rarely exist in older, well developed communities. Proactive planning should be made to plant the "right tree, right place" in the vacant sites, considering available growing space, presence of utilities, and traffic and pedestrian clearance issues, while obtaining the desired aesthetic effects and function of the street tree. Planting the proper type of tree for each planting area will result in a more effective, healthy, and attractive urban forest.

TREE SPECIES DIVERSITY

At the scale of the entire urban forest, species diversity in new plantings should be of major importance. Planting a variety of species can decrease the impact of species-specific pests and diseases by limiting the number of susceptible trees in a population. Moreover, planting a wide variety of tree species can help limit the impacts from physical events, as different tree species react differently to stress. Species diversity helps withstand urban forest impacts from drought, ice, flooding, strong storms, and wind.

As stated in *Section 2: Somerville's Tree Inventory Data*, Norway maple accounts for 14% and callery pear and red maple each account for 10% of Somerville's total public tree population. The dangers of planting monocultures have proven to be devastating. One of Somerville's goals should be to increase species diversity throughout the City, such that no species represents more than 10% and that no one genus comprises more than

20% of the population. Consideration should be given to large trees that provide shade, are aesthetically pleasing, and provide food or habitat for native insects and wildlife. Although the City should consider focusing efforts on planting species that are native to the region, particularly in the face of climate change, the wider effort should focus on urban-tolerant and/or wind-resistant species, regardless of origin. See *Appendix D* for species recommendations.

TREE SPECIES SELECTION

Somerville is located in Zone 6b of the USDA Hardiness Zone Map. This zone identifies a climatic region where the average annual minimum temperature is between -5º and 0º F, precipitation averages 48 inches per year, and the growing season lasts approximately 160 days. Tree species selected for planting in the city should be an appropriate mix of native and non-native tree species for this zone.

Matching a species to its favored climatic and soil conditions is the most important task when planning for a maintainable and survivable landscape. Plants that are well matched to their environmental conditions are much more likely to resist pathogens, insect pests, and severe storm damage and will therefore require less maintenance overall and be more likely to survive.

In addition to considering site characteristics (such as climate, precipitation, native vegetation, availability of space) and soil characteristics (such as soil texture, structure, drainage, pH, water availability, and road salt), specific physical tree features must also be scrutinized to ensure public safety. Some considerations for street trees are the amount of litter dropped by mature trees, the maintenance required, and public acceptance. For example, some species, such as *Salix* spp. (willow) and *Acer saccharinum* (silver maple) have weak wood and typically drop many small branches during a growing season. They are also prone to dropping larger branches, which can be a safety hazard. Other species, such as *Liquidambar styraciflua* (American sweetgum), drop high volumes of fruits. Similarly, female trees of *Magnolia grandiflora* (southern magnolia) or *Ginkgo biloba* produce large or offensive fruits. A few species of trees, including *Crataegus* spp. (hawthorn) and *Maclura pomifera* (osage orange), may have substantial thorns and should be avoided in high-traffic areas. Tree form and mature tree height are also important considerations in tree selection. For example, only short-statured trees should be planted under powerlines to avoid utility conflicts. Trees with low branching habits should be avoided along streets and in high traffic areas to avoid conflicts with pedestrians and vehicles. Trees with wide canopies should not be planted too close to buildings or other structures.

In the face of climate change, plummeting insect populations, and mass extinctions, the City should focus efforts on planting species indigenous to New England and other areas of the East Coast. Species that are native to the coastal New England climate have evolved in environmental conditions that resemble our urban environment, and may be good candidates for planting. Planting species that are native to the region whenever possible will provide additional benefits to the ecosystem at large.

Above all, given the tough growing conditions in an urban environment, tree species should be selected for their durability and low maintenance requirements. These attributes are highly dependent on site characteristics as well as species characteristics.

Refer to *Appendix D* for specific tree species and cultivars suitable for planting in Somerville. This Suggested Tree Species list is meant to be a guideline for selecting which species to plant during future street tree plantings. The list considers maintenance requirements, adaptability to specific planting sites, and suitability to the restrictive conditions of the urban environment, among others. The suggested species have been categorized by mature height classes (small, medium, and large) that match the potential planting site size designations. [The size of the site refers to the mature size of a tree suitable to be

planted in that particular site.] Selecting trees from this list will help to ensure that appropriately sized trees are planted in sites suitable to sustain the tree's natural habit. The list also includes details on which species are native to New England. A select number of species in this list are not recommended for planting along streets, but which are appropriate for planting in parks and public spaces.

How to Plant

The steps taken to properly plant trees must continue to be clearly outlined for City crews and/or contractors performing the work. Planting oversight and/or post planting inspections must continue to be performed to ensure that the work meets the guidelines set forth by the City.

The tree planting methodology outlined below follows industry standards and best practices, including the *American National Standards Institute (ANSI) Z60.1-2014 American Standard for Nursery Stock,* and the *American National Standards Institute (ANSI): Standard A300. Standard Practices for Tree, Shrub and other Woody Plant Maintenance.* See *Appendix E* for the complete set of technical specifications that are included in the City's planting contracts.

CHOOSING HEALTHY PLANTING STOCK

Trees in Massachusetts are largely available as balled and burlapped (B&B) stock. It is important to inspect and select trees from the nursery (when possible), and to check their status upon delivery to ensure that they are healthy and able to survive during the initial shock of planting. Trees with the following symptoms should be rejected: trees with circling or girdling roots; trees with an unhealthy appearance or weak, poorly formed, scarred, or cracked trunks or branches; trees with double leaders or with branches clustered together on the trunk; trees with leaves of abnormal size or unexplained yellowing (possible indication of a health problem), and trees with insects, disease symptoms or signs, or mechanical damage.

HANDLE TREES WITH CARE

Trees are living organisms and are perishable. Protect trees from damage during transport and when loading and unloading. Use care not to break branches, and do not lift trees by the trunk.

If trees are stored prior to planting, keep the roots moist.

SITE PREPARATIONS

Some existing tree wells are too small for an ideal growth space for a tree, and need to be expanded to provide a sufficient area of open soil. The size of the available growth space is a major factor in determining what size tree can be planted (large, medium, or small).

The tree-planting hole should be relatively shallow (typically slightly less deep than the height of the root ball) and quite wide (ideally three times the diameter of the root ball). This will ensure the soil is properly aerated and decompacted prior to planting. Care should be taken not to excavate the planting hole too deep in order to ensure that the root collar of the new tree is at the same level or slightly higher than the surrounding soil grade.

Once the soil is loosened, it should be backfilled with native soil (i.e. the same soil that was excavated) to the proper root ball depth. In some instances the site may require additional soil, however native soil is preferred due to new/different soil creating a pot-effect (when different soils are next to each other, water tends to stay in one of them and not the other).

In most situations, it is not recommended to add soil amendments to the soil in the planting hole

as this can lead to severe differences between texture and structure of soils inside the planting hole and the surrounding soil. Such differences can lead to water being wicked away from or accumulating in the planting hole. However, if the native soil is undesirable, soil amendments can be added as appropriate for local conditions.

TREE PLANTING

One of the most important facets of proper planting is making sure the tree is placed at the correct height in the soil. The root flare of the tree should be place at grade or even 1 inch above grade. This ensures that the structural roots are near the top of the soil. The root flare of many trees gets buried in the nursery. Thus it is essential that, prior to planting, any excess soil is removed from the top of the root ball to expose the root flare. At the time of planting, the entire wire basket and at least 2/3 of the burlap on B&B trees should be removed. Any remaining burlap must be biodegradable.

When backfilling the soil around the root ball, gently tamp and add water to reduce large air pockets and ensure a consistent medium of soil, oxygen, and water.

After planting, the soil should be thoroughly soaked. The tree should be watered with at least 20 gallons of water (10 gallons per inch caliper) at least two times per week for 30 days after planting, and then one time per week for the remaining portion of the growing season.

Staking of the tree should only be done when necessary to keep the tree from leaning (windy sites) or to prevent damage from pedestrians and/or vandals. Stakes should only be attached to the tree with a loose, flexible material, and all staking materials must be removed within one growing season.

TREE MULCHING/ GROUND COVER:

A thin layer of coarse mulch should be applied to the surface of the soil around each newly planted tree. Mulch should never be piled up around the root collar (*i.e.* in mulch "volcanoes"), but rather should be pulled away from the root collar (*i.e.* in mulch "donuts") (**Figure 3.5**). Mulch that buries the root collar provides shelter for insects, fungi, and mammals that could damage the tree, and

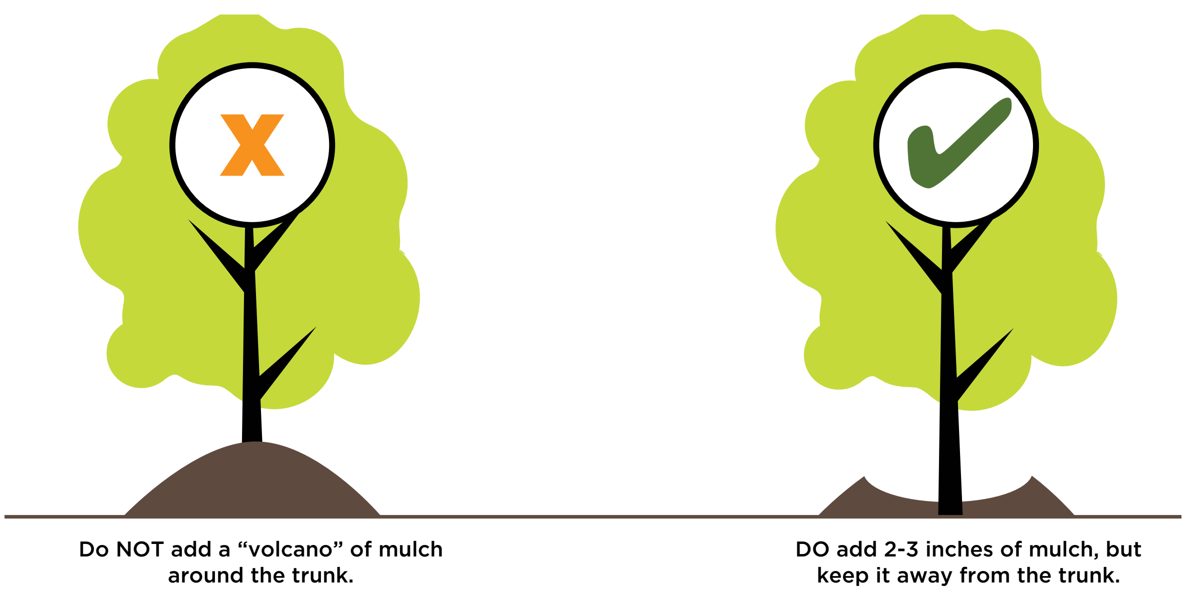


Figure 3.5. Improper mulching (mulch volcano) vs. proper mulching (mulch donut).

also encourages the growth of adventitious roots which can eventually turn into girdling roots.

Mulch should be applied to an area three times the diameter of the root ball to a depth of 2–3 inches (with no mulch applied within 1–3 inches of the trunk). Mulch not only suppresses competition from grass and weeds, but also provides a zone where mowing is not needed, thereby keeping mowers and string trimmers safely away from tree trunks (thus preventing mechanical damage). Mulch also helps to hold moisture in the surface of the soil where most of the feeder roots are to be established.

As an alternative to bark mulch, the City may consider planting short, spreading, perennial groundcovers in some locations. These plants, sometimes referred to as "green mulch" or "living mulch", provide many of the same benefits as bark mulch, while also providing food and habitat for pollinating insects and other wildlife. Some initial investment (in both time and money) would be required to purchase and maintain these plants, so this may not be a viable alternative for all locations.

TREE FERTILIZATION

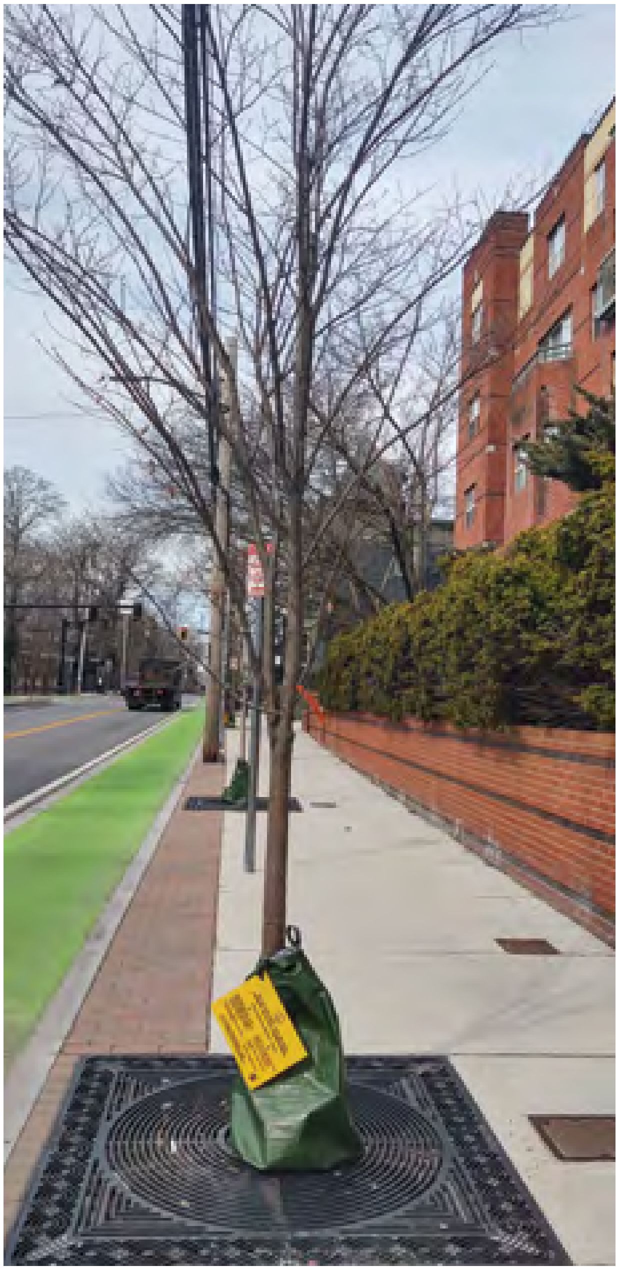
Any fertilization process should not be thought of as "feeding" or "energizing" the plant; instead, arboricultural fertilizers should be understood as essentially replacing soil elements or minerals that are lacking or in short supply for a variety of reasons. Soil pH is also an important consideration. Nutrients may be in adequate supply, but be unavailable for uptake by the tree because of extreme high or low pH conditions. Application of fertilizer may not improve the situation until measures are taken to alter pH levels or to replace the plant with a species better suited for the existing soil conditions.

To account for the urban soil conditions in Somerville a slow release fertilizer is typically used at the time of planting to help with transplant shock, and to increase nutrients of the soil in the tree well. Slow-release fertilizers applied in autumn will help root growth and will still be available the following spring. At the beginning of the second growing season, fertilizers can be applied to the root zone. Nitrogen is usually the limiting nutrient for plant growth. Soil analysis, particularly when combined with a foliar analysis, can determine when other elements are in short supply. The soil analysis should only be reserved for sites that continue to have tree decline, as the process to include all sites would be costly.

Alternative soil amendments should be considered and applied as needed. For example, if the soil is lacking organic matter, adding a 1-2" layer of compost under the mulch layer would increase the organic matter content, which would improve water retention and infiltration, reduce compaction, and increase soil fertility.

TREE PRUNING

At the time of planting, the only pruning that should be done is the removal of broken or dead branches.



Tree Care after Planting

A systematic program of proactive maintenance, specifically designed for newly planted trees, is necessary to provide them with the greatest chance of long-term survival.

Activities such as watering, mulch application, removal of staking materials, and inspections should be adopted to ensure that proper care is taken to protect the investment of a tree planting program and the trees themselves.

Somerville's current planting contracts include watering (weekly during the summer months) and other maintenance activities for a period of two-years after planting (see *Appendix E* for details). Watering is provided by 20 gallon green irrigation bag ("gator bags"), which are placed on the tree stakes to reduce the potential for bark rot and sun scald.

In addition, all new trees planted in accordance with this *Tree Planting Plan* should be pruned 3 years after planting and added to the Young Tree Training cycle (*Section 3.2 Tree Maintenance Plan*).

Educating the community on basic tree care is a good way to promote the City's urban forestry program and encourage tree planting on private property. The City should encourage residents to water trees on the ROW adjacent to their homes and to reach out to the City if they notice any changes in the trees, such as signs or symptoms of pests, early fall foliage, or new mechanical or vehicle damage.

Residents should be made aware that certain behaviors can have a long term detrimental impact on the health and survival of young trees. For example, locking bikes to trees can cause wounds that are difficult to close, and which divert a young tree's limited resources to wound recovery rather than growth. Informational signs can help encourage residents to care for these young trees, and discourage behavior that may damage trees.

Summary and Conclusions

Planting new trees is an important way for Somerville to grow the tree canopy over the long-term. The City should plant trees in the 567 currently available planting sites along the City-owned rights-of-way (ROW) that were identified during the 2018 tree inventory. The City should also continue to plant trees in other areas of the city, both by continuing to fulfill resident requests and by focusing tree planting efforts in high priority planting areas identified by the canopy analysis. To determine the appropriate species to plant in each location, use the "right tree, right place" best practice, taking into account species and site characteristics. Species diversity, climatic conditions, and public needs are also important factors to consider. When possible, use native species to elevate ecosystem functioning. Use best practices to carefully plant trees to give them the best chance of success. Proper planting techniques include choosing quality tree stock, handling trees with care, properly preparing the site for a new tree, planting trees at the proper depth, and protecting the roots and soil with mulch and organic matter when necessary. Improve the health and longevity of newly planted trees by watering them regularly throughout the establishment period, replenishing mulch as needed, and adding trees to the Young Tree Training pruning cycle.

Upon hiring its first Urban Forester and Landscape Planner in 2016, the City of Somerville began to build a structured tree planting program. In the past "right tree, right place" was not always considered, and often only 60 or so trees were planted each year. Since the City hired an Urban Forestry and Landscape Planner, a number of changes have been implemented. Planting practices within the City of Somerville have greatly improved, including careful species selection, acquiring quality stock from nurseries, updating planting specifications to ensure best practices, oversight of contractor plantings, and ensuring that newly planted trees are maintained during their two-year warranty period. In response to scientific literature and industry best practices, the City now plants 2-inch caliper trees, which are the most appropriate and adaptable sized tree to plant as they are small enough to tolerate and recover from transplant shock, but are large enough to not block pedestrian traffic and can handle small amounts of mechanical damage.

While continuing to develop the planting program, a shift has been made toward making data-based decisions. The City now considers the factors outlined above when making short and long term decisions, including species diversity goals (rule of thumb is a maximum of 10% of any species and 20% of any genus) and choosing the proper tree species to complement site restrictions to provide the greatest return on the investment of planting and caring for new street trees.

The Urban Forestry Program has been greatly improved in the last five years, but there is still more to be done. With highly qualified staff, high-capacity and engaged community advocates, and the political support and understanding of the importance of trees, the program can now turn towards the long term goals of expanding the future tree canopy, preserving the existing trees and proactively maintaining the newly planted trees to give them a chance at health and survival in an urban environment.


TEREX
TEREX

3.2 Tree Maintenance Program

While the preservation and expansion of the urban tree canopy are lofty goals, the importance of a tree care program to achieving these goals cannot be underestimated. A comprehensive maintenance program can reduce public safety risk and property damage, improve the health of the overall urban forest, and increase the lifespan and benefits of individual trees. A tree maintenance program is an ongoing process which involves both priority and proactive arboricultural practices.

This tree maintenance program was developed to uphold Somerville's comprehensive vision for preserving its urban forest. This seven-year program is based on the tree inventory data (see *Section 2: Somerville's Tree Inventory Data*); the program was designed to reduce risk through prioritized tree removal and pruning, to improve tree health and structure through proactive pruning cycles, and to mitigate removals and increase canopy cover through tree planting. Work identified in the inventory should be completed based on the assigned risk rating. However, routinely monitoring the tree population is essential so that other Extreme or High Risk trees can be continually identified and systematically addressed. While regular pruning cycles and tree planting are important, priority work (especially for Extreme or High Risk trees) must take precedence to ensure that risk is expediently managed.

Priority & Proactive Maintenance

In this plan, the recommended tree maintenance work was divided into either '**priority**' or '**proactive**' maintenance programs.

Priority maintenance includes tree removals and pruning of trees with an assessed risk rating of High or Extreme Risk. This work should be done first for reasons of public safety.

Proactive maintenance includes pruning of trees with an assessed risk of Moderate or Low Risk as well as pruning young trees. Tree planting, inspections (for structural integrity, presence of disease/pests), and community outreach are also considered proactive maintenance.

Additional information on risk rating and priority/proactive maintenance can be found in *Appendix F*.

PRIORITY Maintenance

EXTREME RISK

- **Perform tree maintenance immediately to reduce hazards**
- **Includes tree removal and pruning**
- **Mostly high-use areas**

HIGH RISK

- **Perform tree maintenance immediately to reduce hazards and improve tree health**
- **Includes tree removal and pruning**
- **Generally high-use areas**

PROACTIVE Maintenance

MODERATE RISK

- **Perform tree maintenance as soon as possible to improve tree health**
- **Includes tree removal and pruning**
- **May be high- or low-use areas**

LOW RISK

- **Perform tree maintenance when convenient to improve aesthetics and eliminate nuisance trees and stumps**
- **Includes tree removals and pruning**
- **Mostly low-use areas but may be high-use areas as well**

ROUTINE PRUNING

- **Perform tree maintenance when convenient to improve aesthetics and eliminate nuisance tree parts**

TRAINING PRUNE

- **Perform corrective pruning to young trees to increase structural integrity and develop a strong architecture of branches before serious problems develop**

PRIORITY MAINTENANCE

A. Tree and Stump Removal

Although tree removal is usually considered a last resort, there are circumstances in which removal is necessary. Trees fail from natural causes including old age, diseases, insect pest infestation, and extreme weather events, and from physical injury due to vehicles, vandalism, and root disturbances. Trees must be removed when they present a danger to the public. Additionally, trees should be removed when corrective pruning will not adequately eliminate the hazard or when correcting problems would be cost-prohibitive. Trees that cause obstructions or interfere with power lines or other infrastructure should be removed when their defects cannot be corrected through pruning or other maintenance practices. Diseased and nuisance trees (invasive trees and trees in poor locations) also warrant removal.

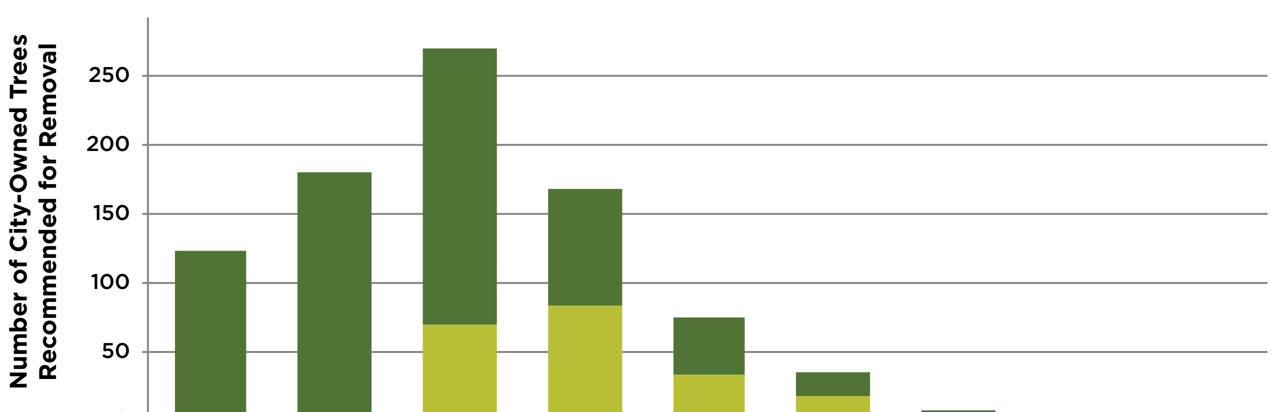
Even though large short-term expenditures may be required, it is important to secure the funding needed to complete priority tree removals. Expedient removal reduces risk and promotes public safety.

In the 2018 tree inventory (see *Section 2: Somerville's Tree Inventory Data*), 864 (out of 11,484 total) City-owned trees, and 290 (out of 2,120 total) State-owned trees were recommended for removal. **Figure 3.6** and **Figure 3.7** present the City-owned trees and State-owned trees, respectively, that were recommended for removal by risk rating and diameter size class (diameter measured at breast height).

CITY-OWNED TREE REMOVAL FINDINGS (ROW and City-owned open spaces)

- The 2018 tree inventory identified 11 High Risk, 200 Moderate Risk, and 653 Low Risk City-owned trees that are recommended for removal. No Extreme Risk trees were identified in the inventory.
- The diameter size classes for the High Risk trees ranged from 9 to 30 inches diameter at breast height (DBH). These trees should be removed immediately based on their assigned risk. High Risk removals and High Risk pruning can be performed concurrently.

Figure 3.6. City-owned trees recommended for removal by risk rating and diameter size class.



Risk Rating	1″–3″	4″–6″	7″–12″	13″–18″	19″–24″	25″–30″	31″–36″	37″–42″	≥43″
Low	123	180	202	86	41	17	3	1	0
Moderate	0	0	68	78	30	17	5	2	0
High	0	0	1	5	4	1	0	0	0

Diameter Size Class

- Most of the City-owned Moderate Risk trees were smaller than 31 inches DBH. These trees should be removed as soon as possible after all High Risk removals and prunings have been completed.

- Low Risk trees pose little threat; these trees are generally small, dead, invasive, or poorly formed trees that need to be removed. Eliminating these trees will reduce breeding site locations for insects, reduce disease host potential, increase the aesthetic value of the area, and make new sites available for more appropriate species to be planted. Healthy trees of an undesirable species or those growing in poor locations are also included in this category. All Low Risk trees should be removed when convenient and after all High and Moderate Risk removals and prunings have been completed.

- Of the City-owned trees recommended for removal, 32 are ash trees which are susceptible to Emerald Ash Borer infestation (see *Section 3.3: Invasive Insects and Disease Management Strategy*).

- The inventory also identified 231 stumps recommended for removal on City-owned land. Almost all of these stumps were larger than 5 inches in diameter. Stump removals should occur when convenient.

STATE-OWNED TREE REMOVAL FINDINGS

- On State-owned land, the inventory identified 1 High Risk tree, 31 Moderate Risk trees, and 258 Low Risk trees that are recommended for removal. No Extreme Risk trees were identified in the inventory.

- The State-owned High Risk tree is approximately 11 inches diameter at breast height (DBH). This tree should be removed immediately based on its assigned risk.

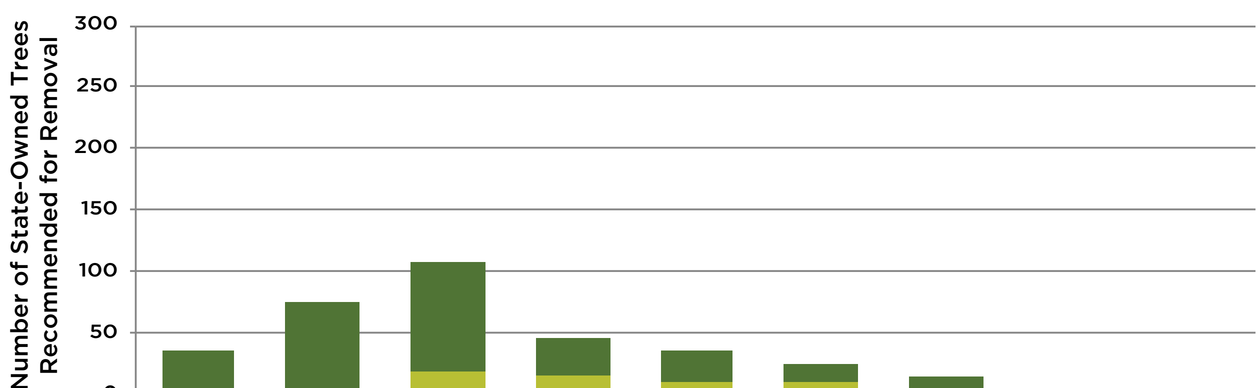
- Most State-owned Moderate Risk trees were smaller than 31 inches DBH. These trees should be removed as soon as possible after all High Risk removals and prunings have been completed.

- As detailed in the City-owned Tree Findings, Low Risk trees present little threat to public safety, and should be removed when convenient and after all High and Moderate Risk removals and prunings have been completed.

- Six (6) of the state-owned trees recommended for removal are ash trees that are susceptible to EAB.

- The inventory identified 24 stumps recommended for removal on State-owned land. Almost all of these stumps were larger than 10 inches in diameter. Stump removals should occur when convenient.

Figure 3.7. State-owned trees recommended for removal by risk rating and diameter size class.



Risk Rating	1″–3″	4″–6″	7″–12″	13″–18″	19″–24″	25″–30″	31″–36″	37″–42″	≥43″
Low	31	66	90	39	14	8	4	3	3
Moderate	0	1	12	7	5	5	1	0	0
High	0	0	1	0	0	0	0	0	0

Diameter Size Class

B. Tree Pruning

High and Moderate Risk pruning generally requires cleaning the canopy of both small and large trees to remove defects such as dead, diseased, and/or broken branches that may be present even when the rest of the tree is sound. In these cases, pruning the branch or branches can correct the problem and reduce risk associated with the tree.

Figure 3.8 and **Figure 3.9** present the City-owned trees and State-owned trees, respectively, that were recommended for pruning by size class.

CITY-OWNED TREE PRUNING FINDINGS (ROW AND CITY-OWNED OPEN SPACES)

The inventory identified 8 High Risk, and 325 Moderate Risk City-owned trees recommended for pruning.

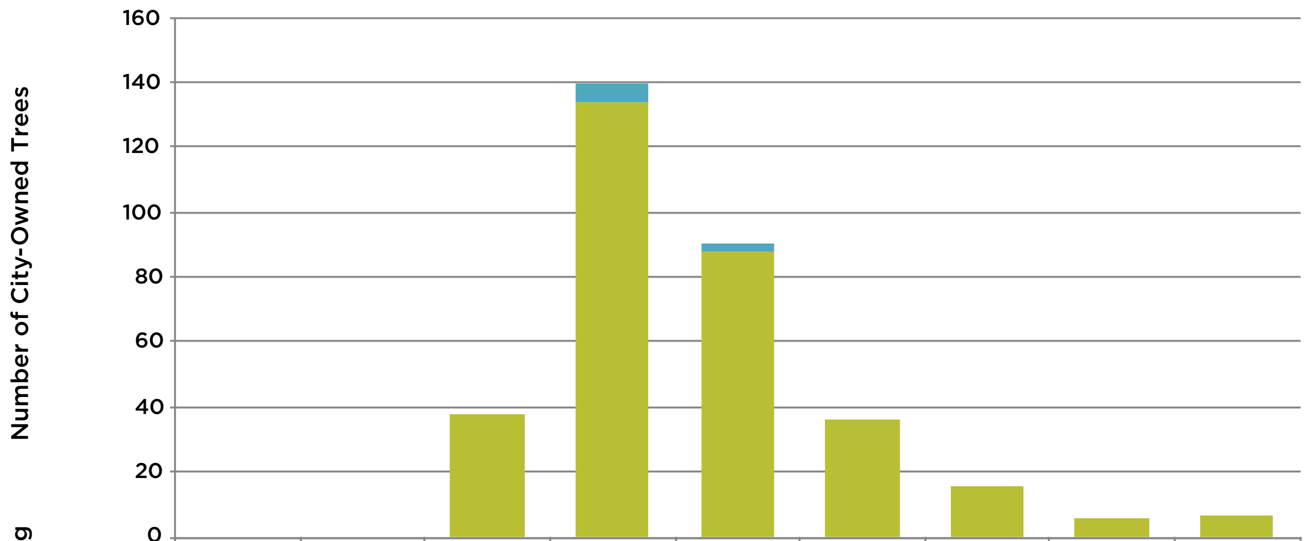
The High Risk trees ranged in diameter from 13 to 24 inches DBH. Pruning should be performed immediately based on assigned risk and may be performed concurrently with other High Risk removals. Moderate Risk trees ranged in size from 7 inches DBH to over 43 inches DBH.

Most of the City-owned trees (over 10,000) were categorized as Low Risk trees recommended for pruning. These trees should be included in a proactive, routine pruning cycle after all the higher risk trees are addressed.

STATE-OWNED TREE PRUNING FINDINGS

The inventory identified 2 High Risk and 32 Moderate Risk State-owned trees recommended for pruning. Trees with High Risk pruning needs were in the 19–24 inches DBH and 43+ inches DBH diameter size classes. Trees with moderate risk pruning needs ranged from 7 inches DBH to over 43 inches DBH.

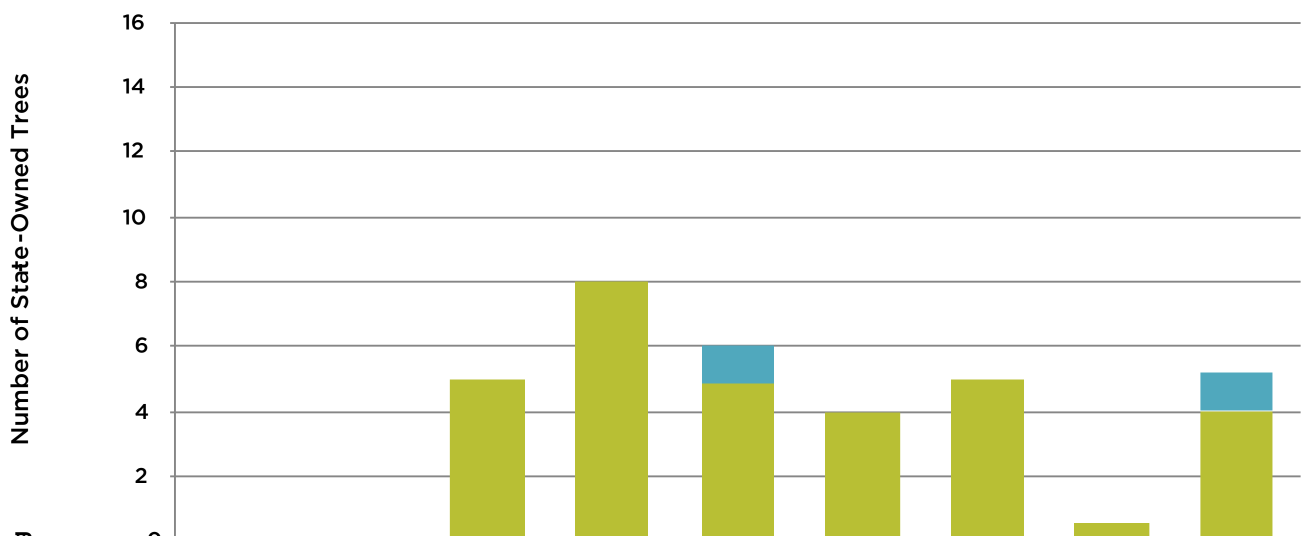
Figure 3.8. High and Moderate Risk trees recommended for pruning by diameter size class (City-owned trees only).



Risk Rating	1″–3″	4″–6″	7″– 12″	13″–18″	19″– 24″	25″–30″	31″– 36″	37″– 42″	≥43″
High	0	0	0	6	2	0	0	0	0
Moderate	0	0	38	134	88	36	16	6	7

Diameter Size Class (inches)

Figure 3.9. High and Moderate Risk trees recommended for pruning by diameter size class (State-owned trees only).



Risk Rating	1″–3″	4″–6″	7″– 12″	13″–18″	19″– 24″	25″–30″	31″– 36″	37″– 42″	≥43″
High	0	0	0	0	1	0	0	0	1
Moderate	0	0	5	8	5	4	5	1	4

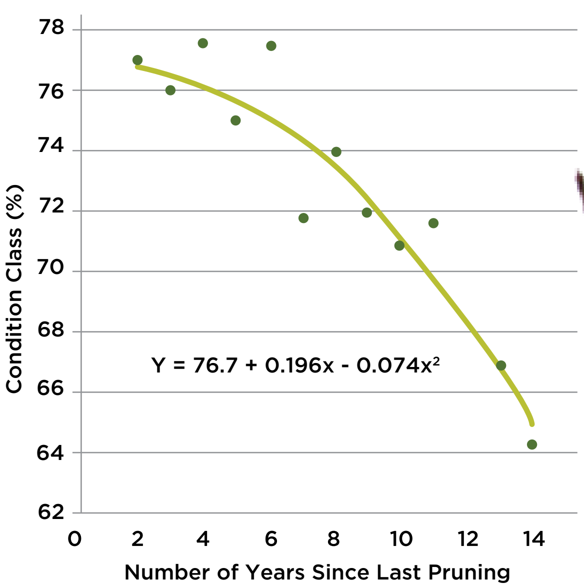
Diameter Size Class (inches)

BOX 3.1: Why Prune Trees on a Cycle?

For many communities, a proactive tree management program is considered unfeasible. An on-demand (reactive) response to urgent situations is the norm. However, research has shown that a proactive program that includes a routine pruning cycle will improve the overall health of a tree population. For example, Miller and Sylvester (1981) examined the frequency of pruning for 40,000 street and boulevard trees in Milwaukee, Wisconsin. They found that the health condition of trees decreased as the length of the pruning cycle increased. When pruning was not completed for more than 10 years, the average tree condition was 10% lower than trees that had been pruned within the last several years. Miller and Sylvester suggested that a pruning cycle of five years is optimal for urban trees.

Proactive tree maintenance has many advantages over on-demand maintenance, the most significant of which is reduced risk. In a proactive program, trees are regularly assessed and pruned, which helps detect and eliminate most defects before they escalate to a hazardous situation with an unacceptable level of risk. Other advantages of a proactive program include increased environmental and economic benefits from trees, more predictable budgets and projectable workloads, and reduced long-term tree maintenance costs. Although historically Somerville has not had a proactive maintenance program, one of the goals of this Management Plan is to put forth a feasible method of achieving this type of program.

Figure 3.10. Relationship between average tree condition class and the number of years since the most recent pruning (adapted from Miller and Sylvester 1981). The light green trend line shows that a tree's condition decreases as the length of time between pruning cycles increases.



PROACTIVE MAINTENANCE

Proactive tree maintenance that actively mitigates elevated-risk situations will bolster tree health and public safety. These maintenance activities include pruning, young tree training, tree planting, other types of tree care, and tree inspections.

A. Pruning Cycles

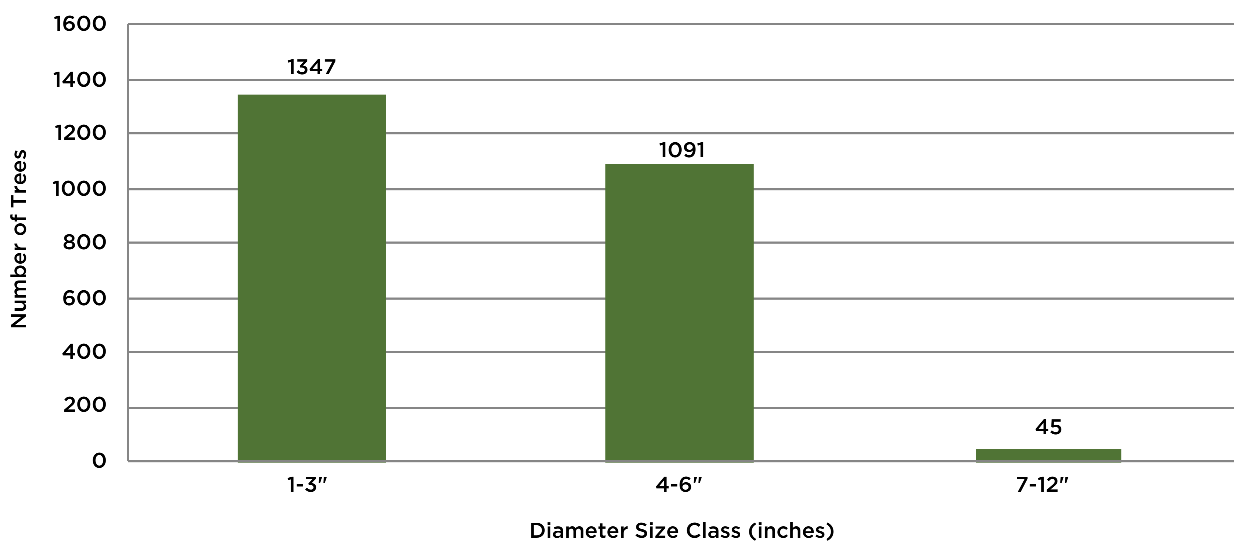
The goals of pruning cycles are to visit, assess, and prune trees on a regular schedule to improve health and reduce risk (**Box 3.1**). Pruning cycles should begin after all Extreme and High Risk trees are corrected through removal or pruning. Due to the long-term benefits of pruning cycles (**Figure 3.10**), these pruning cycles should be implemented as soon as possible. To ensure that all trees receive the type of pruning they need to mature with better structure and lower associated risk, two pruning cycles are recommended: the young tree training cycle (YTT Cycle) and the routine pruning cycle (RP Cycle). The cycles differ in the type of pruning, the general age of the target tree, and length of time of the cycle.

The recommended number of trees in the pruning cycles will need to be continually modified to reflect changes in the tree population as trees are planted, age, and die. Newly planted trees will enter the YTT Cycle once they become established. As young trees reach maturity, they will be shifted from the YTT Cycle into the RP Cycle. When a tree reaches the end of its useful life, it should be removed and eliminated from the RP Cycle.

YOUNG TREE TRAINING CYCLE

Young Tree Training (YTT) is a type of pruning performed to improve tree form or structure and encourage a wind-resistant urban forest. Younger trees sometimes have poor branch structures that can lead to problems as the tree ages, including codominant leaders, multiple limbs attaching at the same point on the trunk, and crossing/interfering limbs. These problems can be remedied easily and inexpensively while trees are small and immature. If not alleviated while trees are young, these potential problems can lead to poorly attached branches and/or wood decay as the tree ages. As they grow, trees

Figure 3.11. City-owned trees recommended for the Young Tree Training Cycle by diameter size class.



with poor branching can become safety risks and create potential liability for Somerville.

Young tree training consists of correcting structural problems though the removal of dead, dying, diseased, interfering, conflicting, and weak branches, as well as selective trimming to direct future branch growth. YTT pruning is also performed to provide adequate pedestrian and vehicular clearance, as trees that have insufficient clearance are prone to having their branches torn or ripped off.

Trees included in the YTT Cycle generally measure less than 8 inches DBH and less than 20 feet in height. YTT pruning is relatively inexpensive since the work can generally be performed from the ground with a pole pruner or pruning shears. YTT pruning is species-specific, since many trees, such as Betula nigra (river birch), may naturally have more than one leader. For such trees, YTT pruning is performed to develop a strong structural architecture of branches so that future growth will lead to a healthy, structurally sound tree.

Recommendations for YTT Cycle

A YTT program would be extremely beneficial for the overall health and quality of Somerville's urban forest in both the short- and long-term. Somerville should implement a three-year YTT Cycle that includes all existing young trees. In the 2018 inventory, 2,483 City-owned trees were identified and recommended for Young Tree Training (**Figure 3.11**). Since the number of existing young trees is relatively small, and the benefit of beginning the YTT Cycle is substantial, an average of 828 trees (one-third) can be structurally pruned each year over 3 years, beginning in Year One of the maintenance program. Based on this recommendation, Somerville initiated the YTT Cycle in 2020, and completed YTT pruning for 822 trees.

In future years, the number of trees in the YTT Cycle will be based on tree planting efforts and growth rates of young trees. As trees are planted, they will need to enter the YTT Cycle after establishment. Training pruning should not be done immediately after a tree is planted since it is already under stress from transplanting and needs as much of its leaf canopy as possible in order to manufacture food for proper establishment in its new site. Only dead or broken branches should be removed at the time of planting. Newly planted trees should receive their first training prune three years following planting and continue on a 3-year cycle.

ROUTINE PRUNING CYCLE

Routine Pruning (RP) involves the pruning of established, maturing, and mature trees that need canopy cleaning, crown raising, and/or crown reducing to remove deadwood and improve structure. Over time, routine pruning can decrease the amount of reactive maintenance required and minimize instances of elevated risk, thereby providing the basis for a more defensible risk management program. Included in this cycle are Low Risk trees that require pruning and pose some risk but for which the tree or the defect is of smaller size and/or has less potential for impacting a target. The defects found within these trees can usually be remediated during an RP Cycle.

Routine Pruning Cycle Length

The length of the RP Cycle is based on the size of the tree population and an assumption as to a reasonable number of trees to prune per year. Generally, the RP Cycle recommended for a tree population is five years (Vogt, Hauer and Fischer, 2015), but may extend to seven years if the population is large. On average, based on Davey Resource Group's experience with urban forests and cities in the United States, a 7 to 10-year routine pruning program is an acceptable rotation time to efficiently sustain an urban forest.

Recommendations for Routine Pruning Cycle

Based on the current number of trees that require routine pruning and the estimated funding level, it is recommended that the City establish a six-year RP Cycle in which approximately one-sixth of the tree population is pruned each year. The 2018 tree inventory identified approximately 7,600 City-owned trees that should be pruned during the RP Cycle. Thus, an average of 1,267 trees should be pruned each year over the course of the six-year cycle. It is recommended that the RP Cycle begin in Year Two of this seven-year plan, after all High and Moderate Risk trees are pruned and the YTT Cycle is underway.

This six-year RP cycle does not incorporate trees that will be planted in the future. As newly planted trees are added to the routine maintenance cycle, the City should evaluate whether a seven or ten year cycle is more realistic.

B. Tree Planting

Tree planting is an important facet of maintaining and expanding the City's urban forest. The City's goal is to plant at least 350 trees on public property each year. Planting new trees help to mitigate the loss of trees due to necessary removals. See *Section 3.1: Tree Planting Plan* for more details.

C. Other Tree Care

The urban environment is a challenging place for trees to grow, and sometimes additional types of tree maintenance can help maintain or improve tree health. Examples of other types of tree care include:

- **Water:** Trees need regular watering, particularly during the establishment period (first 2-3 years after planting). Supplemental watering may also be needed during periods of drought and/or extreme heat.
- **Mulch:** Applying mulch or other types of groundcover suppresses competition from grass and weeds, and holds moisture in the surface of the soil where most of the feeder roots are. Mulch also creates a zone where mowing is not needed, thereby keeping mowers and string trimmers safely away from trees (thus preventing mechanical damage to the trunk and roots).
- **Protect:** Damage to the bark and wood of trees creates wounds that compromise the long term health of trees, especially when they are young. To reduce the potential for wounding the bark and wood, make sure that bikes are not locked to trees, that signs are not posted on trees with nails or tape, and that branches are not broken or ripped off of the trunk. An educational campaign can help inform residents about these important tree protections.

- **Soil Amendments:** Arboricultural fertilizers are used to replace soil elements or minerals that are lacking or in short supply for a variety of reasons. Soil analysis, particularly when combined with a foliar analysis, can determine if any soil nutrients are in short supply.

- **Root Pruning:** Girdling roots or circling roots that have the potential to become girdling can decrease the lifespan of a tree. Pruning these types of roots can help a tree live longer.

- **Soil Decompaction:** Decompaction of heavily compacted soil can promote tree health, as it allows for increased water holding capacity and higher oxygen levels.

- **Pest management:** Pest damage on trees should be assessed, and in some cases treatment may be warranted. For more details see *Section 3.3: Invasive Insect and Disease Management Strategy* and *Appendix G*.

- **Cabling and bracing:** Cables and/or braces can be installed in trees to reduce stress damage from high winds, the weight of ice or snow, and heavy foliage. They are used to help strengthen weak branches or limbs so that they are able to better withstand severe weather and to reduce potential risk.

The City should assess trees and apply these types of maintenance as needed. Many of these maintenance tasks can be expensive; thus, the City may only be able to perform these tasks on a limited number of trees.

D. Inspections

Inspections are essential to uncovering potential problems with trees. They should be performed by a qualified arborist who is trained in the art and science of planting, caring for, and maintaining trees. Arborists are knowledgeable about the needs of trees and are trained and equipped to provide proper care. In addition to locating potential new hazards, inspections are an opportunity to look for signs and symptoms of pests and diseases. Somerville has a large population of trees that are susceptible to pests and diseases, such as ash, oak, and maple.

Trees along the street ROW should be regularly inspected and attended to as needed based on the inspection findings. Some trees may need to be inspected more regularly than others. For example, unless already slated for removal, trees noted as having Poor wood condition (*Section 2: Somerville's Tree Inventory Data)* should be inspected on a regular basis. In the 2018 inventory, 1,177 City-owned trees and 276 State-owned trees had Poor wood condition ratings. A good rule of thumb would be to inspect these trees on a yearly basis or after major storm events. Corrective action should be taken when warranted. If their wood condition worsens, tree removal may be required.

When trees need additional or new work, they should be added to the maintenance schedule and budgeted as appropriate.

Table 3.1. Estimated Costs for Somerville's Seven-Year Urban Forestry Maintenance Program (City-owned Trees Only)

Estimated Costs for Each Activity			Year 1		Year 2		Year 3	
Activity	**Diameter**	**Cost/Tree**	**# of Trees**	**Total Cost**	**# of Trees**	**Total Cost**	**# of Trees**	**Total Cost**
High Risk Removals	**1-9.9"**	**$100**	1	$100	0	$0	0	$0
	10-19.9"	**$600**	6	$3,600	0	$0	0	$0
	20-29.9"	**$780**	4	$3,120	0	$0	0	$0
	30-39.9"	**$1,280**	0	$0	0	$0	0	$0
	40" +	**$1,360**	0	$0	0	$0	0	$0
Activity Total(s)			**11**	**$6,820**	**0**	**$0**	**0**	**$0**
Moderate Risk Removals	**1-9.9"**	**$100**	0	$0	35	$3,500	0	$0
	10-19.9"	**$600**	75	$45,000	51	$30,600	0	$0
	20-29.9"	**$780**	32	$24,960	0	$0	0	$0
	30-39.9"	**$1,280**	7	$8,960	0	$0	0	$0
	40" +	**$1,360**	0	$0	0	$0	0	$0
Activity Total(s)			**114**	**$78,920**	**86**	**$34,100**	**0**	**$0**
Low Risk Removals	**1-9.9"**	**$100**	0	$0	0	$0	0	$0
	10-19.9"	**$600**	0	$0	0	$0	100	$60,000
	20-29.9"	**$780**	0	$0	37	$28,860	0	$0
	30-39.9"	**$1,280**	0	$0	4	$5,120	0	$0
	40" +	**$1,360**	0	$0	0	$0	0	$0
Activity Total(s)			**0**	**$0**	**41**	**$33,980**	**100**	**$60,000**
High Risk Pruning	**1-9.9"**	**$125**	0	$0	0	$0	0	$0
	10-19.9"	**$250**	8	$2,000	0	$0	0	$0
	20-29.9"	**$500**	0	$0	0	$0	0	$0
	30-39.9"	**$750**	0	$0	0	$0	0	$0
	40" +	**$1,000**	0	$0	0	$0	0	$0
Activity Total(s)			**8**	**$2,000**	**0**	**$0**	**0**	**$0**
Moderate Risk Pruning	**1-9.9"**	**$125**	0	$0	17	$2,125	0	$0
	10-19.9"	**$250**	100	$25,000	89	$22,250	0	$0
	20-29.9"	**$500**	90	$45,000	0	$0	0	$0
	30-39.9"	**$750**	20	$15,000	0	$0	0	$0
	40" +	**$1,000**	9	$9,000	0	$0	0	$0
Activity Total(s)			**219**	**$94,000**	**106**	**$24,375**	**0**	**$0**
Priority Work Activity Grand Total(s)			**352**	**$181,740**	**233**	**$92,455**	**100**	**$60,000**

Year 4		Year 5		Year 6		Year 7		Seven-Year Cost
# of Trees	Total Cost	# of Trees	Total Cost	# of Trees	Total Cost	# of Trees	Total Cost	
0	$0	0	$0	0	$0	0	$0	**$100**
0	$0	0	$0	0	$0	0	$0	**$3,600**
0	$0	0	$0	0	$0	0	$0	**$3,120**
0	$0	0	$0	0	$0	0	$0	**$0**
0	$0	0	$0	0	$0	0	$0	**$0**
0	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**$6,820**
0	$0	0	$0	0	$0	0	$0	**$3,500**
0	$0	0	$0	0	$0	0	$0	**$75,600**
0	$0	0	$0	0	$0	0	$0	**$24,960**
0	$0	0	$0	0	$0	0	$0	**$8,960**
0	$0	0	$0	0	$0	0	$0	**$0**
0	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**$113,020**
100	$10,000	200	$20,000	139	$13,900	0	$0	**$10,000**
73	$43,800	0	$0	0	$0	0	$0	**$103,800**
0	$0	0	$0	0	$0	0	$0	**$28,860**
0	$0	0	$0	0	$0	0	$0	**$5,120**
0	$0	0	$0	0	$0	0	$0	**$0**
173	**$53,800**	**200**	**$20,000**	**139**	**$13,900**	**0**	**$0**	**$181,680**
0	$0	0	$0	0	$0	0	$0	**$0**
0	$0	0	$0	0	$0	0	$0	**$2,000**
0	$0	0	$0	0	$0	0	$0	**$0**
0	$0	0	$0	0	$0	0	$0	**$0**
0	$0	0	$0	0	$0	0	$0	**$0**
0	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**$2,000**
0	$0	0	$0	0	$0	0	$0	**$2,125**
0	$0	0	$0	0	$0	0	$0	**$47,250**
0	$0	0	$0	0	$0	0	$0	**$45,000**
0	$0	0	$0	0	$0	0	$0	**$15,000**
0	$0	0	$0	0	$0	0	$0	**$9,000**
0	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**$118,375**
173	**$53,800**	**200**	**$20,000**	**139**	**$13,900**	**0**	**$0**	**$421,895**

Table 3.1. Estimated Costs for Somerville's Seven-Year Urban Forestry Maintenance Program (City-owned Trees Only)								
Estimated Costs for Each Activity			Year 1		Year 2		Year 3	
Activity	Diameter	Cost/ Tree	# of Trees	Total Cost	# of Trees	Total Cost	# of Trees	Total Cost
Routine Pruning and Monitoring	Starting in Year 2	$100,000	0	$0	~1267	$100,000	~1267	$100,000
Activity Total(s)			0	$0	~1267	$100,000	~1267	$100,000
Young Tree Training Pruning (3-year cyle)	Training	$50	828	$41,400	828	$41,400	827	$41,350
Activity Total(s)			828	$41,400	828	$41,400	827	$41,350
Ash Tree Treatments*	Treatment	$60,000	~350-400	$60,000	~350-400	$60,000	~350-400	$60,000
Activity Total(s)			~350-400	$60,000	~350-400	$60,000	~350-400	$60,000
Proactive Work Activity Grand Total(s)			~1,203	$101,400	~2,470	$201,400	~2,469	$201,350
New Tree Planting & Maintenance	Planting	$1,000	350	$350,000	350	$350,000	350	$350,000
Planting Activity Total(s)			350	$350,000	350	$350,000	350	$350,000

*The number of Ash Trees that are treated each year varies, as costs are calculated by caliper inch. Approximately 350-400 trees are treated each year.

Estimated Costs for Each Activity	Year 1		Year 2		Year 3	
	# of Trees	Total Cost	# of Trees	Total Cost	# of Trees	Total Cost
Priority Work Activity Grand Total(s)	352	$181,740	233	$92,455	100	$60,000
Proactive Work Activity Grand Total(s)	~1,203	$101,400	~2,470	$201,400	~2,469	$201,350
Planting Activity Total(s)	350	$350,000	350	$350,000	350	$350,000
Activity Grand Total	~1,905		~3,053		~2,919	
Cost Grand Total		$633,140		$643,855		$611,350

Year 4		Year 5		Year 6		Year 7		Seven-Year Cost
# of Trees	Total Cost	# of Trees	Total Cost	# of Trees	Total Cost	# of Trees	Total Cost	
~1267	$100,000	~1267	$100,000	~1267	$100,000	~1267	$100,000	$600,000
~1267	$100,000	~1267	$100,000	~1267	$100,000	~1267	$100,000	$600,000
828	$41,400	828	$41,400	827	$41,350	828	$41,400	$289,700
828	$41,400	828	$41,400	827	$41,350	828	$41,400	$289,700
~350-400	$60,000	~350-400	$60,000	~350-400	$60,000	~350-400	$60,000	$300,000
~350-400	$60,000	~350-400	$60,000	~350-400	$60,000	~350-400	$60,000	$420,000
~2,470	**$201,400**	**~2,470**	**$201,400**	**~2,469**	**$201,350**	**~2,470**	**$201,400**	**$1,309,700**
350	$350,000	350	$350,000	350	$350,000	350	$350,000	$2,450,000
350	**$350,000**	**350**	**$350,000**	**350**	**$350,000**	**350**	**$350,000**	**$2,450,000**

Year 4		Year 5		Year 6		Year 7		Seven-Year Cost
# of Trees	Total Cost	# of Trees	Total Cost	# of Trees	Total Cost	# of Trees	Total Cost	
173	**$53,800**	**200**	**$20,000**	**139**	**$13,900**	**0**	**$0**	**$421,895**
~2,470	**$201,400**	**~2,470**	**$201,400**	**~2,469**	**$201,350**	**~2,470**	**$201,400**	**$1,309,700**
350	**$350,000**	**350**	**$350,000**	**350**	**$350,000**	**350**	**$350,000**	**$2,450,000**
~2,993		**~3,020**		**~2,958**		**~2,820**		
	$605,200		**$571,400**		**$565,250**		**$551,400**	**$4,181,595**

Maintenance Schedule

Utilizing data from the 2018 tree inventory, an annual maintenance schedule was developed that details the number and type of tasks recommended for completion each year over the course of 7 years. Budget projections were made using industry knowledge and public bid tabulations, along with estimates for contractor work provided by Somerville staff. A complete table of estimated costs for Somerville's seven-year tree management program is presented in **Table 3.1**.

The schedule provides a framework for completing the inventory maintenance recommendations over the next seven years. Following this schedule can shift tree care activities from an on-demand (reactive) system to a more proactive tree care program.

To implement the maintenance schedule, the City's tree maintenance budget should be no less than $633,140 for the first year of implementation, no less than $643,855 for the second year, and no less than $551,000 for the final year of the maintenance schedule (**Table 3.1**). Annual budget funds are needed to ensure that High risk trees are remediated and that crucial YTT and RP Cycles can begin. An increase in funds is needed for the second year of the program in order to initiate the RP Cycle. Please refer to *Section 4.2: Funding Analysis*, for a more through discussion of the City's budget.

If routing efficiencies and/or contract specifications allow for the completion of more tree work, or if the schedule requires modification to meet budgetary or other needs, then the schedule should be modified accordingly. Unforeseen situations such as severe weather events may arise and change the maintenance needs of trees. Should conditions or maintenance needs change, budgets and equipment will need to be adjusted to meet the new demands. With proper professional tree care, the safety, health, and beauty of the urban forest will improve.

Inventory and Plan Updates

Keeping the tree inventory data and maintenance plan up to date can streamline work load management and lend insight into setting accurate budgets and staffing levels. Regular updates are important so that the City can sustain its program and accurately project future program and budget needs. Specific recommendations include:

- Conduct inspections of trees after all severe weather events. Record changes in tree condition, maintenance needs, and risk rating in the inventory database. Update the tree maintenance schedule and acquire the funds needed to promote public safety. Schedule and prioritize work based on risk.

- Perform routine inspections of public trees as needed. Windshield surveys (inspections performed from a vehicle) in line with *ANSI A300 (Part 9)* (ANSI 2011) will help city staff stay apprised of changing conditions. Update the tree maintenance schedule and the budget as needed so that identified tree work may be efficiently performed. Schedule and prioritize work based on risk.

- If the recommended work cannot be completed as suggested in this plan, modify maintenance schedules and budgets accordingly.

- Update the inventory database electronically using TreeKeeper® 8.0 or similar computer software as work is performed. Add new tree work to the schedule when work is identified through inspections or resident reports (i.e. 311 requests).

- Re-inventory the street ROW, and update all data fields in seven years, or re-inventory a portion of the population ($1/7^{th}$) every year over the course of seven years.

- Revise the *Tree Maintenance Program* after seven years when the re-inventory has been completed.

Summary and Recommendations

A comprehensive tree maintenance program that includes priority and proactive maintenance will increase the health and vitality of Somerville's urban forest while also making it safer for the public. A summary of the recommended maintenance activities are as follows:

- Remove trees that are recommended for removal, focusing first on High and Moderate Risk trees.

- Complete pruning work for trees identified as having high and moderate risk pruning needs.

- Ensure that the state performs necessary removal and pruning work on state-owned High and Moderate Risk trees.

- Establish a seven-year routine-pruning cycle for the City's tree population.

- Continue the three-year young tree training cycle.

- Continue planting as many trees as possible to grow the urban forest.

3.3 Invasive Insect and Disease Management Strategy

Throughout the United States, urban and community forests are under increased pressure from exotic and invasive insects and diseases. Exotic pests that arrive from overseas typically have no natural predators in their invaded territories and can become invasive when trees and shrubs do not have appropriate defense mechanisms to fight them off. Mortality from these pests and diseases can range from two weeks, as is the case with oak wilt (*Ceratocystis fagacearum*), to at least seven years, as seen with emerald ash borer (EAB) (*Agrilus planipennis*).

An integral part of tree management is maintaining awareness of invasive insects and diseases in the area and knowing how to best manage them. Depending on the tree diversity within Somerville's urban forest, an invasive insect infestation or disease has the potential to spread quickly and devastate the tree population.

EAB is the focus of this section as it is currently the most damaging and prevalent pest in Somerville. Because of the increasing severity of damage to ash species caused by EAB, this section provides different management strategies for dealing with this pest, including details on how to effectively monitor EAB, increase public education, approach reforestation, and work with stakeholders. Additional EAB reference materials can be found on the City of Somerville's Urban Forestry webpage (www.somervillema.gov/urbanforestry).

Other potential threats such as Asian longhorned beetle (ALB, *Anoplophora glabripennis*), spotted lanternfly (SLF, *Lycorma delicatula*), and oak wilt (*Ceratocystis fagacearum*) are also discussed in this section, but in less detail. These additional pests are a concern as they pose real threats to trees across Somerville. A more complete list of pests and diseases that may affect Somerville's tree population is provided in *Appendix G*. If residents or staff members of Somerville notice specific signs and symptoms of any type of pest or disease, the tree should be inspected and monitored. Early diagnosis of a disease/pest is critical and could save thousands of trees.

Emerald Ash Borer (EAB)

Emerald ash borer (*Agrilus planipennis*) is a small insect native to Asia. In North America, EAB is an invasive species that is highly destructive to all ash tree species in its introduced range, including all ash species that are native to the United States.

EAB is thought to have been introduced to North America in the 1990s, but it was not positively identified in this continent until 2002 in Canton, Michigan. The presence of EAB has been confirmed in 35 states (**Figure 3.12**). EAB has killed at least 50–100 million ash trees in the U.S. and threatens another 7.5 billion ash trees throughout North America. EAB has been identified in Massachusetts—including in the greater Boston area—and poses a serious threat to the health and condition of ash trees in Somerville's urban forest. See **Figure 3.13** for areas in Massachusetts with known EAB infestations. EAB was first positively identified

Figure 3.12. EAB detections throughout North America as of July 1, 2020
Map by United States Department of Agriculture, Animal and Plant Health Inspection Service.

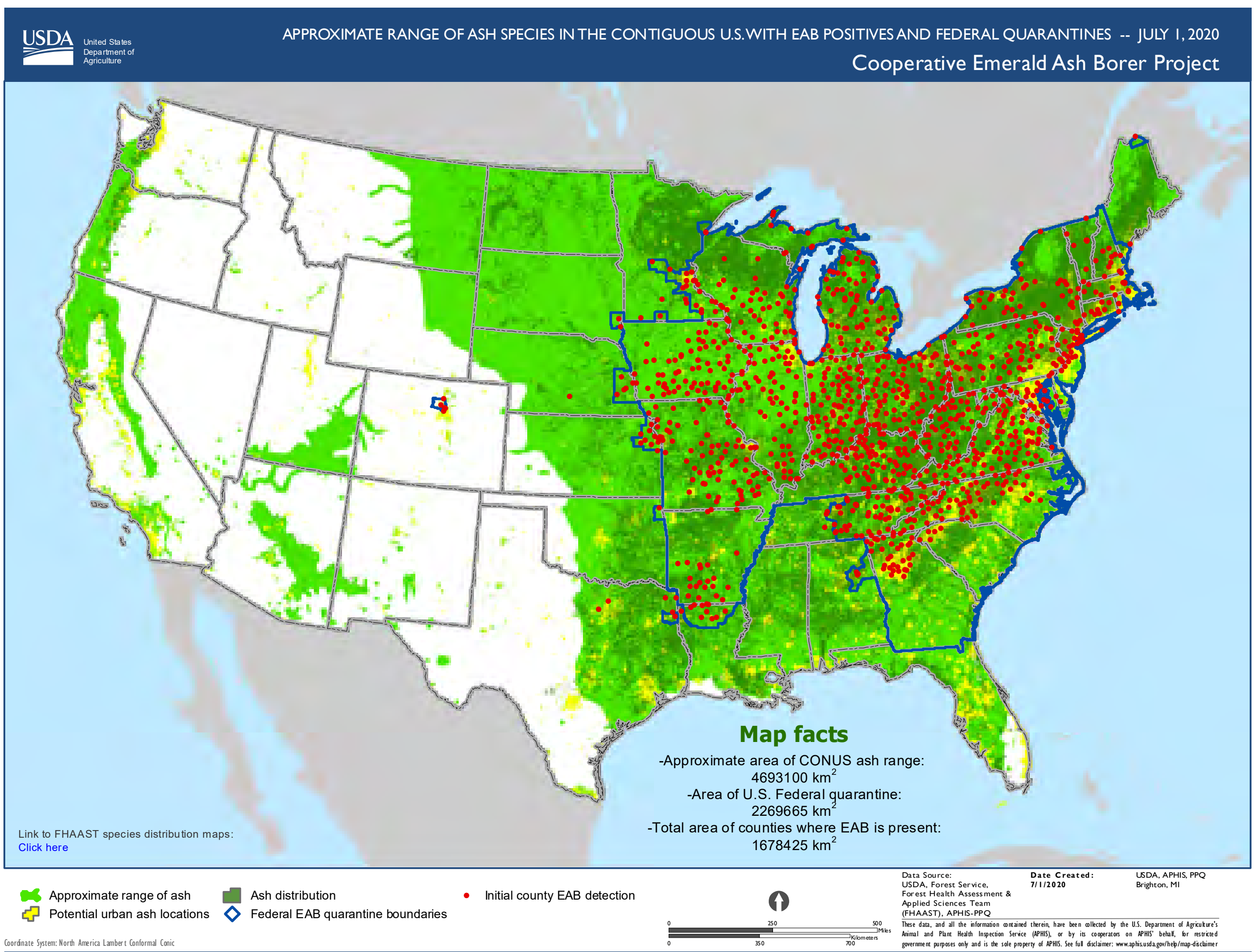
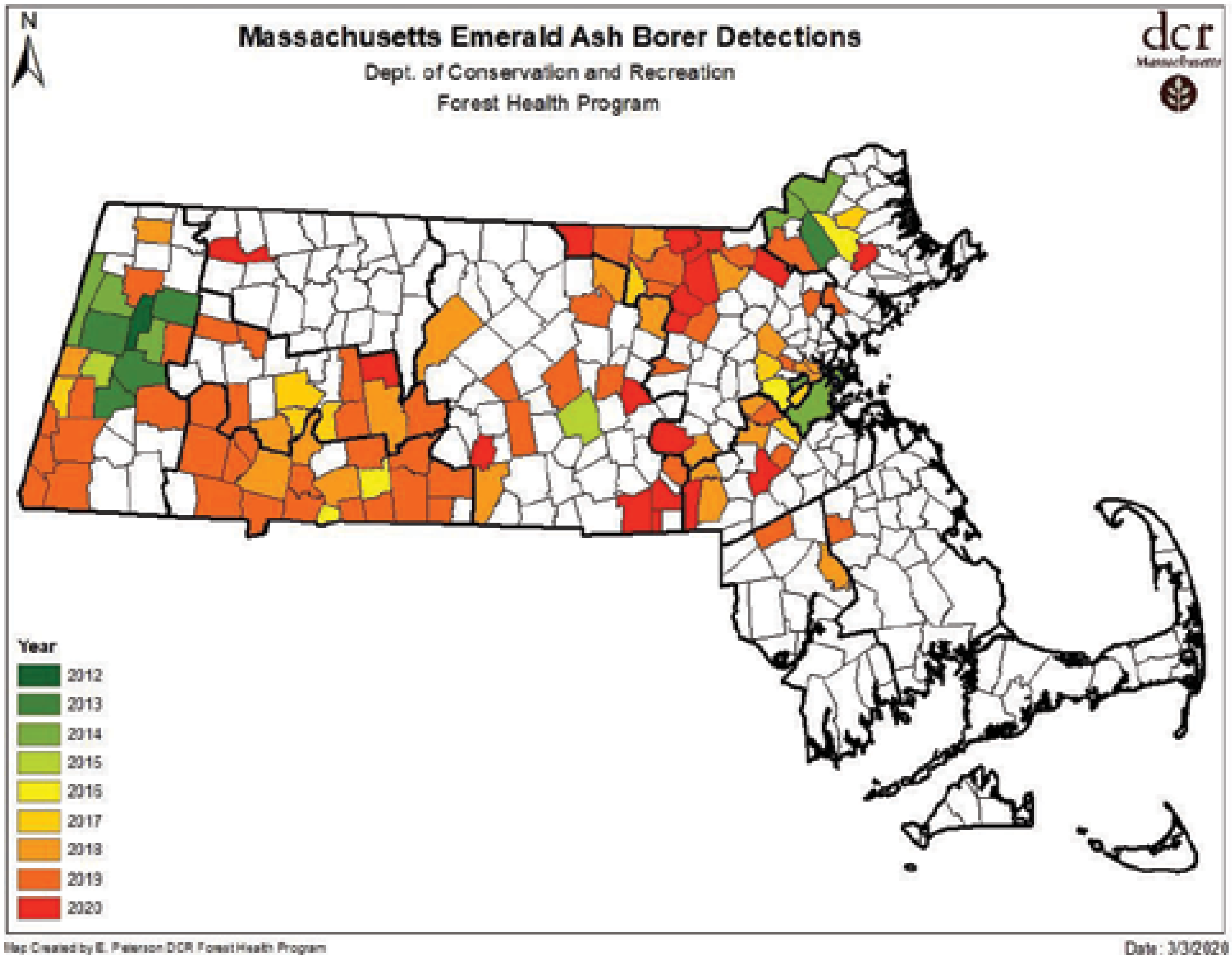


Figure 3.13. Massachusetts EAB Detections as of March 2020.
Map by the Department of Conservation and Recreation, Forest Health Program.



in Somerville in the Fall of 2018, with a single beetle caught in one of 10 traps that were hung around the city. In 2019, 25 beetles were found across 7 of the 10 traps.

The potential damage of EAB rivals that of chestnut blight and Dutch elm disease (see **Box 2.1** in *Section 2: Somerville's Tree Inventory Data*). For perspective, chestnut blight is caused by a fungus that was introduced in North America around 1900. By 1940, chestnut blight wiped out virtually all of the mature American chestnut trees across the country. Chestnut blight is believed to have been imported by chestnut lumber or through imported chestnut trees. Dutch elm disease (DED) is caused by a fungus and is spread by the elm bark beetle and transmitted underground between roots of infected trees. DED was first reported in the United States in 1928 and was believed to have been introduced by imported timber. Since its discovery in the United States, it has killed millions of elm trees.

EAB adults are approximately 5/8 inches in length (photograph credit: Howard Russell, Michigan State University, Bugwood.org).

EAB larvae (photograph credit https://extension.colostate.edu).

EAB larvae consume the cambium and phloem, creating "S"-shaped galleries that effectively girdle the tree and eventually cause death within a few years. (photograph credit: Troy Kimoto, Canadian Food Inspection Agency, Bugwood.org).

EAB Identification

The adult EAB beetle is elongate, metallic green and 3/8- to 5/8-inch long. The adult beetle emerges from late May until early August, feeding on a small amount of foliage. The adult females then lay eggs on the trunks and branches of ash trees and, in roughly a week, the eggs hatch into larvae, which then bore into the tree. Larvae are creamy white in color, can grow up to an inch long, and are found underneath the bark of the trees. The larvae tunnel and feed on the inner bark and phloem, creating winding galleries as they feed. This cuts off the flow of the water and nutrients to the tree, causing dieback and death.

EAB can be very difficult to detect. Initial symptoms include yellowing and/or thinning of the foliage and longitudinal bark splitting. The entire canopy may die back, or symptoms may be restricted to certain branches. Declining trees may sprout epicormic shoots at the tree base or on branches. Woodpecker injury (aka "blonding" of the bark) is often apparent on branches of infested trees, especially in late winter, as they feed on the larvae. Removal of bark reveals tissue callusing and frass-filled serpentine tunneling. The "S"-shaped larval feeding tunnels are about 1/4 inch in diameter. Tunneling may occur from upper branches to the trunk and root flare. Adults exit from the trunk and branches in a characteristic D-shaped exit hole that is about 1/8 inch in diameter. The loss of water and nutrients from the intense larvae tunneling can cause trees to lose between 30% and 50% of their canopies during the first year of infestation. Trees often die within two years following infestation.

These trees contain the D-shaped borer holes created by EAB when the adult beetle exits the tree.

This ash tree is experiencing blonding of the bark (from woodpeckers stripping off the outside layers of the bark to eat the EAB larvae) and epicormic shoots. Epicormic shoots are a result of dormant buds which are simulated to grow due to tree stress.

This ash tree is declining from EAB infestation. The loss of water and nutrients from intense larvae tunneling can cause the trees to lose between 30% and 50% of their canopies during the first year of infestation

Photograph courtesy of Elizabeth McKinley, Davey Resource Group.

State and Federal Response

The Department of Conservation and Recreation (DCR) is the leading agency responsible for control of invasive pests in Massachusetts. DCR declared EAB a public nuisance in Massachusetts and enacted a quarantine restricting the movement of ash trees and non-coniferous firewood across state lines (Massachusetts DCR Forest Health Program, 2020).

The United States Department of Agriculture Animal and Plant Health Inspection Service (USDA-APHIS) is a federal agency that assists with regulatory and control action of invasive pests. USDA-APHIS and other state and federal agencies have been actively researching integrated management control measures, including the use of biological controls, developing resistant ash species, and testing various insecticides. Since 2003 scientists have been searching for natural enemies of EAB in the wild. This has led to the discovery of several parasitoid wasps native to China, namely *Tetrastichus planipennisi*, a gregarious larval endoparasitoid, *Oobius agrili,* a solitary, parthenogenic egg parasitoid, and *Spathius agrili,* a gregarious larval ectoparasitoid (USDA Forest Service, 2019). These parasitoid wasps have been released in various states (including include Colorado, New York, Indiana, Michigan, Minnesota, and Massachusetts) to evaluate their potential as a possible biological control of EAB. The wasps will not eradicate the beetle but may be able to help keep EAB populations low, particularly in dense stands of ash. Determining the success of these parasitoid wasps on being effective biological control agents will take many years of research due to the long life cycle of ash trees and the large population numbers spread across the country.

Somerville's Public Ash Tree Population & Management Strategy History

Ash trees are one of the more common genera in Somerville; the City could potentially lose up to 5% of its tree population due to EAB. Somerville's 2018 public tree inventory (see *Section 2: Somerville's Tree Inventory Data*) contains 1036 ash trees on public property in Somerville, 836 of which are on City-owned property (rights-of-way and open spaces). Of these trees, 32 were recommended for removal based on health or safety concerns. The majority of the City-owned ash trees in the 2018 inventory were rated to be in Fair condition (53%), followed by those in Good condition (39%), and a significantly smaller percentage in Poor or Dead condition (8%). **Table 3.2** presents the diameter class of each ash tree by condition class. Of the 836 City-owned ash trees inventoried, 3 were identified

Table 3.2. Ash Tree Condition by Diameter Class Matrix

	Diameter Size Class (inches)								
	1–3.9	**4–6.9**	**7–10.9**	**11–12.9**	**13–19.9**	**20–29.9**	**30–39.9**	**40+**	**Total**
Good	3	17	54	48	131	13	1	0	267
Fair	1	37	124	102	206	25	0	1	496
Poor	1	17	18	13	13	5	0	0	67
Dead	5	1	0	0	0	0	0	0	6
Total	**10**	**72**	**196**	**163**	**350**	**43**	**1**	**1**	**836**

as having shown potential signs and symptoms of EAB, and an additional 16 had signs of other boring insects.

Somerville proactively formed an EAB action plan in 2016 when EAB was found in neighboring cities. The action plan included:

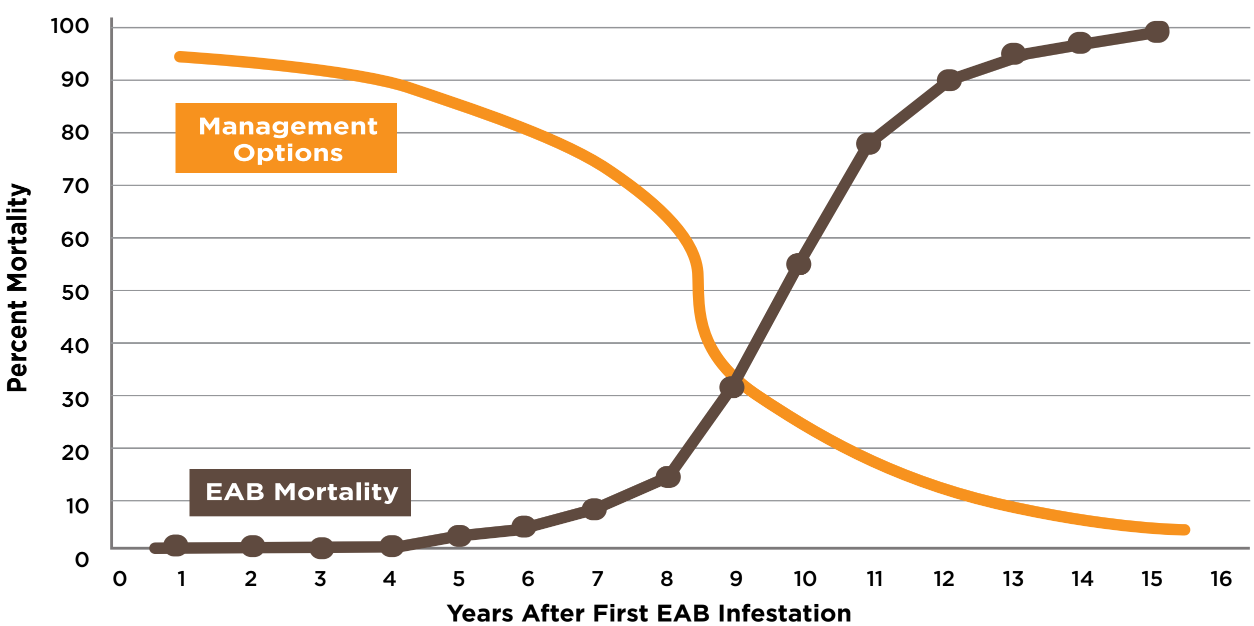
- Inventorying of all publicly-owned ash trees (2016 & 2018).
- Removing many of the ash trees that were in Dead or Poor condition (mostly 2016–2018).
- Protecting the healthy ash trees in the City using an organic insecticide treatment (2016–ongoing).

As infestation of EAB becomes more prevalent in Somerville, the City should continue to explore strategies for managing EAB that provide the most economic benefit and increase public safety.

Somerville's EAB Management Strategy Options

There are various management strategies for dealing with EAB, including doing nothing, removing and replacing all ash trees, using insecticides to treat all ash trees, or any combination of these strategies. These strategies vary in cost, level of effort, and benefits. The number of options a community has for dealing with EAB begin to decline soon after an infestation occurs. **Figure 3.14** presents a unique tool for deciding viable management options for varying levels of EAB infestations (risk-benefit relationship). This figure is based on a "Do Nothing" strategy (i.e. no treatments and no removals). About 6 years after an infestation occurs, the EAB-related mortality of ash trees quickly begins to increase while the number of management options quickly begin to decrease.

Figure 3.14: Ash tree mortality begins to increase sharply around 5 years after EAB infestation. The number of management options shows an inverse relationship with ash tree mortality. Figure adapted from: Emerald Ash University (www.emeraldashborer.info)



Considering that EAB was found in Somerville in 2018, Somerville's tree population in 2020 is approximated to be at Year Two on the graph (**Figure 3.14**). At this position, the City has time to prepare and improve its management options. The more time that passes after an infestation occurs the more the options for management decrease.

EAB STRATEGY 1: DO NOTHING

This strategy involves not removing and not treating any ash trees (i.e. stopping treatments). Do nothing lets EAB run its course while the community has no strategy for dealing with EAB or its ash trees. This strategy is economical in the beginning of an infestation because it doesn't cost any money, but it becomes an extreme public safety issue within a few years as the ash trees begin to die. This strategy would also lead to the continued spread of EAB to neighboring communities as EAB adults are good fliers. This management strategy is NOT recommended.

EAB STRATEGY 2: REMOVE AND REPLACE ALL ASH TREES

This strategy involves removing and replacing all ash trees in the City. This strategy would benefit public safety from the EAB infestation but would have an impact on the City's budget and would immediately reduce the city's canopy cover. In order to achieve this strategy and remove all of the ash trees in one year or less, the City would most likely have to contract out at least some of the work. Moreover, removing mature ash trees in Good and Fair condition would take away all of the valuable benefits that these trees provide to the City and would leave some areas that have a full canopy of ash with no moderate- or large-sized trees at all (e.g. some sections of Willow Avenue). By increasing public safety, this strategy ultimately benefits the City but requires high upfront cost. Replacing all of these ash trees once they have been removed will be very important.

The total approximate cost for this strategy would be $1,208,460 (**Table 3.3**).

Table 3.3. Estimated Costs Associated with EAB Management Strategies

Management Strategy	Management Action	# of Trees	Total DBH (inches)	Estimated Cost
1. Do Nothing	No treatment, no removals	0	0	$0
	Strategy 1. Total Estimated Cost			**$0**
2. Remove and Replace All Ash Trees	Remove trees	836	10,654	$372,460
	Replace trees	836		$836,000
	Strategy 2. Total Estimated Cost			**$1,208,460**
3a. Treat All Ash Trees	Treat all of the City-owned ash trees	836	10,654	$114,960*
	Strategy 3a. Total Estimated Cost (every two years)			**$114,960***
3b. Treat All Ash Tree Recommended for Treatment	Treat the City-owned ash trees recommended for treatment in the 2018 inventory	705	9,243	$99,730*
	Strategy 3b. Total Estimated Cost (every two years)			**$99,730***
4. Combination of Removals and Treatment	Remove trees	357	3,424	$103,100
	Treat trees	479	7,230	$78,010*
	Replant trees	357		$357,000
	Strategy 4. Total Estimated Cost			**$538,110**

*Costs recurring every two years

Currently the City is using TreeAzin™ (an organic insecticide) to treat the 705 City-owned ash trees that are healthy enough to treat.

This ash tree in Somerville is being treated against EAB. Until EAB leaves the area, the tree will require treatment every two years.

EAB STRATEGY 3: TREAT ALL (OR MOST) ASH TREES

Treating all of Somerville's ash trees could reduce the annual mortality rate, stabilize removals, and would be less expensive than removing and replacing all ash trees. The treatment consists of injecting an insecticide directly into the xylem of the ash trees. The xylem is what transfers nutrients and water throughout the tree, and is, unfortunately, what the EAB eats. Treating all ash trees would enable these trees to continue providing the city with environmental benefits.

On the other hand, treating all ash trees is not an ideal practice because some of the trees eventually become infested with EAB and some are less desirable to retain. Ash trees that are treated can still become infested with EAB (especially unhealthy trees) when they have weakened defense systems and/or are not effective at taking up the chemical treatment. An ash tree with a damaged xylem will not transport the insecticide throughout its system very well, which can cause the treatment to fail. Thus, a better practice is to only consider treating healthy ash trees.

Currently the City is using TreeAzin™ (an organic insecticide) to treat the 705 City-owned ash trees that are healthy enough to treat. These 705 trees in good and fair condition were recommended for treatment in the 2018 inventory; the remaining 131 City-owned ash trees were not recommended for treatment because they were not healthy enough to effectively take up treatment. To be effective, this treatment must be injected into a tree every two years. It cost approximately $100,000 every two years to treat these 705 ash trees. To spread out this cost, the City treats half of the ash trees every year, meaning that it cost the City approximately $50,000 per year (**Table 3.3**). The City has also been treating some of the healthiest trees on State-owned land (MassDOT and DCR) to ensure that these trees survive for as long as possible.

The two-year cost for treating all 836 City-owned ash trees is approximately $115,000 (equivalent to approximately $57,500 every year; **Table 3.3**).

EAB STRATEGY 4: COMBINATION OF REMOVALS AND TREATMENT

This strategy is intended to give the City options for a combination of removing and treating ash trees to stabilize annual removals, annual budgets, and prolong the life of ash trees in Good and Fair condition. This strategy involves removing ash trees in Dead or Poor condition, and trees that provide little benefit and/or have current health problems. **Table 3.4** is an EAB matrix table intended to organize trees that should be considered for removal and trees that should be considered for treatment. The following sections explain why certain ash trees should be considered for removal and treatment.

Table 3.4. EAB Matrix Table. Trees in the categories highlighted in orange are recommended for removal, and those in green are recommended for treatment. Trees in the categories highlighted in yellow should be considered for treatment (low-moderate priority).

		1–3.9	4–6.9	7-10.9	11–12.9	13–19.9	20-29.9	30-39.9	40+	Total
Condition Class	Good	3	17	54	48	131	13	1	0	267
	Fair	1	37	124	102	206	25	0	1	496
	Poor	1	17	18	13	13	5	0	0	67
	Dead	5	1	0	0	0	0	0	0	6
	Total	**10**	**72**	**196**	**163**	**350**	**43**	**1**	**1**	**836**

Based on the number of trees in the different size class and condition categories, Davey Resource Group (DRG) makes the following recommendations:

357
TREES FOR REMOVAL

Trees in the Poor and Dead condition class are recommended for removal because they are more susceptible to EAB infestation and do not take up the treatment well. If these trees are not removed, they could pose a public safety issue in the future. A total of 73 Poor and Dead trees are recommended for removal and replacement.

The remaining 58 trees that are less than 7 inches DBH, as well as the 226 trees in Fair condition and between 7 inches and 12.9 inches DBH, are recommended for removal and replacement. These trees do not provide as many benefits to the community as mature ash trees, and thus the treatment costs outweigh the benefits. It would be in the best interest of the City to remove these trees and replace them with a more diversified mix of trees (see *Section 3.1 Tree Planting Plan* for recommended planting strategies).

232
CANDIDATE TREES FOR CHEMICAL TREATMENT
(Low–Moderate Priority of Treatment)

The intent here is to defer removal of a large block of trees in Fair Condition between 13 inches and 40+ inches DBH. These 232 trees are considered to be low–moderate priority for chemical treatment. Eventually, many of these trees may become infested with EAB if treatments stop, meaning these trees would have to be removed. Treating these trees could help minimize short-term budgets due to removals. Treatment can be economically beneficial and reduce the chance for a public safety issue in the near future.

247
CANDIDATE TREES FOR CHEMICAL TREATMENT
(High Priority of Treatment)

Candidates for chemical treatment should be in Good condition with no more than 30% dieback. Such trees should be located in an appropriate site (i.e., not under overhead utilities). Continually treating these 247 ash trees will help keep these trees around for a long time.

For maximum retention of a healthy urban tree canopy, it is recommended that the City of Somerville treat all 479 City-owned ash trees that are Low-Moderate and High priority candidates for treatment, and that the rest of the ash trees be removed. It is also recommended that the stumps are removed at the same time as the trees so that replacement trees can be planted immediately. **Table 3.5** shows that the total cost for removal, treatment, and replanting will be approximately $538,110 over a two-year period. This is significantly less than the cost to remove all ash trees, and this option means that many beautiful, shade-producing trees will be saved. Under this scenario, ash tree treatment costs for City-owned trees will be less than $39,005 every year (treating all recommended ash trees over the course of two years), depending on ash tree mortality. Treating only the larger, healthier ash trees saves the City over $10,000 per year in treatment costs compared to treating all healthy ash trees (**Table 3.4**).

Table 3.5. Estimated Costs Associated with Combination Treatment and Removal EAB Strategy

Activity	Diameter	Estimated Cost/ Tree	# of Trees	Total DBH	Total Estimated Cost
Removal	1-3.9”	$100	10		$1,000
	4-6.9”	$100	72		$7,200
	7-10.9”	$100	142		$14,200
	11-12.9”	$600	115		$69,000
	13-19.9”	$600	13		$7,800
	20-29.9”	$780	5		$3,900
	30-39.9”	$1,280	0		$0
	40”+	$1,360	0		$0
Activity Total (removal)			**357**		**$103,100**
Treatment (over two years)	1-3.9”	$10.79 per inch of DBH	0		$0
	4-6.9”		0		$0
	7-10.9”		54	496.7	$5,359
	11-12.9”		48	576.3	$6,218
	13-19.9”		337	5201.5	$56,124
	20-29.9”		38	874	$9,430
	30-39.9”		1	32.8	$354
	40+		1	48.7	$525
Activity Total (treatment)			**479**		**$78,010**
Replanting		$1,000	357		$357,000
Activity Total (replanting)			**357**		**$357,000**
Option Totals			**1,193**		**$538,110**

Somerville's Public Ash Trees - Summary and Recommendations

Somerville has conducted biannual ash tree treatments since 2016, treating approximately 50% (by caliper inch) of the heathy public ash tree population each year. To adequately protect a tree from EAB, it will need to be treated every two years for the foreseeable future. As such, due to financial constraints, the City may choose to treat fewer trees over time.

Somerville should proactively remove ash trees that are in Poor condition or are in poor locations during road reconstruction projects and other public works associated activities. By proactively removing ash trees during construction, the cost and impacts related to EAB infestation are predicted to be lower.

Furthermore, Somerville should consider removing all ash trees less than 7 inches DBH, along with ash trees that are Dead or in Poor condition. Trees in Fair condition that are between 7 and 12.9 inches should also be removed. These trees provide little benefit and/or have current health problems.

Posting information about EAB on ash trees around the city could encourage private homeowners to become more proactive in managing their ash trees (photograph credit: Rainbow Tree Care).

To maintain the tree canopy in the city, ash trees that are removed should be replaced with a diversity of species using the "right tree, right place" strategy (see *Section 3.1 Tree Planting Plan*). The cost of replanting could be spread out over multiple years by establishing a goal that a certain amount of trees need to be planted each year. For example, it would take the City approximately 6 years to replace the 357 ash trees recommended for removal if the City were to plant 60 trees per year, at a cost of approximately $60,000 per year. This cost could be reduced by working with private property owners and/or volunteers, or by obtaining grants for funding reforestation efforts.

Ash Trees on Private Property & Public Education

EAB will also impact trees located on private property. The number of ash trees on private property in Somerville is unknown. The cost to remove ash trees on private property will likely be higher than the cost to remove ROW ash trees because these areas are often more inaccessible.

It is crucial for Somerville property owners to be well informed about EAB. Their assistance and cooperation will be vital in detecting the spread of EAB, managing ash trees on private property, and expediting reforestation after removals of infected ash trees are complete. Public education will also help to reduce the potential of City involvement with regulating tree removals on private properties.

It is vital for Somerville to educate the public on how to detect EAB, provide information about treatment options, and relay the importance of reforestation to allow the public to make informed and proactive choices about managing infested ash trees. This could help put City officials at ease by having fewer private trees become a public safety issue.

The City of Somerville's Urban Forestry website (www.somervillema.gov/urbanforestry) has detailed information on EAB and the treatment strategy for the City's public trees. When EAB was first discovered in Somerville (in 2018), the City issued a press release and held a public meeting. To further the public education process, the City should continue to inform the public about EAB. The following are examples of ways the City can inform the public about all of these issues:

- Provide residents with EAB fact sheets (e.g., Massachusetts Department of Conservation and Recreation's *Emerald Ash Borer* fact sheet)
- Display information packets at public buildings
- Postcard mailings to homeowners in Somerville
- Door hangers explaining ash tree maintenance options (e.g., Herms et al., 2019)
- Presentations to community groups
- Keep information about EAB on the City's website up to date
- Tie ribbons around ash trees and place tags on the trees with information about EAB
- Provide additional press releases
- Write City newsletter articles
- Post on social media
- Discuss EAB on radio and TV programs

Dying and infested ash trees on private property pose a threat to human and public safety. Somerville should consider amending the current Tree Preservation Ordinance such that EAB is specifically acknowledged as a public nuisance and treated in similar fashion as Dutch elm disease and other insect pests or plant diseases. In the event that City officials have to get involved with private property owners about a potential infested ash tree, Somerville could consider utilizing the City's Tree Preservation Ordinance. Refer to *Section 4.3: City of Somerville Tree Ordinance & Policy Review* for more information on Somerville's Tree Preservation Ordinance.

Asian Longhorned Beetle (ALB)

Asian longhorned beetle (*Anoplophora glabripennis*) is a serious threat to a large number of America's hardwood tree species. Like EAB, this invasive pest arrived from Asia within the last few decades. However, unlike EAB, ALB targets many common species (maple, birch, horse chestnut, poplar, willow, elm, and ash) and is, for the most part, untreatable. Over 34% of Somerville's publically-managed trees consist of ALB host species (**Table 3.6**).

First found in Brooklyn in 1996, ALB has since been detected in Worcester, Boston, southwest Ohio, Chicago, Central Long Island, New Jersey, and Toronto. It has not yet been detected in Somerville.

Infestation of ALB is untreatable. The management of ALB is under state and federal regulations. If ALB is found, the USDA institutes an immediate removal of host trees and a strict quarantine of ALB host materials to stop the spread of this devastating pest. Destruction of host trees is the only acceptable control practice to eradicate the beetle. The impact of removing host trees can be devastating to a community. The most important thing to help stop the spread of ALB is early detection, which requires vigilant monitoring. Proper identification of ALB is critical, and thus it is important to educate the public and City staff on the signs and symptoms of ALB.

Apart from seeing the beetle itself, a tree that is infested with ALB will show distinctive signs, including perfectly round exit holes that are ¼ inch or larger, egg sites that look like little wounds on the tree and sometimes have chew marks on the edges, frass (sawdust-like material) on the ground or on tree branches, and tunneling under the bark. Educational materials on ALB can be found at the USDA-APHIS website, www.beetlebusters.info (USDA Animal and Plant Health Inspection Service, 2020).

ALB currently has been eradicated in Boston, Chicago, New Jersey, Queens, and Manhattan. Eradication efforts can vary slightly depending on the area, but it generally involves a ground survey crew, and/or climbers that look at all potential host trees in the area. Any trees that are found to have ALB will be removed. This is why educating the public and City staff for signs and symptoms of this pest is so important. The earlier ALB is detected, the quicker it will likely be eradicated.

Table 3.6. Species in Somerville's 2018 tree inventory that are subject to ALB infestation

Genus	Common Name	Number of Trees	Percentage of Tree Inventory
Acer	maple	3,784	28%
Aesculus	horsechestnut	1	<1%
Betula	birch	173	1%
Fraxinus	ash	1,034	8%
Populus	poplar	52	1%
Salix	willow	4	<1%
Ulmus	elm	427	3%

On the left, a tree with multiple ALB egg sites. Below, ALB exit hole (photograph credit: Pennsylvania Department of Conservation and Natural Resources - Forestry, Bugwood.org)

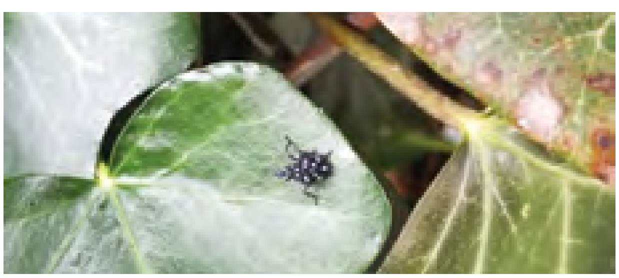
Adult Asian longhorned beetle. (photograph credit: Joe Boggs, Ohio State University, Bugwood.org)

Spotted Lanternfly

Spotted lanternfly (*Lycorma delicatula*) is an invasive insect native to China. It was first discovered in Pennsylvania in 2014, and the infestation has since spread into New Jersey, Maryland, Deleware, Virginia, and West Virginia (**Figure 3.15**).

In December 2018, a single dead adult was found in Boston, Massachusetts after being discovered in a shipment of poinsettias from Pennsylvania (Orth, 2019). In September 2020, two additional dead adults were found in Massachusetts, one each in the towns of Mildford and Norwood. Although no infestations have yet been detected in Massachussets, it is notable that this insect has been found in multiple counties in neighboring states.

The spotted lanternfly lays it's eggs on plant surfaces, firewood, cars, and other non-host material, which can easily be transported. Because early detection and proper identification can help prevent an infestation, Somerville residents and City staff should be educated about this invasive insect.



Spotted laternfly prefers the host tree-of-heaven (*Ailanthus altissima*), but it feeds on a wide range of fruit, ornamental and woody trees, and agricultural crops (such as apples, peaches, grapes, and hops) (USDA Animal and Plant Health Inspection Service, n.d.). While the knowledge of the life cycle and epidemiology of the spotted laternfly is still unfolding, removing tree-of-heaven may help slow it's spread.

The 2018 tree inventory included 133 tree-of-heaven trees. However, it should be noted that this is not an exact number because a majority of these trees were in unmaintained areas, and in large clusters. When a grouping of these trees occurred during the inventory, a single point was assigned, along with a note approximating the number of trees in the area. A good example of this is behind the fire station at 651 Somerville Avenue. This unmaintained woodlot was not inventoried, but one point was placed there to indicate that there were dozens of tree-of-heaven trees located there.

The majority of the tree-of-heaven trees in the inventory were found along the Community Path (45% of inventoried tree-of-heavens). The DBH of the inventoried tree-of-heaven trees ranged from small whips (1 inch diameter or less) to over 37 inches. To reduce the number of hosts available for spotted lanternfly, it would be most prudent to remove the largest trees first as they will disperse the most seeds. After removal, an herbicide should be applied to any remaining stumps and roots, as whips can sprout quickly from the remaining runner roots.

On the top left, Spotted Lanternfly nymph.
On the bottom, an adult Spotted Lanternfly next to an egg site.

On the top left and above, Spotted Lanternfly infestations on tree-of-heavens. On the bottom left, Spotted Lanternfly egg sites on a rubber spool. The color and the ability of SLF to lay eggs on various sites makes it easy for human transportation

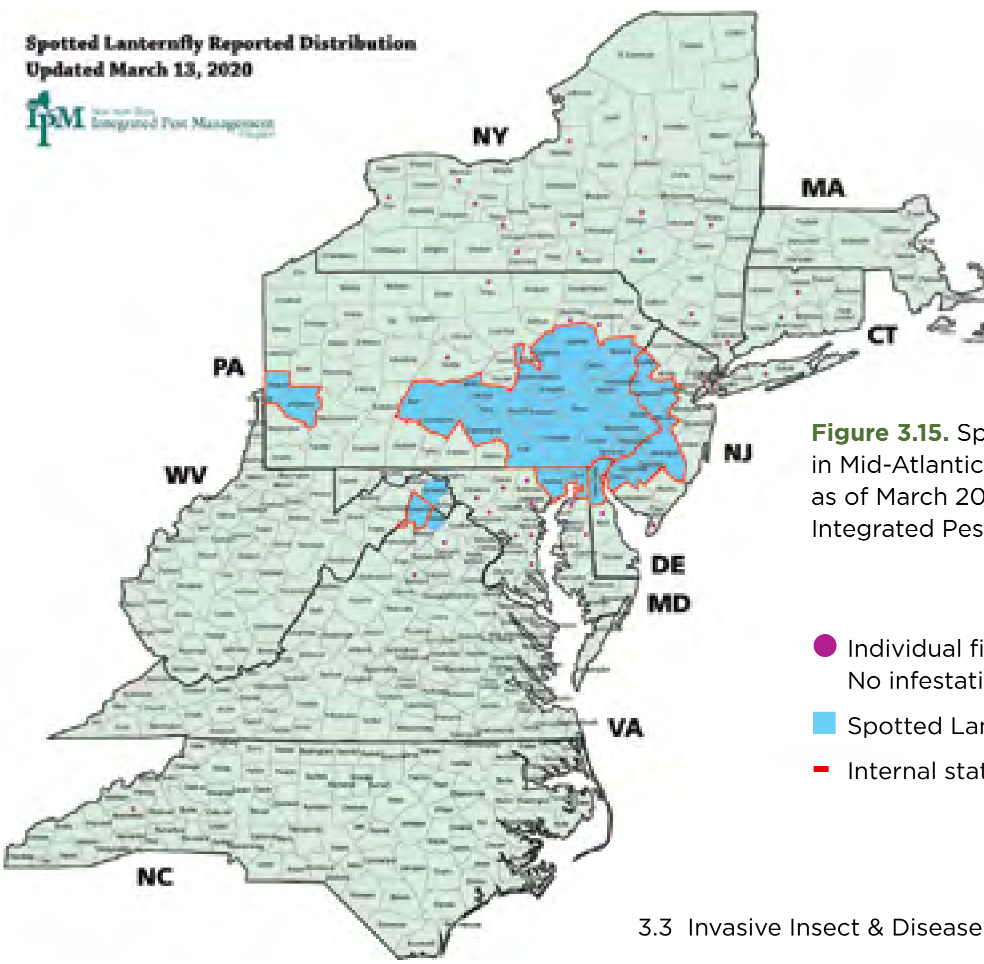


Figure 3.15. Spotted Lanternfly Detections in Mid-Atlantic and New England States as of March 2020. Map by New York State Integrated Pest Management Program.

- Individual finds of Spotted Lanternfly. No infestation present.
- Spotted Lantenfly infestation present.
- Internal state quarantine areas.

Oak Wilt

Oak wilt is caused by a fast-acting fungus, *Ceratocystis fagacearum*, and is considered to be an invasive and aggressive disease. It can result in the decline and death of oak trees in as little as two weeks by clogging the tree's vascular system. Oak trees comprise 6% of Somerville's public trees and likely a similar percentage of private trees.

Oak wilt has yet to be found in Massachuetts, but within New York, oak wilt has been found near Albany, Canandaigua, and in Queens. The fungus is spread from tree to tree by boring insects that carry fungal spores, and through root grafts underground. This disease is most devastating to trees in the red oak subgenus, including *Quercus coccinea* (scarlet oak), *Q. imbricaria* (shingle oak), *Q.palustris* (pin oak), *Q. phellos* (willow oak), and *Q. rubra* (red oak). Somerville's public tree 2018 inventory contains 596 oak trees in the red oak subgenus. The fungus will also attack trees in the white oak subgenus, though it is not as prevalent and spreads at a much slower pace in these trees. The most resistant species to oak wilt include *Q. macrocarpa* (burr oak) and *Q. muehlenbergii* (chinkapin oak).

Oak wilt symptoms on red oak leaves. Photograph credit: C.E. Seliskar, Bugwood.org.

Control and management of oak wilt requires a thorough knowledge of preventive strategies and control measures. The best preventive strategy is to limit wounding (including pruning wounds) of oaks during warm weather when the insect vectors are flying. Immediate attention to adequately dress wounds on oak is an appropriate management strategy for protecting the tree against potential disease. Correct diagnosis is another critical element of reducing the spread of oak wilt. Trees with syptoms should be inspected by a certified arborist and samples should be sent to a lab for diagnosis. The UMass Plant Diagnostic Laboratory website (https://ag.umass.edu/services/plant-diagnostics-laboratory) contains directions on how to cut samples and submit them properly. If diganosed, it is very important to limit the spreading of oak wilt to other nearby oaks. Cutting root grafts is essential as oak wilt can move from tree to tree when they share a common root system. In some cases it may be necessary to remove nearby oak trees to prevent spreading.

Additional resources on oak wilt include Gleason et al. (2018), Rexrode and Brown (1983), and the USDA Forest Service Pamphlet "How to Identify, Prevent, and Control Oak Wilt" (USDA Forest Service, 2017)

Other Diseases

There are various other diseases and pest issues that have been found to affect trees in Somerville, including anthracnose, Verticilum wilt, giant tar spot, and aphids. Treatment of these diseases and pests is often unnecessary as the symptoms are mostly aesthetic and will not negatively impact the health or longevity of trees unless they are heavily infested for many years in a row. However, proper management can minimize their impact to tree canopies. Treatment of these diseases should be done at the discretion of trained City personnel and based on the incidence and severity of disease and likelihood of spread.

Anthracnose is a common foliar disease of shade trees caused by fungi. Anthracnose will periodically surface on susceptible species, and has been found on maple, sycamore and plane trees in Somerville in past years. This disease kills leaf tissue and may cause defoliation to occur. Although this can reduce the aesthetic value and vitality of the affected trees, the trees are often able to recover. While certain management steps can be taken to reduce the prevalence of this disease (noted below), the best long-term course is to focus on planting resistant tree varieties.

Anthracnose symptoms on red maple leaves. https://ag.umass.edu/landscape/fact-sheets/maple-anthracnose.

The Anthracnose fungus generally overwinters in infected, dead leaves on the ground. In American sycamore and London planetree, it also overwinters in infected buds or in cankers formed at the base of an infected leaf or twig. In maple trees, like Norway maple, Anthracnose only impacts the leaves. During cool and wet springs, minute blister-like swellings in the infected tissues release thousands of spores. These get blown around, land on newly-developed leaves, and cause infection and death of the tissue, resulting in tan to brown areas on the leaves. Varying amounts of leaf drop take place, depending upon the severity of the disease that season (the cooler and wetter the spring, the more severe Anthracnose will be). Conditions are then ready to repeat the cycle the following year.

Current recommendations for preventing anthracnose in shade trees include the following:

1. Rake and destroy infected leaves and prune off cankered branches. This will reduce the potential for infection in the following year.

2. Fungicidal treatments during leaf development will help prevent leaf infection and defoliation. Trunk injections of Arbortect® can also be used to manage sycamore anthracnose.

3. Plant tree species resistant to the fungus.

Although Anthracnose is highly prevalent in the landscape, the damage it causes is generally insignficant. Treatment is often not warranted, but may be considered for high-value trees or areas.

Verticillium Wilt is caused by soil-borne fungus *(Verticillium dahliae* and *V. albo-atrum*). Verticillium is often associated with maple but can affect several other species, including ash, Kentucky coffee tree, elm, and plum. Symptoms include yellow foliage, abnormally heavy seeding, and dieback of shoots and branches (often on one side of a tree). Streaking of vascular tissue can accompany external symptoms. Although the fugus is widespread, many plants are able to resist the pathogen, particularly when they are healthy and vigorous. Because the fungus originates in the soil, fungicides often have little to no effect. Once present, the fungus will persist in the soil indefinitely. Therefore, if replacement of trees affected with Verticillium wilt is needed, replant with species not susceptible to the fungus such as birch, gingko, linden, pear, oak, or sycamore.

Giant tar spot is caused by the fungus *Rhytisima acerinum*. This fungus primarily affects maples and sycamores; but especially Norway maples (both the fungus and tree are from Europe). The lifecycle is very similar to Anthracnose, as are the management options. Giant tar spot becomes more apparent on the leaves in the late summer. The fungus overwinters in the infected fallen leaves. When the weather warms up in the spring, spores are released. These spores infect the new leaves on the trees and the cycle begins all over again. Sanitation is the best method of control. Simply raking up the fallen leaves and disposing of them will eliminate the source of giant tar spot for the following growing season. Thoroughly composting the leaf debris can break the cycle.

Giant tar spot on a fallen Norway maple leaf.

Zoomed in profile of an aphid. Aphids are about the size of a pinhead.

Aphids *(Aphidoidea)* are a sap sucking insect. While these pests aren't invasive they can be a nuisance. Aphids will suck the sap of leaves on a tree or plant, and then will discrete a sugary substance called honeydew. This sticky honeydew can be found on anything underneath infested trees (ex. cars parked under trees, sidewalks, fences, etc.), and these objects can become unslightly when subsquent growth of sooty mold occurs.

Aphids are one of the most common insects founds on trees, shrubs, and ornamental plants. There are hundreds of species of aphids, and most plant species host at least one type of aphid.

On Somerville's public trees, aphids have been found to be a particular nuisance on littleleaf linden (*Tilia cordata*) and American linden (*Tilia americana*).

As trees that are stressed are more susceptible to disease and decline, one of the best preventative measures is to keep the trees healthy. Regular deep watering during the summer months is an effective way to prevent or reduce water stress in trees. If a tree is already heavily infested with aphids, one safe and effective way to remove the aphids is by washing them off with a strong blast of water. However, this is not a practical solution for large trees with dense canopies. Altneratively, natural enemies of aphids, such as ladybugs, can be used to help to control aphid populations. Systemic insecticides are not recommended for use against aphids as they also target other important beneficial insects, including bees and other pollinators.

For information on other potential pests, please refer to *Appendix G*.

Invasive Insect and Disease Management Strategies Recommendations/ Conclusions

Somerville's urban forest is vulnerable to a number of existing and potential invasive insects and diseases. Early detection is a crucial step in managing these pests, and thus vigilant monitoring is key. Important strategies for protecting Somerville's urban forest include:

- Adapt the current EAB mitigation strategy for public trees by treating all large, healthy ash trees, and by removing smaller ash trees and those in poor/dead condition. Trees that are removed should be replaced as soon as possible to reduce impact to the city's tree canopy.

- Create public educations campaigns to inform the public about EAB, ALB, SLF, oak wilt, and other invasive insects and diseases.

- To reduce the possibility of an oak tree contracting oak wilt, do not prune oak trees during the growing season.

3.4
Storm Preparedness Plan

Introduction

The purpose of an emergency storm preparedness plan is to mitigate, respond, and recover from an emergency or natural disaster in a timely manner. This section focuses on establishing protocols to outline the steps needed to have an effective strategy in place. Advanced planning will go a long way toward minimizing the impacts of natural disasters on the urban forest.

Keys of an Effective Emergency Storm Preparedness Plan

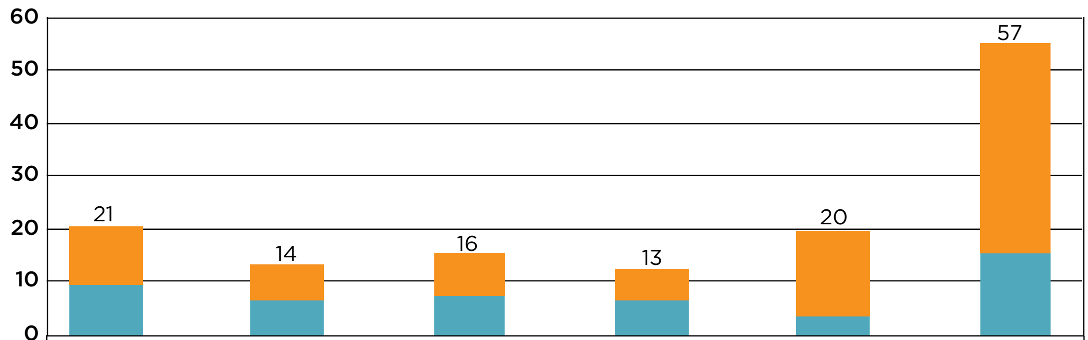
- **Mitigation:** activities to reduce the effects of disasters
- **Preparedness:** plan a response prior to disaster
- **Response:** activities performed during a disaster to minimize hazards in effective, efficient, and equitable ways
- **Recovery:** returning to normal following a disaster

The City of Somerville, Massachusetts lies in a climate zone that exhibits four distinct seasons. This creates the potential for rapid changes in temperature, humidity, and barometric pressure, and sets the stage for severe weather events, such as tornadoes, thunderstorms, hurricanes, hail, high winds, ice, and snow. Northerly hurricane tracks and related deluges are ever-present threats.

The Köppen climate classification (Köppen, 1884) rates Somerville as Dfa. Dfa is characterized as a continental region, but fully humid, and the existence of a hot summer. The Dfa category is used for the following climatic conditions: the coldest month averages below 32°F, at least one month's average temperature is above 71.6°F, and at least four months averaging above 50°F. For context, annual precipitation totals for the Boston area include an average rainfall of 43.77 inches, and an average snowfall of 43.8 inches. In 2018, the Boston area received 53.32 inches (+9.55 inches above average) of rainfall, and 50.9 inches (+7.1 inches above average) of snowfall (National Weather Service Forecast Office, 2020).

Global climate change, manifested by increased rainfall and atmospheric instability, presents a sense of urgency for urban forestry professionals. The main urban forestry concerns for this near-coastal city are flooding and strong winds in the form of tropical storms, microbursts, bombogenesis events or hurricanes. Nearly every year, Massachusetts encounters remnants of, or fully seasoned, warm-water hurricanes. Somerville residents certainly remember these

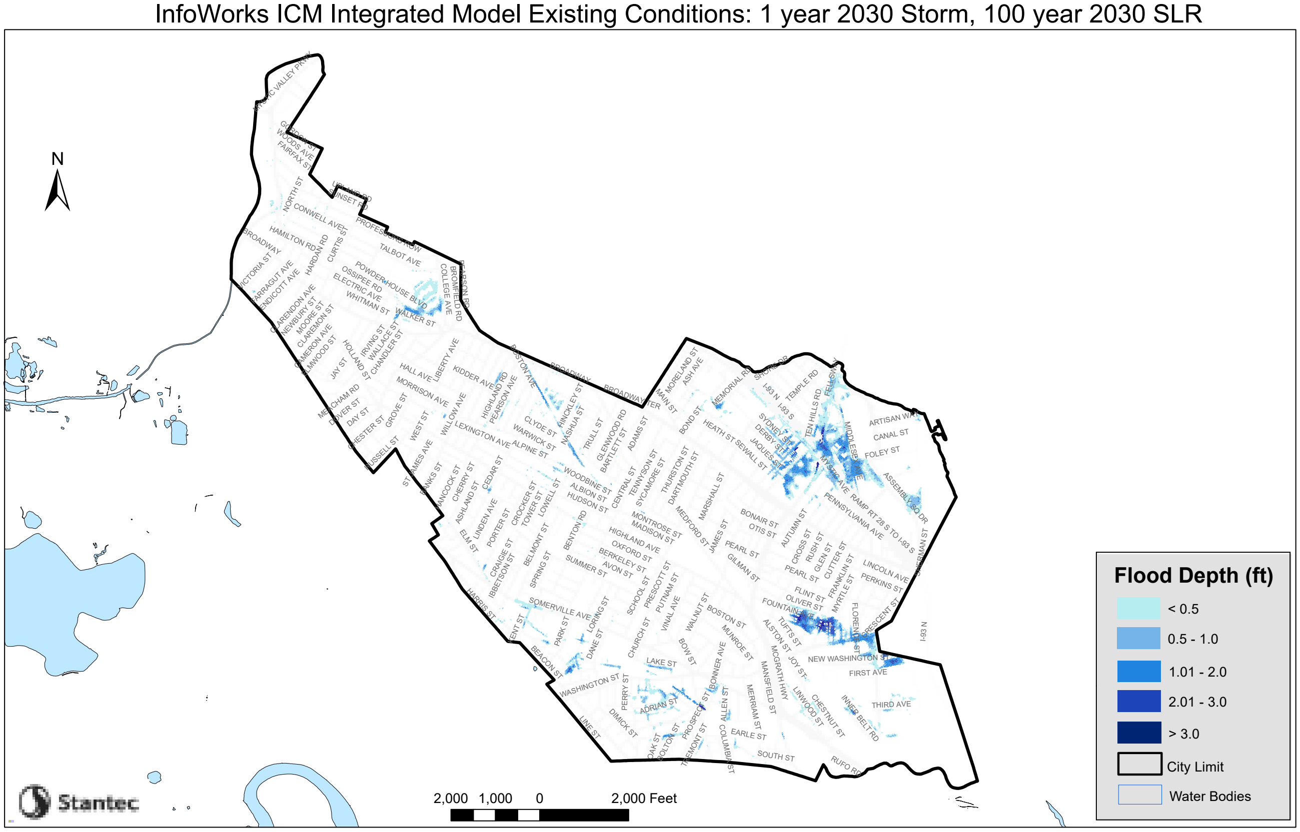
Figure 3.16. Days of Coastal Flooding Since 1950: Boston, Massachusetts. Graph parses out coastal flood days associated with natural events versus flood days associated with sea level rise due to human-caused climate change (Strauss et al., 2016).



	1955–64	1965–74	1975–84	1985–94	1995–2004	2005–14
Natural Floods	10	7	8	7	4	16
Human-caused Floods	11	7	8	6	16	41

Figure 3.17 Frequent Storm Flooding – Present Day; https://www.somervillema.gov/departments/programs/flood-ready (City of Somerville, n.d.).

InfoWorks ICM Integrated Model Existing Conditions: 1 year 2030 Storm, 100 year 2030 SLR



types of storm events from the not too distant past, such as Hurricane Sandy (2012) and Hurricane Bob (1991). **Figure 3.16** demonstrates a dramatic increase in the Coastal Flood Days in Boston, Massachusetts in the last decade. Areas of particular flood concern in Somerville are those areas that are 6' or more below sea level, as well as specific areas subject to localized flooding (**Figure 3.17**).

The National Oceanic and Atmospheric Administration reports that, on average, only 1 tornado is confirmed in the state of Massachusetts each year. Thus, the threat of tornadoes, and the resulting damage that occurs, is relatively low in Somerville. But with the changing climate, the region is experiencing more frequent and severe non-tornado weather events.

Severe weather can create catastrophic damage and significant volumes of debris that needs to be processed. Therefore, proactive cities have developed emergency response and recovery plans for sever weather events. Traditionally, these plans address serious public safety and health issues, but commonly overlook trees and woody debris in the mitigation efforts.

When catastrophic disasters such as tornadoes, ice storms, and severe straight-line winds strike a metropolitan center, thousands to millions of cubic yards of debris are produced. Trees and vegetation can account for approximately 30% of this debris volume.

Beyond the task of collecting and disposing of this debris are additional urban forest management considerations, including increased threat to life, hindrance to life-saving efforts, power outages, and personal and public property damage. The impacts of these additional tree-related considerations are not always quantifiable but can overwhelm city services and slow down the recovery process.

Despite a substantial tree canopy, proactive action in Somerville is needed. There are a number of threats facing the city in the coming years that will stress the urban forest and could reduce overall canopy cover. The loss of canopy poses a threat to air and water quality and leads to higher levels of carbon in the atmosphere, more heat stress, and a degradation of quality of neighborhoods and property values. The following sections provide a summary of the most pressing potential future threats.

Climate Change: Sea Level Rise and Coastal Flooding

The impacts of climate change in Somerville have the potential to be severe, causing rising sea levels and flooding. There is a trend towards increasing sea levels in Boston (**Figure 3.18**), and, as shown in **Figure 3.19**, and described in the *City of Somerville Climate Change Vulnerability Assessment* (City of Somerville, 2017), the annual chance of localized flooding will be significant in the next 50 years. This will cause saltwater intrusion, higher storm surges, and coastal erosion. The consequence of such events on the City's urban forest is higher tree mortality over time, as few trees in the Northeast can withstand lengthy exposure to saline or brackish water. There are not a lot of solutions related to preserving tree canopy in this situation except to plant species that are more tolerant to salt exposure (both from salt spray and saline soils). The following tree species are recommended for areas with the potential for increased salt exposure, particularly in the neighborhoods of Ten Hills and East Somerville: *Taxodium ascendens* (pond cypress), *T. distichum* (bald cypress), *Nyssa sylvatica* (black tupelo), *Quercus bicolor* (swamp white oak), *Q. lyrata* (overcup oak), and *Magnolia grandiflora* (southern magnolia). These species have been incorporated into the recommended tree species list found in *Appendix D*.

There is a trend towards increasing sea levels in Boston. The annual chance of localized flooding will be significant in the next 50 years.

Figure 3.18 Sea Level Rise Since 1920 in Boston, MA (NOAA, n.d.).

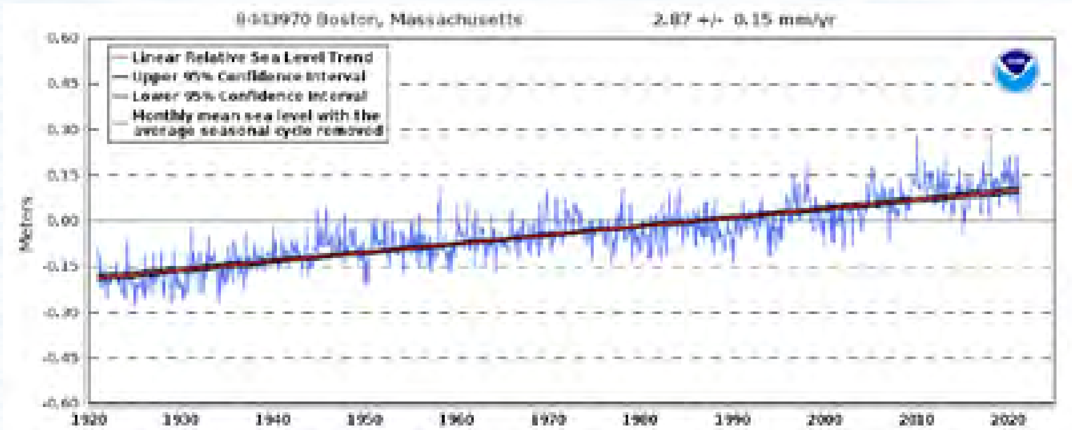
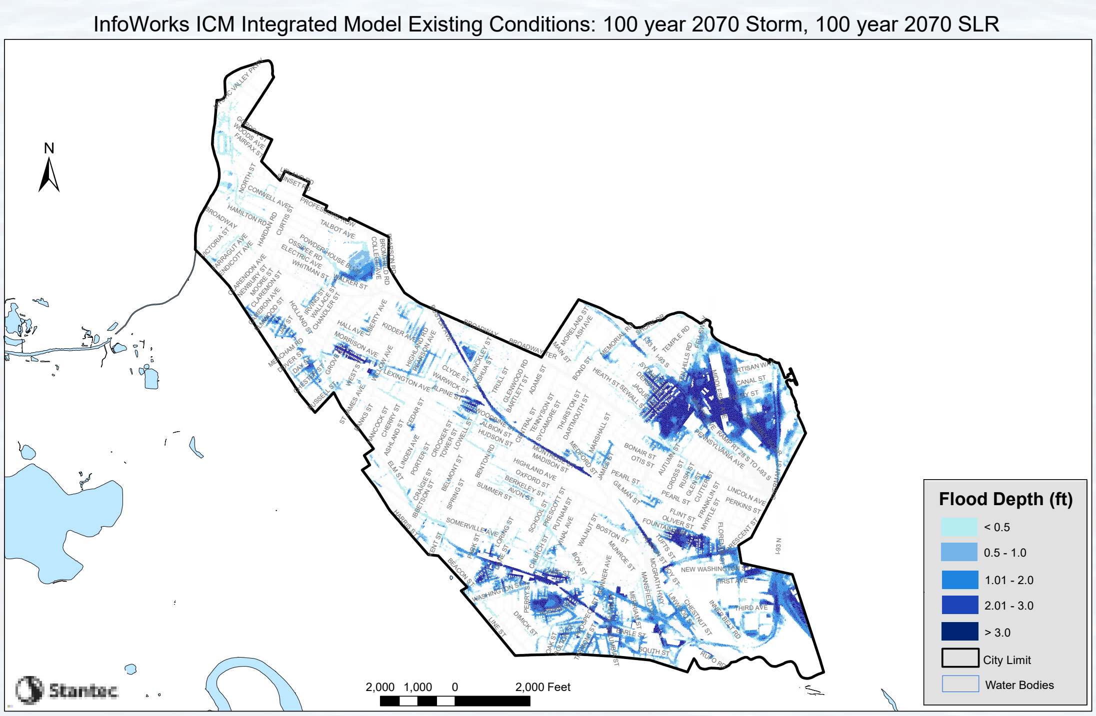


Figure 3.19. Extreme Storm Flooding - 2070. https://www.somervillema.gov/departments/programs/flood-ready (City of Somerville, n.d.)



More Frequent and Severe Storms

As a result of climate change, increases in the frequency and severity of storms are occurring throughout the East Coast. This impacts the urban forest in a number of ways:

- More storm damage and subsequent loss of trees.
  - *Poorly or infrequently managed trees are more susceptible to breakage in storms.*
  - *Certain species are more susceptible to breakage in storms, particularly those with weak wood and/or poor branch architecture.*
  - *Premature post-storm tree removals on private land tend to occur, often as a result of fear and lack of professional assessment.*
- Power outages occur when the wrong trees are situated next to power lines.
- High volumes of stormwater runoff due to extensive impermeable surfaces and less green land cover can exacerbate an already difficult problem.

Proper planting (see *Section 3.1: Tree Planting Plan*) and preventive maintenance (see *Section 3.2: Tree Maintenance Program*) can greatly reduce storm hazards. In addition, when disasters occur, an emergency plan can provide solid data, facts, and protocols to ensure service continuity and timely recovery and restoration.

The Emergency Plan that follows addresses many facets of the urban forestry program, including Somerville's emergency storm response system and the role of the local, county, state, and federal government, ranging from overall management objectives to specific details. Topics range from short-term program priorities to long-term management objectives.

Tree Population Characteristics Related to Storm Damage Risks

The recent tree canopy and public tree inventory data can provide insight into the vulnerability of Somerville's urban forest to severe weather events. It is well known that storm impacts tend to be higher for some types trees than others:

- Certain species of trees are more prone to breaking and splitting in storms (e.g., silver maple, littleleaf linden, callery pear).
- Trees that are under utility lines and have been poorly pruned in the past are more prone to storm damage.
- Trees in poor condition or with crown, trunk, or root defects can fail in even moderate storms.
- Mature trees have a higher risk of storm damage.
- Trees under stress from insect and disease pressures are also more likely to fail in a storm.

Also of note is that the timing of a storm event can have a major effect on the overall damage sustained by the tree. The canopy of a tree can act as a sail when the tree is in full leaf out. This can make the tree subject to windfall due to high wind activity in the summer and fall months, especially combined with heavy rains and supersaturated soil conditions.

The Somerville 2018 citywide tree inventory includes data on 13,604 total publicly owned trees (*Section 2: Somerville's Tree Inventory Data*). To provide a generalized vulnerability assessment of Somerville's urban forest, the 2018 tree inventory was assessed in terms of the frequency of storm-prone species, tree condition, and the susceptibility of the urban forest population to pests.

Table 3.7. Wind Resistance of Tree Species to Hurricanes (Adapted from Duryea and Kampf, 2007).

High	Medium-High	Medium-Low	Low
American holly *(Ilex opaca)*	American hophornbeam *(Ostrya virginiana)*	American elm *(Ulmus americana)*	Bradford pear *(Pyrus calleryana)*
Baldcypress *(Taxodium distichum)*	black tupelo *(Nyssa sylvatica)*	black cherry *(Prunus serotina)*	Chinese elm *(Ulmus parvifolia)*
dogwood *(Cornus florida)*	red bud *(Cercis canadensis)*	boxelder *(Acer negundo)*	Leyland cypress *(× Cupressocyparis leylandii)*
southern magnolia *(Magnolia grandiflora)*	sweetgum *(Liquidambar styraciflua)*	hackberry *(Celtis occidentalis)*	tuliptree *(Liriodendron tulipifera)*
	river birch *(Betula nigra)*	red maple *(Acer rubrum)*	
	ironwood *(Carpinus caroliniana)*	red mulberry *(Morus rubra)*	
	Japanese maple *(Acer palmatum)*	silver maple *(Acer saccharinum)*	
	mockernut hickory *(Carya tomentosa)*	sycamore *(Platanus occidentalis)*	
	pignut hickory *(Carya glabra)*	weeping willow *(Salix × sepulcralis)*	
	sugar maple *(Acer saccharum)*	white oak *(Quercus alba)*	

STORM-PRONE SPECIES FREQUENCY

Fast-growing, weak-wooded species have the highest potential to create the largest amount of debris after storms. Somerville's urban forest shows some concern for diversity, and some of the most commonly planted species are also among the species that are most prone to storm damage. Trees in the Maple genus comprise 28% of the total tree population in Somerville's 2018 inventory, exceeding the desired 20% rule (*Section 2: Somerville's Tree Inventory Data*). Norway maple, which can suffer severe damage in storms, makes up 14% of Somerville's public trees. Other commonly planted tree species such as callery pear (10%) and red maple (10%) are more prone to storm damage and should be monitored closely for defects and disease. When planting new trees, these species should be avoided when possible. Tree planting should always follow the "right tree, right place" strategy (*Section 3.1 Tree Planting Plan*). Special consideration should be given to planting tree species with high or medium-high wind resistance (**Table 3.7**) and moderate to low ice storm susceptibility (**Table 3.8**) to increase the resilience of Somerville's urban forest to storms.

TREE CONDITION AND SIZE

To avoid road blockage along important routes, Somerville should prioritize removing trees that have been recommend for Removal (*Section 3.2: Tree Maintenance Program*), especially the 243 trees (1.8% of the inventory) that have an elevated risk rating associated with them (*Section 2: Somerville's Tree Inventory Data*). Trees that are removed should be replaced with species that are appropriate for the site, in terms of their mature size and wind resistance needs, among other things.

Table 3.8. Ice Storm Susceptibility of Tree Species (Adapted from Hauer et al., 2006).

Low	Moderate	High
American hophornbeam *(Ostrya virginiana)*	American beech *(Fagus grandifolia)*	American elm *(Ulmus americana)*
American hornbeam *(Carpinus caroliniana)*	American sycamore *(Platanus occidentalis)*	American linden *(Tilia americana)*
Amur maple *(Acer tataricum ginnala)*	boxelder *(Acer negundo)*	bigtooth aspen *(Populus grandidentata)*
baldcypress *(Taxodium distichum)*	chestnut oak *(Quercus prinus)*	black cherry *(Prunus serotina)*
balsam fir *(Abies balsamea)*	common chokecherry *(Prunus virginiana)*	black locust *(Robinia pseudoacacia)*
bitternut hickory *(Carya cordiformis)*	douglas-fir *(Pseudotsuga menziesii)*	black oak *(Quercus velutina)*
black walnut *(Juglans nigra)*	eastern white pine *(Pinus strobus)*	Bradford pear *(Pyrus calleryana 'Bradford')*
black tupelo *(Nyssa sylvatica)*	gray birch *(Betula populifolia)*	butternut *(Juglans cinerea)*
bur oak *(Quercus macrocarpa)*	green ash *(Fraxinus pennsylvanica)*	common hackberry *(Celtis occidentalis)*
Colorado blue spruce *(Picea pungens)*	Japanese larch *(Larix kaempferi)*	eastern cottonwood *(Populus deltoides)*
crabapple *(Malus spp.)*	loblolly pine *(Pinus taeda)*	honeylocust *(Gleditsia triacanthos)*
eastern arborvitae *(Thuja occidentalis)*	northern red oak *(Quercus rubra)*	Jack pine *(Pinus banksiana)*
eastern hemlock *(Tsuga candensis)*	paper birch *(Betula papyrifera)*	pin cherry *(Prunus pensylvanica)*
eastern redcedar *(Juniperus virginiana)*	pin oak *(Quercus palustris)*	pitch pine *(Pinus rigida)*
European larch *(Larix decidua)*	red maple *(Acer rubrum)*	quaking aspen *(Populus tremuloides)*
European mountainash *(Sorbus aucuparia)*	red pine *(Pinus resinosa)*	river birch *(Betula nigra)*
ginkgo *(Ginkgo biloba)*	scarlet oak *(Quercus coccinea)*	Siberian elm *(Ulmus pumila)*
Kentucky coffeetree *(Gymnocladus dioicus)*	Scotch pine *(Pinus sylvestris)*	silver maple *(Acer saccharinum)*
littleleaf linden *(Tilia cordata)*	sourwood *(Oxydendrum arboreum)*	slippery elm *(Ulmus rubra)*
northern catalpa *(Catalpa speciosa)*	sugar maple *(Acer saccharum)*	Virginia pine *(Pinus virginiana)*
Norway maple *(Acer platanoides)**	tamarack *(Larix laricina)*	willow *(Salix spp.)*
Norway spruce *(Picea abies)*	tuliptree *(Liriodendron tulipifera)*	
Ohio buckeye *(Aesculus glabra)*	white ash *(Fraxinus americana)*	
pignut hickory *(Carya glabra)*	yellow birch *(Betula alleghaniensis)*	
shagbark hickory *(Carya ovata)*	yellow birch *(Betula alleghaniensis)*	
swamp white oak *(Quercus bicolor)*		
sweetgum *(Liquidambar styraciflua)*		
white oak *(Quercus alba)*		
white spruce *(Picea glauca)*		
witchhazel *(Hamamelis virginiana)*		
yellow buckeye *(Aesculus flava)*		

*Invasive species in Massachussets; do not plant.

Tree planting should always follow the "right tree, right place" strategy (*Section 3.1 Tree Planting Plan*). Special consideration should be given to planting tree species with high or medium-high wind resistance (Table 3.7) and moderate to low ice storm susceptibility (Table 3.8) to increase the resilience of Somerville's urban forest to storms.

In addition to tree health, tree maturity has shown to be a risk factor during storms (Duryea and Kampf, 2007). Mature trees that fail during a storm can create a higher risk of causing damage and creating excessive debris. Mature trees within recent construction zones pose an increased risk due to potential for stress and damage to the tree's root system. Mature trees comprised 4% of the tree population in Somerville's 2018 tree inventory, and 14% of the City-owned mature trees were found to be Dead or in Poor condition (*Section 2: Somerville's Tree Inventory Data*).

Insect and Disease Issues

Urban forests are consistently under pressure from exotic and invasive insects and diseases. See *Section 3.3: Invasive Insect and Disease Management Strategy* for specific invasive insects and diseases that are currently impacting Somerville's urban forest, or have the potential to in the future. Trees weakened by attacks from pests and diseases may be more prone to damage during a storm event. For example, the branches of ash tree infested with Emerald Ash

Borer (EAB) become incredibly weak, which can lead to severe limb defects from wind events or from snow loading. This can lead to a large increase in debris in less severe storms that normally wouldn't create a large problem. Eventually, if left untreated and the infestation becomes worse, whole tree failure is possible from these storm events.

The frequency and severity of pests and disease are likely to worsen throughout the U.S. as the climate warms. The best solution for local communities lies in proper proactive care (budgeting, monitoring, smart management) as well as planting a higher diversity of species and resistant tree species. Species less susceptible to certain pests have been incorporated into the recommended tree species list in *Appendix D*.

Suggested Operations and Protocols

RECOMMENDED RESPONSES

When a storm event causes damage to publicly owned trees, Somerville must act quickly to eliminate hazards, remove tree debris, and restore access to the city's roadways, so operations can resume. Somerville's cleanup priorities are: **1)** site safety; **2)** providing access and ensuring community operations resume; and **3)** systematically restoring trees. **Table 3.9** lists Somerville's woody debris cleanup priorities.

Table 3.9. Prioritized Urban Forest Emergency Responses

Priority	Urban Forest Emergency Situation
1	Trees down, injured people caught in a car or home
2	Branches on power lines (report to proper utility)
3	Trees down, blocking street based on priority list
4	Trees split or hanging that have a high probability of falling, causing personal injury or property damage
5	Trees or branches that have fallen and are blocking sidewalks or community path
6	Public trees that have fallen and are at rest on buildings
7	Trees or branches that have fallen and are blocking driveways
8	Trees or branches that have fallen and are at rest in publicly owned lawns or tree lawns, and other areas of public parks and public properties

Storm Emergency Categories in the Urban Forest

Storm severity and resulting damage in the urban forest vary from storm to storm; the degree of response and resources needed to respond to each storm will vary as well. For planning purposes, severe weather can generally be classified into three classes: Class I, II, and III. The following descriptions of these classes and the response required by the City Somerville are offered for consideration and adoption as part of an official city-wide emergency response plan.

CLASS I – MINOR STORM EVENT

Class I storms are those that are moderate in severity city-wide and/or those which are more severe, but for which damage is restricted to very few locations or a small geographic area of Somerville.

Damage reports and service requests are made directly by residents and from staff inspections. Damage is corrected, and debris is disposed of by Somerville Department of Public Works (DPW) staff and contractors on site or following customary procedures.

Generally, storm damage remediation and clean-up for Class I storms can be achieved by Somerville DPW staff (Tree Crew and Buildings and Grounds) and/or contractors, requires no additional funding or special equipment, and is completed quickly.

Class I – Storm Mitigation Procedures

- Somerville DPW staff receives calls/reports from residents and other Somerville agencies.
- Somerville DPW staff inspects damages and determines appropriate mitigation; utility companies are called as required.
- Somerville DPW staff and/or contractors immediately resolve damage and dispose of debris.
- Somerville DPW staff performs a final inspection, completes work order(s) and/or otherwise notes the occurrence of tree damage in the tree inventory database, with support from Public Space and Urban Forestry (PSUF) staff.

CLASS II – LARGE STORM EVENT

Class II storms are those that are long in duration or are severe enough to cause widespread damage throughout the city. Damage mitigation may also include trees on private property that fall into or threaten the public right-of-way or other property. Mitigation priority areas will be major roads, public health and services facilities, and areas or sites where public safety is at risk.

Recovery from Class II storms requires assistance beyond the normal staff and resources. Damage mitigation for these storms will usually require the assistance of outside contractors and other Somerville departments. The assistance will come in the form of additional staff and equipment, communication assistance, public safety measures, electrical hazard reduction, and customer service.

Table 3.10. Prioritized Mitigation Priorities along Roadways in Somerville

Priority	Streets
1	**Main roads, cross-town streets, bus routes and the "hospital hills"** **Main roads**: Broadway, College Avenue, Cutter Avenue, Elm Street, Grove Street, Highland Avenue, Holland Street, Powder House Boulevard, Summer Street, Warner Street. **Cross-town Streets:** Beacon Street, Cedar Street, Central Street, Cross Street, Curtis Street, Dane Street, Lowell Street, Medford Street, North Street, Packard Avenue, Park Street, Pearl Street, School Street, Somerville Avenue, Sycamore Street, Walnut Street, Washington Street, Willow Avenue. **State-owned Streets**: McGrath Highway, Fellsway, Mystic Avenue, Alewife Brook Parkway, I-93 ramps
2	**The eleven (11) city squares including traffic islands** Assembly Square, Ball Square, Concord Square, Davis Square, Gilman Square, Magoun Square, Porter Square, Powder House Square (rotary), Teele Square, Union Square, Wilson Square
3	**Side streets**

Class II Storm Mitigation Procedures

- Somerville DPW staff assesses damage and immediately communicates with police and fire to determine the extent of the damage.
- An informal Emergency Operations Center (EOC) should be convened to receive calls/reports and to coordinate mitigation response.
- Somerville DPW staff inspects damage, determines mitigation levels and needs, and sets work priorities.
- Under the guidance of the EOC leader, personnel and equipment resources are designated to the various tasks.
- Somerville DPW staff and contractors resolve damage, process debris on site where appropriate, or transport debris to storage site.
- Somerville DPW staff, with support from PSUF, makes final tree inspections and updates the tree inventory database.
- Any stored debris is processed appropriately.
- Somerville DPW staff, with support of Communications and PSUF staff, communicates with the residents about its response activities and status using the Somerville's website, social media platforms, etc.

CLASS III – CATASTROPHIC STORM EVENT

Class III storms will be rare but can and have occurred in Middlesex County. Generally, these will result from hurricanes and widespread ice storms. Damage will be severe and widespread on both public and private property.

A “State of Emergency” will likely be called during and after a Class III storm event. A full EOC should be convened by the mayor. Other local, state, and federal emergency management agencies will be involved, as well as Eversource, National Grid, and other controlling utility companies. It may become necessary to identify additional funds that can be used to finance additional contractual services, equipment, and staff overtime for the mitigation efforts.

Mitigation priorities will be first determined by public safety, health, and welfare needs. The first priority of roads to be cleared are those primary streets and highways that provide evacuation routes and/or access to hospitals, shelters, police, fire and rescue stations, and other facilities providing vital public services. Mitigation priorities along roadways in Somerville are shown in **Table 3.10**.

Emergency road-clearing takes precedence over removal of debris. At a minimum, debris is to be moved to the side of the roadway that will allow for emergency traffic in each direction and not create conflict with future utility restoration efforts by others.

Class III Storm Mitigation Procedures

- Somerville staff assesses damage and immediately communicates with the EOC and the designated Somerville DPW staff leader to determine the extent of the damage. Other Emergency Management agencies may also be in the communication channels.
- Somerville may secure additional regional tree debris disposal site(s) as needed.
- Somerville DPW staff inspects tree-related damage, determines mitigation levels and needs, and sets work priorities.
- Somerville DPW, allied agencies, and contractual staff resolve damage, process debris on site where appropriate, or transport debris to storage site.
- Somerville DPW staff, with support from PSUF staff, makes final inspections and updates the tree inventory database.
- Any stored debris is processed appropriately.
- Somerville staff assists EOC team members and Mayor with completion of required state and FEMA forms.
- Somerville DPW staff, with support of Communications and PSUF staff, communicates with the residents about its response activities and status, and provides advice for the treatment of private trees that have been damaged using the Somerville’s website, social media platforms, etc.

Working with External Contractors

Prior to any storm event, it is important for Somerville to setup contracts and agreements for any work that may be needed after a storm event. Those agreements should be scalable to each individual storm event. Both internal and external crews must be flexible in their work activities and must have the equipment and training to be able to perform the necessary work.

RECOMMENDATIONS:

- Establish pre-qualifications for contractors as prerequisites to working for the City during storm emergencies.
- Grow and foster relationships with contractors, arborists, utility companies, and others to support operations.
- Determine internal and external staff and equipment needs for the different storm emergency categories. For example:
  - *Define operational needs for each Storm Class Level. Considerations include:*
    - » Staffing and equipment needs, including the number of people required (and what skills are needed) and the amount of equipment needed.
    - » The amount and types of tools and personal protection equipment (PPE) needed.
    - » A competent field supervisor and customer contact person(s). Provide the contact information and contact method.
  - *Ensure all applicable industry standard training is current, including:*
    - » Current OSHA safety and other training, including annual refreshers.
    - » Current tree rescue and climbing certification.
    - » Current first aid and CPR training.
    - » Define a standard for workday (time of day and duration) and response time expectations.

Mutual Aid Agreement

Mutual Aid Agreements (MAAs), as defined by FEMA, are agreements between agencies, organizations, and jurisdictions that provide a mechanism to quickly obtain emergency assistance in the form of personnel, equipment, materials, and other associated services. The objective of an MAA is to allow for the rapid, short-term deployment of emergency assistance before, during, and after a storm event. A signed contract does not require assistance to be provided or received, but rather offers a tool for use as dictated by need. These contracts are critical to managing large-scale storm events successfully. It is not ideal to have an MAA with nearby towns. If a natural disaster hits Somerville, it is likely to affect the surrounding area. Taking this into account it would be beneficial to look outside the immediate region to solicit a MAA.

RECOMMENDATIONS:

- Understand the emergency response capabilities of the surrounding communities.
- Identify additional resources that could be used in a worst-case scenario to offset any potential issues with response of contractors.
- Develop relationships with professional groups within the industry such as the Massachusetts Arborists Association and International Society of Arboriculture to lend assistance.

SUGGESTED MAA COMPONENTS INCLUDE:

- Service and equipment types.
- Chain of command for activating the agreement.
- Communication procedures.
- Appropriate training requirement(s).
- Certifications and qualifications required.
- Insurance and indemnification requirements.

Current Resources

During and after a storm emergency, and depending on the severity of the storm and the damage sustained, Somerville calls upon Highway Division (Tree Crew), Buildings and Grounds, and other DPW maintenance employees to address the community's needs. The Somerville Water & Sewer Department is staffed and equipped to address water infrastructure damage. The electric provider, Eversource, would be contacted for electric power issues, and National Grid and Eversource would be contacted for any gas line issues. Contractors are also used to supplement Somerville staff when needed and available. City staff have trucks and equipment available to manage and mitigate tree-related storm damage.

Woody vegetation debris is transported to the Somerville's City Yard 2 for temporary storage and final processing. This area has large paved areas, easy access for vehicles and heavy equipment, and is conveniently located for staff and contractors. Additional chippers and a tub grinder that processes wood and brush into mulch could be acquired to assist in the debris processing post storm event.

Below is a map of Somerville illustrating the functional street hierarchy and priority public spaces that can be utilized to prioritize Somerville's post storm efforts (**Figure 3.20**).

PARTNERS

Storm response and mitigation in Somerville, especially after severe events, will require the resources and expertise of a variety of external partners. Multiple partnerships are a necessity in storm response given the variety of legal, jurisdictional, and operational missions even within a municipal boundary. Partnerships can result in an effective and efficient response when the expertise and resources of each possible partner is acknowledged and properly utilized.

The following is a brief description of Somerville's major partners in a storm emergency and during recovery efforts.

1. **Utility Agencies**

Electric distribution lines in Somerville are controlled by Eversource, who is a key partner during a storm emergency. Only Electrical

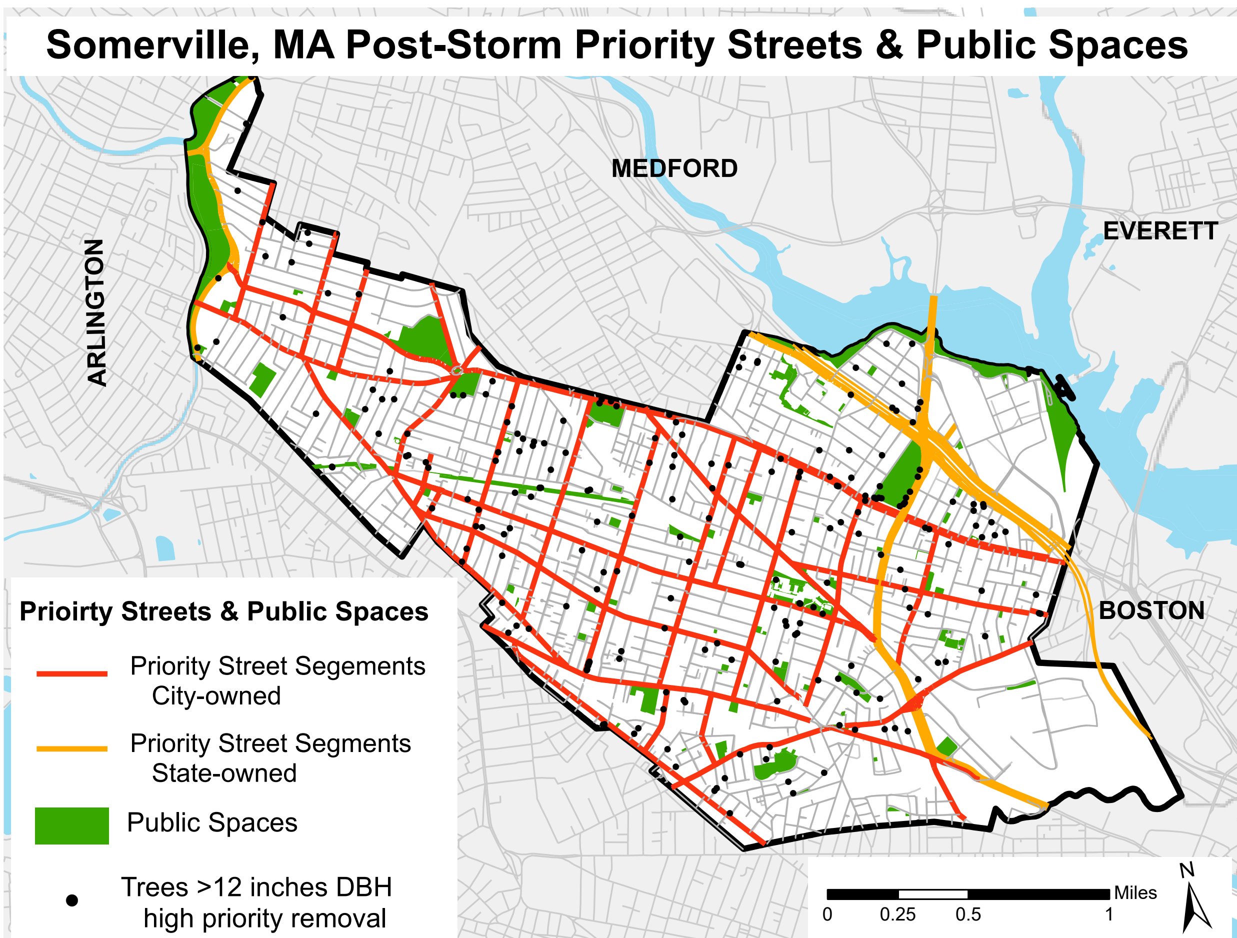


Figure 3.20. Somerville Priority Street and Public Spaces Map. Trees along the priority streets that are greater than 12 inches DBH and listed as high priority removals (i.e. high to moderate risk rating) should be removed as soon as possible.

Hazards Awareness Program (EHAP) trained staff are qualified to work around energized lines. They have the resources to mobilize quickly and respond appropriately to emergency situations involving trees and utilities. During a widespread storm event, Somerville will likely also need to communicate and coordinate with the Massachusetts Department of Public Utilities. Where whole trees or limbs are down or resting on energized lines, rescue and clean-up efforts cannot proceed until power lines have been addressed by the trained personnel of these agencies. Prioritization of where utility agencies respond first generally is: three-phase aerial electric lines; single-phase aerial electric lines; secondary electric lines; and then service (or residential) drops.

2. Massachusetts Department of Transportation (MassDOT)

MassDOT is responsible for the safety and maintenance of interstate and state routes within and around the City of Somerville. During a storm emergency, they can respond with staff and equipment to clear such rights-of-way and assist with Somerville streets if authorized.

3. Contractors

Labor and equipment for debris clearance, removal, and disposal should be available from local contractors. It is advisable to have contractors, such as tree service companies, debris processing companies, and equipment and tool rentals, already under contractual agreements with Somerville. During an emergency, Somerville could enter into new emergency contracts and modify existing contracts to supply the personnel and equipment necessary to efficiently deal with storm mitigation efforts.

4. State of Massachusetts

When the response efforts appear to be beyond the capability of Somerville or the county, the State can normally provide the next level of assistance by declaring a state of emergency. The Massachusetts Department of Energy Resources (DOER) and Massachusetts Emergency Management Agency (MEMA) aids local emergency response leaders during major or complex emergencies or disasters. Both DOER and MEMA assist local jurisdictions with recovery from natural or man-made disasters, in addition to coordinating mitigation programs designed to reduce the impact of future disasters on a community. Additionally, they will typically evaluate the disaster situation and provide advice to the governor on the availability of state resources to assist local efforts.

The Massachusetts Homeland Security Division's website, https://www.mass.gov/homeland-security-initiatives, offers a toolbox of information to assist with the process of requesting aid and making claims for reimbursement through a State-Share Grant Program.

5. Federal Government

The U.S. Army Corps of Engineers may be able to respond to a storm event for up to 10 days without a Presidential Declaration; the Federal Highway Administration may provide grant assistance to Massachusetts for debris clearing, tree removal, and repair of roads; and the Federal Emergency Management Agency (FEMA) provides financial and administrative assistance after storms that are declared a federal emergency.

FEMA is the major federal agency that will be a partner of Somerville in the event of a severe storm emergency. FEMA recommends that communities have an *Emergency Operation Plan* and, since debris removal is reported as the most significant storm-related problem, a *Debris Management Plan*.

FEMA will reimburse Somerville for debris removal costs if a federal disaster is declared. FEMA will also reimburse Somerville for removing certain trees during a federal disaster. Trees which sustain greater than 50% crown loss and are on the public right-of-way are eligible for removal cost reimbursement. However, trees that are completely on the ground after a storm and can be moved away with other debris are usually included in the debris estimates. FEMA often does not cover stump removal unless a hazard situation is present.

Finally, FEMA will also reimburse Somerville for hazard reduction pruning immediately following a storm during a federal disaster. In general, broken or hanging branches that are 2 inches or greater in diameter and that are still in the crown of a tree can be pruned under the hazard reduction reimbursement policy. The pruning cost is not extended to the entire tree but is limited only to the removal of branches contributing directly to the hazard.

Final reimbursement of storm-related damages from FEMA is dependent on accurate record keeping and documentation of storm-related cleanup work.

FUNDING AND BUDGET FOR URBAN FOREST EMERGENCIES

Storm and emergency response will require funding for staff overtime, contractual services, and equipment rental. Somerville is strongly encouraged to analyze past storm events (hurricanes) and provide for sufficient regular funding and contingency funding to support an adequate response for various levels of storm damage.

As mentioned previously, removal of debris from public property is eligible for reimbursement from FEMA under most cases when a federal disaster has been declared and when it constitutes an immediate threat to life, public safety, or property. This includes the removal of tree debris (downed limbs, trees) and the pruning or removal of trees to remove imminent hazards (hanging limbs or trees so damaged that they are structurally unstable). The removal of any tree debris located on public right-of-way is eligible for reimbursement, including material that originated on private property and has been dragged to the right-of-way by residents during a specified period.

In order to receive FEMA funding, it is critical to be prepared and fully document all losses and money spent. Most damage assessments through FEMA must be done immediately after the disaster event. The calculated dollar amount is then sent to the Emergency Management Director. FEMA has a public assistance program that is open to municipal departments and non-profit hospitals. These grants can be applied for to assist with a variety damages, including debris removal and emergency protective measures.

Historically, FEMA funding for storm damage mitigation reimbursements has been made available in Massachusetts. For example, over $30.4 million in public assistance grants on 695 individual applications were provided in the state (including adjacent Suffolk County) after a weakened hurricane Irene hit Massachusetts in August 2011 (see **Figure 3.21**).

FEMA Funding Programs

The following is a summary of key federal disaster aid programs that were offered by FEMA and administered by the state when under a presidential disaster declaration:

- Payment of no less than 75% of the eligible costs for emergency protective measures

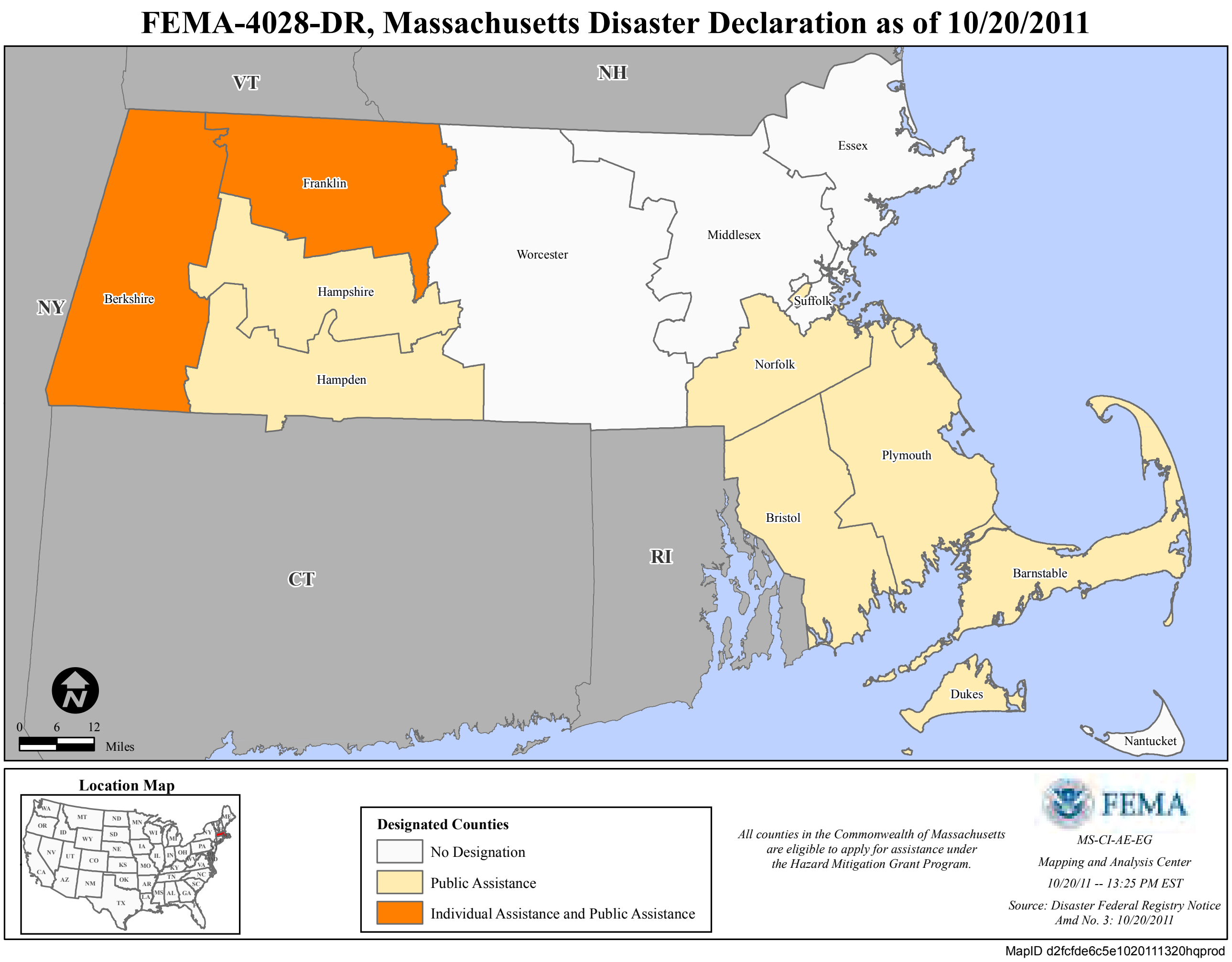


Figure 3.21. Massachusetts Tropical Storm Irene (DR-4028) Public Disaster Declaration Areas; source: https://www.fema.gov/disaster/4028 (FEMA, n.d.).

taken to save lives and protect property and public health. Emergency protective measures assistance is available to state and eligible local governments on a cost-sharing basis (Source: FEMA funded; state administered).

- Payment of no less than 75% of the eligible costs for repairing or replacing damaged public facilities, such as roads, bridges, utilities, buildings, schools, recreational areas and similar publicly owned property, as well as certain private non-profit organizations engaged in community service activities (Source: FEMA funded, state administered).
- Payment of no less than 75% for snow assistance, for a specific period of time during or proximate to the incident period. Snow Assistance may include snow removal, de-icing, salting, snow dumps, and sanding of roads (Source: FEMA funded, state administered).
- Payment of no more than 75% of the approved costs for hazard mitigation projects undertaken by state and local governments to prevent or reduce long-term risk to life and property from natural or technological disasters (Source: FEMA funded; state administered).

TRAINING

Somerville staff should receive safety and technical training through in-the-field and classroom methods. To ensure safe and effective work, staff should receive regular and updated training sessions for first-aid, CPR, chainsaw use, tree risk assessment, and minimum approach distances for energized electric lines. These topics should be considered as basic minimum training opportunities.

Additional training should be provided to key personnel in topics that include electric hazard assessment (EHAP), aerial lift training, advanced climbing, crane operations, and aerial rescue. Consider having key staff members receive training to become ISA Certified Arborists. Develop annual "scenario training" with tree emergency response topics and situations.

Types of training and certifications:

- Safe work practices
- Applicable OSHA regulations
- ANSI standards
- Incident Command Systems
- First Aid and CPR
- Tree risk assessments
- Electrical hazard awareness
- Tree pruning and felling practices during emergency conditions
- Communications
- Storm recognition and mitigation
- Storm restoration practices

Conduct Periodic Drills:

- Invite stakeholders and key individuals.
- Bring experts in to assist with training and practice if needed.

EMERGENCY RESPONSE PUBLIC RELATIONS

It will be essential to identify an individual to serve as a Safety Officer in preparation of an emergency to act as point person for effective and uniform communication. This person will help ensure compliance of contractors to the applicable OSHA Regulations, ANSI Standards and BMPs. Throughout the preparation and implementation phases of the plan the Safety Officer would work in cooperation with Somerville's Tree Warden and Urban Forestry staff, as well as the local Eversource utility arborist. Additionally, the Safety Officer would be responsible for identifying and training the staff needed for the process logistics. Communication is critical to surviving disasters, especially when dealing with the public and those who have been impacted by the storm event. If information is not actively managed during tree emergencies, disorganization will complicate recovery work. Public relations should be coordinated through the Safety Officer/EOC or the mayor's office. Important aspects of storm response communication are as follows:

Communication

- Creating public safety announcements about:
  - *Threats from downed conductors.*
  - *Non-local crews who are travelling in convoys.*
  - *Blind spots created by heavy equipment.*
  - *Traffic issues involving traffic lights, work zones, downed limbs and trees.*

- Develop avenues for communication – web, television, radio, email, social media, phone calls, and text alerts.
  - *Determine threshold as to when to notify.*
  - *Develop a short, concise statement to be modified per the severity of the incident.*
- Develop an alternate communications plan that works when large power outages shut down electronic networks.

Recommendations for General Public Relations

- Publicize the phone numbers and staff person/position for public contact.
- Work with the media early and often.
- Take time to get accurate information out.
  - *Be frank about the extent of damage and the estimated time needed for recovery.*
  - *Publicize your next actions and decisions. People get most upset when they do not know what is going to happen or when.*
- Deliver important messages to the community.
  - *"Stay safe" – watch for hangers, leaning trees, downed wires, chainsaw injuries, etc.*
  - *"Stay calm" – it may not be a bad as it seems, help is on the way, panic results in poor decision making.*
  - *"Get help from arborists who are insured, and preferably Certified Arborists."*
  - *"Think critically when deciding to remove a tree or not—as long as no hazard is present."*
- Indicate how the public can help.
  - *Placing debris at the curbside properly.*
  - *Keeping debris away from fire hydrants and valves.*
  - *Separating recyclable and flammable materials.*
- Emphasize the need for careful professional damage assessment.
  - *People often feel deeply about trees after a disaster, wanting either to "kill" or "save" them all, and they need to hear voices of reason from Somerville officials.*
  - *Trees can recover from substantial damage. Sometimes "unrecoverable" trees at first glance may be judged as much less serious by an experienced professional arborist.*

Summary and Recommendations

With this Storm Preparedness plan, and other urban forest management resources available to Somerville, such as the tree inventory and the rest of this Urban Forest Management Plan, the City of Somerville is fairly well prepared to handle the severe weather events that inevitably will impact Somerville's trees. With only minor adjustments in its approach to storm response, Somerville should be able to manage future events and be better prepared to seek reimbursement for the large expenses that sometimes accompany large storm events.

Recommendations for improving storm response and recovery program and actions:

- Be sure all staff are signed up for the Emergency Alert System through www.mass.gov/alerts.

- Continue to update Somerville's street and park tree inventories. Current data will provide much needed information that can be used to maintain the urban forest and help to reduce future storm damage.

- Address High Risk trees and EAB-infested trees promptly to remove them from the population to reduce preventable damage.

- Remove Low Risk but storm prone species from the population when their service lives are over and replace with more resilient species (**Tables 3.7** and **3.8**).

- Practicing proper pruning techniques, eliminating codominant stems, and keeping trees as healthy as possible, all helps in the creation of a more wind resistant urban forest. This is an important facet of the Young Tree Training Program (see *Young Tree Training* in *Section 3.2 Tree Maintenance Program*).

- Utilize Homeland Security office to provide quick notification to Massachusetts Homeland Security Division and FEMA if reimbursement from disaster funds is anticipated. Develop a clear system of record keeping that will provide required information so that reimbursement is achieved where allowed. This step can save Somerville several thousands of dollars in costs for cleanup of storm debris from future storm events.

- Complete the Tree Emergency Plan Worksheet (*Appendix H*) and distribute appropriately. Review the Worksheet annually and update information as needed.

- Communicate to all appropriate Somerville staff and partners the procedures for prioritizing and managing urban forest damage after storms per the three storm categories.

- Provide staff training, particularly on tree risk and working with potential electrical hazards.

- Commit to providing residents with timely messaging about Somerville's response and recovery activities and about tree damage and correction topics. Prepare public relations materials ahead of time so that they are easily accessible when the storm strikes.

Partner Information

Department of Massachusetts Homeland Security and Emergency Services

https://www.mass.gov/homeland-security-initiatives

Disaster Relief Grants

https://www.grantwatch.com/cat/48/disaster-relief-grants.html

FEMA Disaster Management Toolkit - Debris Management Guide

https://www.fema.gov/pdf/government/grant/pa/demagde.pdf

Emergency Management Director (EMD)

https://www.mass.gov/find-your-local-emergency-management-director-emd

Massachusetts Department of Energy Resources (DOER)

https://www.mass.gov/orgs/massachusetts-department-of-energy-resources

Massachusetts Department of Public Utilities

https://www.mass.gov/orgs/department-of-public-utilities

Massachusetts State Emergency Response Commission (SERC)

https://www.mass.gov/service-details/massachusetts-state-emergency-response-commission-serc

Massachusetts State Police

https://www.mass.gov/orgs/massachusetts-state-police

The Massachusetts Emergency Management Agency (MEMA)

https://www.mass.gov/orgs/massachusetts-emergency-management-agency

Ready.gov – Citizen Emergency Readiness Campaign

https://www.ready.gov/

United Way Disaster Relief

https://www.unitedway.org/recovery

Somerville Emergency Management Director

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Deputy Chief Charles Breen,
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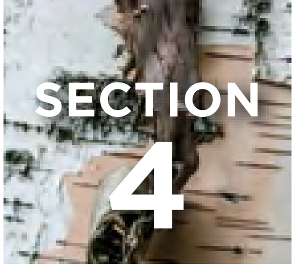
cbreen@somervillema.gov



THE ROAD MAP

As described in *Section 2: Somerville's Tree Inventory Data*, the City of Somerville is responsible for the management of an urban forest comprised of approximately 11,484 City-owned trees growing along streets and in City-owned open space. This valuable community asset provides over $1 million in quantifiable benefits annually to Somerville—and many more unquantifiable benefits—and is the only City infrastructure that both appreciates in value over time and provides a positive return on investment for public funds allocated to its care. *Section 3.2: Tree Maintenance Program* provides an understanding of the workload necessary to maintain and enhance the City's urban forest over the next seven years. For example, 88% of the City's trees require some level of routine pruning (including young tree training).

This Section of the *Urban Forest Management Plan* describes the details of how the City's urban forestry program operates, how it is funded, and current ordinances and policies that guide the program and the protection of the trees in the city. It further provides recommendations for developing a more robust and efficient urban forestry program, as well as suggestions for bolstering public engagement. This Section should be used as a Road Map for the City to increase operational efficiency, identify additional funding avenues, better protect the cities trees, and advance outreach strategies.


AMERICAS MEAT MARKET
ACOUGUE BRASILEIRO
CITYLINE

4.1 Operations Review

Introduction

The City of Somerville is fortunate to have a significant tree canopy, a healthy street tree population, a tree ordinance and citizen committee, knowledgeable City staff, and contractual resources to perform tree planting and tree care work when needed. Despite these assets, the City's forestry program does not operate as proactively as it should, and is underfunded and understaffed for its projected workload and recommended program responsibilities outlined in *Section 3.2: Tree Maintenance Program*. Major goals for Somerville's Tree Maintenance Program are shown in **Table 4.1**. This Operations Review provides a better understanding of the existing care of Somerville's trees, highlights the strengths of the program overall, and identifies challenges/areas for improvement. Specifically, this Operations Review 1) evaluates the efficacy and appropriateness of Somerville's present urban forestry management practices; 2) determines if there are sufficient resources allocated and available to maintain a safe, viable, and sustainable urban forest; 3) provides goals, guidelines, and new strategies that can help standardize and optimize the management of Somerville's urban forestry program and arboricultural practices and create a proactive maintenance program. It should be used to guide future City resource allocations as well as staff and program development so that Somerville can move toward appropriately managing, maintaining and growing its urban forest in the best way possible.

The information presented in this Operations Review was compiled from an examination of the City's organizational structure, budgets, staffing levels and types, City plans and policies, GIS and tree inventory data, and other urban forestry program information, followed by interviews with key staff. Urban forestry operations and management practices were then evaluated as they relate to staffing levels, equipment resources, and budgets, with the aim of identifying specific options for improving the efficiency and effectiveness of work. Recommendations were made following industry standards and best management practices.

Table 4.1. Major goals of Somerville's Tree Maintenance Program (*Section 3.2*)

General Urban Forest Goals	Street Tree Maintenance Program Goals
Minimize risk and liability related to public trees	Perform all priority tree removal and pruning work in the next 2 years
Protect trees and preserve their role in defining the City's character	Establish a preventive Routine Pruning cycle of at least 6 years
Develop a proactive management regime for public trees	Establish a Young Tree Training cycle of 3 years
Ensure tree benefits for future generations through a sustainable planting program	Plant at least 350 trees each year

The focus of the analysis was to identify the strengths of the program and determine whether there are any large operational gaps or challenges that could potentially interfere with the implementation of the recommendations in *Section 3.2: Tree Maintenance Program*.

1. City Organizational Structure, Personnel & Productivity

Somerville's urban forest is overseen and managed by two divisions: Public Space and Urban Forestry (PSUF) and the Department of Public Works (DPW) Highway Division's Tree Crew.

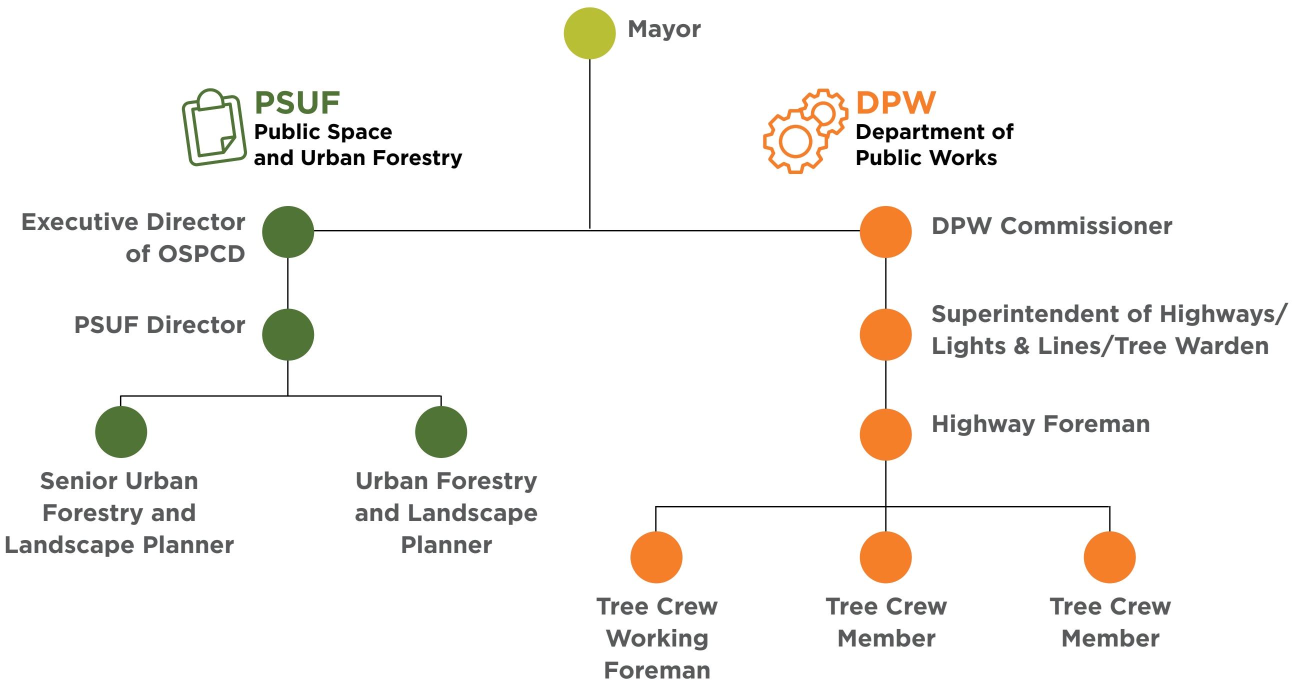
PSUF
Public Space and Urban Forestry

Public Space and Urban Forestry (PSUF) is a division of the Mayor's Office of Strategic Planning and Community Development (OSPCD) and is the planning arm of the urban forestry program. PSUF is responsible for design and management of the public realm, including protecting and preserving existing trees, planting new trees, communicating with city residents, and planning for the future. PSUF has two (2) full-time staff members who oversee tree planting and maintenance, keep track of data, staff the Urban Forest Committee and Conservation Commission, ensure compliance with the Tree Preservation Ordinance, and interact with constituents and elected officials. These positions, the Senior Urban Forester and Landscape Planner and the Urban Forester and Landscape Planner, are relatively new positions, both created within the past 5 years. Staff in these professional urban forester positions have arboricultural certifications (i.e. from the Massachusetts Arborist Association, International Society of Arboriculture, etc.), but do not perform tree removal or pruning work. Both urban foresters have been designated as Deputy Tree Wardens. These urban foresters support the urban forestry management program by managing contracts related to tree planting, young tree training, and parks tree health, performing planting site reviews and planting oversight, guiding interdepartmental cooperation and partner relations, issuing permits, attending and leading community meetings, designing and supporting special events, and carrying out other administrative duties as needed. PSUF staff are located in City Hall (93 Highland Avenue) and report to the director of PSUF.

DPW
Department of Public Works

Department of Public Works Tree Crew is organizationally located within the Highway Division of the Department of Public Works (DPW) and is responsible for the day-to-day field operations related to the urban forest, including pruning trees, performing tree removals, grinding stumps, picking up downed limbs, and responding to tree damage from storm. Currently the DPW Tree Crew has three (3) full-time staff dedicated to tree maintenance. They are avail-

Figure 4.1 Organizational chart of Somerville staff who work directly on urban forestry matters.



able to perform other duties as needed or in an emergency, but their primary job responsibilities center on urban forest maintenance tasks. These positions require a hoisting license and a Commercial Driver's License (CDL); however, arboricultural certification or experience is not required, although it is preferred. Presently, no one on the crew has arboricultural certification although some have many years of on-the-job experience. The DPW's Highway Foreman and Superintendent of Highways instruct the tree crew on their daily work assignments and manage some of the tree maintenance contracts, with some advice from the PSUF Urban Foresters at City Hall, or based on 311 requests. The Superintendent of Highways is also the City's Tree Warden, who has formal, state-designated authority to protect the city's public shade trees per Massachusetts General Laws Chapter 87. This staff is supported by DPW's Administrative staff, including clerical staff that monitor, print, and forward 311 requests to Tree Crew Management. Once work orders are completed, clerical staff also close out 311 requests. The DPW Tree Crew is located in the DPW building (1 Franey Road) and reports to the Superintendent of Highways.

The challenge with the division of the Urban Forestry staff between two departments is that miscommunications can occur between the departments/divisions, which can lead to inefficient, ineffective or duplicative services. This can be improved by strengthening the formal communication, coordination and collaboration process between PSUF and DPW Tree Crew staff and managers. Both DPW Tree Crew and PSUF staff conduct tree inspections based on requests by residents and other city departments, as well as self-directed assessments. In addition to regular communication about tree removals, staff from PSUF and DPW meet monthly to discuss urban forestry practices. Nevertheless, as the two departments operate independently, keeping apprised of the day-to-day decisions and operations is a challenge.

PERSONNEL & PRODUCTIVITY

The 2014 Urban and Community Forestry Census of Tree Activities reports that the national average number of dedicated urban forestry program employees for cities with populations of between 50,000 and 99,999 is 6 full-time and 3 part-time or seasonal workers (Hauer and Peterson 2016). As described above, the City of Somerville currently has 5 full-time staff dedicated to urban forestry matters (two urban foresters and three laborers). For the goals and recommendations of *Section 3.2: Tree Maintenance Program* to be achieved, the City's urban forestry program would benefit from additional crews and technical staff dedicated solely to the program. It is recommended that for each tree crew, at least one staff member be certified in arboriculture or at a minimum has extensive experience in the field. Dedicated and informed staff with clearly defined job responsibilities will provide better and faster responses to resident and interdepartmental requests. Increased responsiveness will reduce public tree risks, elevate the professionalism of the city, and increase the efficiency of the operations.

For the goals and recommendations of *Section 3.2: Tree Maintenance Program* to be achieved, the City's urban forestry program would benefit from additional crews and technical staff dedicated solely to the program.

While the City recognizes the need for additional staff, they have faced challenges in attracting and retaining qualified staff in the DPW Tree Crew. The City should work through the union to evaluate its compensation and training package for DPW Tree Crew workers and identify ways to make it more attractive for both recruitment and retention of department employees.

Seasonal and intern positions are an option for addressing program staffing capacity needs. Seasonal/intern positions could be assigned to assist the PSUF urban foresters with inspections, administrative permit reviews, utility coordination/inspections, and public education. They could also be assigned to help with inventory updates, data entry, and reporting, or to assist with the Young Tree Training program. The City of Somerville should explore recruitment options including Massachusetts technical high schools such as Essex North Shore Agricultural & Technical School, or Norfolk County Agricultural School. These schools train students in arboriculture, teaching them basic climbing and pruning techniques and tree identification. Some students even have CDL licenses by the time they graduate.

USE OF CONTRACTORS AND CITY PERSONNEL

Presently, tree care contractors perform most of the maintenance work for trees that have branches in powerlines, as City staff do not have certifications to work around utility wires. Depending on the workload, tree care contractors are sometimes hired to assist with tree pruning and the removal of dead and dangerous trees. The City also uses a consulting arborist to help with tree assessments and appraisals. This consulting arborist works in the City an average of one day per month. The DPW's Superintendent of Highways manages the contracts for on-call tree maintenance and for the consulting arborist.

In addition, almost all tree planting in the City is performed by contractors. The PSUF urban foresters manage these planting contracts, which includes all tree planting activities as well as tree watering and maintenance during a two-year establishment period. The urban foresters also manage the newly established (2019) Parks Tree Health and Young Tree Training Program contracts.

If the capacity and knowledge base exists, cities can use in-house staff and equipment to perform urban forestry tasks, or they can hire contractors who specialize in various arboricultural disciplines and services to do the work. To increase efficiency and lower costs, a combination of in-house personnel and contractors can be used.

The following summary of the advantages and disadvantages of using contracted and in-house staff for urban forestry operations, technical advice, and management has been adapted from the *Urban Forestry Best Management Practices for Public Works Managers: Staffing* (American Public Works Association's, n.d.).

The City's current practice of contracting tree crews to assist with tree pruning and removals, and consultants to assist with tree risk management and appraisals is a good approach for supplementing and complementing existing City staff. Using this combination of contracted labor, equipment, and expertise in conjunction with City staff is a viable solution to accomplish the quantity and diversity of work that the management plan outlines in the near future.

Whether beginning the routine pruning program (see *Section 3.2: Tree Maintenance Program*), increasing the number of tree planting projects, or performing public education, Somerville's need for additional staff to support the urban forest management program should be a priority in the next few years. The City should take into account needs and funding levels when deciding whether to hire more in-house staff or outside contractors.

CITY ORGANIZATIONAL STRUCTURE, PERSONNEL & PRODUCTIVITY RECOMMENDATIONS

- Hire operational staff with arboricultural certifications or provide incentives for current staff to obtain certifications.
- Evaluate compensation and training package for DPW Tree Crew workers and identify ways to make it more attractive for both recruitment and retention of qualified department employees.
- Strengthen the formal communication, coordination and collaboration process between PSUF and DPW Tree Crew staff and managers.
- Explore hiring part-time/seasonal employees to provide urban forest management support.
- Consider establishing an internship program to assist with the urban forestry program as needed; students could come from University of Massachusetts, Tufts University, Essex North Shore Agricultural Technical School, Norfolk County Agricultural School, and/or various vocational schools in the region.
- Assess opportunities to expand the capacity of current staff, or supplement with contractual staff for specific time periods or specific projects.
- Consider combining the PSUF Urban Foresters and the DPW Tree Crew staff into one centralized facility.

IN-HOUSE

Crews and Work Production

Advantages

- Staff can be more knowledgeable about the community and can be motivated by pride and residency.
- Workforce is more stable.
- More flexible for other work assignments.
- May respond more quickly to emergencies.
- More control over training and specializations.
- Quality can be perfected over time through training to meet community standards.
- No administrative time is needed to write and oversee contracts.

Disadvantages

- Large investment in equipment and maintenance per crew or person.
- Workers are paid wages and benefits year-round.
- The city responsible for damage caused by crew actions.
- The city bears the costs for on-the-job injuries and workmen's compensation.
- Administrative time is required for human resources tasks

CONTRACTED

Crews and Work Production

Advantages

- Funds are only paid for work performed and when completed to specifications and the satisfaction of the city.
- Labor is available for peak demands and special projects; there is the option of cancellation and there is no cost when work is not needed or when the weather is poor.
- Contractor provides all required equipment, tools, and supplies; repair, maintenance, and downtime of equipment are not the responsibility of the city.
- All insurance and workman's compensation is the responsibility of the contractor.
- Contractor provides employee supervision, training, and certifications.
- Liability for damage to public and private property is the responsibility of the contractor.

Disadvantages

- Contractors are bound by the specifications of the contract; their work assignments are not as flexible.
- May not be as quick to respond to emergencies as in-house crews.
- Contractors still require oversight and management by city staff.
- Administrative time is required for contract writing, monitoring, and invoice processing.

Urban Forestry Technical Advice, Management, and Support

IN-HOUSE

Technical, Management, and Support Staff

Advantages

- If job description and requirements are written correctly, staff can be very knowledgeable and experienced.
- Has strong ties within the community.
- Has or will build "institutional knowledge".
- Is available at a moment's notice to perform a wider variety of tasks.
- Is directly accountable to the residents and the city.

Disadvantages

- May only be experienced in limited aspects of arboriculture and urban forest management.
- Some investment in equipment must be made, such as a vehicle, computer, and diagnostic tools.
- City must invest time and funding for obtaining and maintaining certifications, licenses, and other training.
- Fringe benefit costs and long-term pension obligations could present cost barriers to staff expansion.

CONTRACTED

Technical Support Staff

Advantages

- Usually is very experienced and knowledgeable on a wide array of topics.
- Can provide a high level of knowledge in a specific area, such as hazard tree identification, tree valuation, ordinances and technical specifications, tree preservation.
- Usually is fully equipped with a vehicle, computer, and all other tools/resources needed to perform work.
- All certifications, licensing, and continuing education are already in place and separately provided.
- Contracted personnel do not require long term pension obligations from the city.
- Can be more easily released from service.

Disadvantages

- Contract agreement may limit flexibility in job assignments.
- If used regularly, and for an extended period of time, contract staff can be more expensive in the long term.
- Administrative time must be provided for contract writing, monitoring, and invoice processing

2. Training and Staff Development

Training and staff development are important not only for on-boarding new hires and teaching them about the City's programs and operations, but also for introducing new technical concepts, practical techniques, and safety principles to the field staff, and to teach administrative staff about the capabilities of any new computer software system designed for urban forest management tasks.

The City's DPW Tree Crew staff currently have CDL and hoisting licenses, but have no formal arboriculture training. They should be given a comprehensive, ongoing, and consistent training program. A quality training program is essential for keeping staff safe, efficient in their work, and motivated about learning new skills. Currently, the City does not have a formal arboricultural training program and no defined budget specifically for this purpose.

For staff involved with tree maintenance, planting, and urban forest management, diverse training is needed given the nature of the resource and the unique and potentially highly dangerous working conditions. At a minimum, most urban forest management programs in the country provide training to all forestry employees in these areas:

- Tree identification and basic tree physiology
- *ANSI A300* pruning, maintenance, and tree protection standards
- *ANSI Z133* safety requirements
- Job site set-up, flagging, and safety
- First Aid, CPR
- OSHA compliance
- Electrical Hazards Awareness Program
- Chainsaw safety
- Defensive driving

More advanced training, such as tree protection techniques, insect and disease detection, diagnosis, and management, and to obtain arboricultural credentials is recommended to increase the professionalism of the staff and program, and to further ensure safe working conditions and improved tree health.

The City should not only offer more training, but also formalize it. That means creating an annual training schedule for all employees and tracking the training. Documentation of safety training is especially important. Also, greater emphasis should be placed on OSHA requirements due to the associated liability/ financial risks to the City should it not be able to document training post-accident and during incident investigation. Documentation of training for each employee would also help shed light on deficiencies and aid in customizing a training program for that employee's current job description and future career path.

Training for staff involved in urban forest maintenance can be provided by a variety of sources, such as other City employees, the Massachusetts Arborists Association, the Massachusetts Department of Conservation and Recreation, equipment manufacturer representatives, and local and regional professional organizations such as the New England Chapter of the International Society of Arboriculture. Depending on the topic, training can be offered annually, seasonally, at weekly "tailgate" sessions, or as needed.

Training does more than just educate workers. Training supports professional development and job advancement, and positively influences attitudes and morale. By providing a variety of quality training programs on a consistent basis, the City can keep its staff motivated about learning new concepts and performing its work responsibilities in the best, safest, and most effective ways possible.

TRAINING & STAFF DEVELOPMENT RECOMMENDATIONS

- Provide regular and formal safety, equipment use, and arboricultural training to staff performing urban forest management tasks.

- Consider providing all staff with the opportunity to become Massachusetts Certified Arborists or International Society of Arboriculture (ISA) Certified Arborists as well as ISA Municipal Specialists.

- Somerville should encourage staff to attend at least 1-2 trainings or conferences per year. Such trainings and conferences are offered by the Massachusetts Arborists Association, the Massachusetts Department of Conservation and Recreation, the New England Chapter of the International Society of Arboriculture, and other local and regional professional organizations.


SIGNALIER ATR 41
311
WORKS
DANVERS
Ford
800-270-0727

3. Equipment

The City has a large bucket truck, chippers, and vehicles to perform routine and emergency tree pruning and removal. The City also owns and operates a stump grinder to remove stumps. When equipment needs to be repaired the City uses their central repair garage or contracted vehicle repair and maintenance vendors. Based on the current 3-person crew, the equipment and fleet are generally adequate to perform their assignments, although some equipment is outdated and should be replaced. Moreover, if additional staff and/or seasonal temporary staff are hired, additional vehicles and equipment will need to be purchased or rented. **Table 4.2** provides a list of the City's current forestry equipment; the aerial truck and one of the tree chippers are over 10 years old and require replacement, and the stump grinder does not perform adequately according to the crew. Staff has also requested a smaller aerial truck for easier maneuverability around the city.

To accomplish the work plan outlined in *Section 3.2: Tree Maintenance Program*, any additional or specialty equipment needed may be provided by the contractual tree and landscape crews who will perform the work. The City also has a budget line item to rent necessary equipment if required.

EQUIPMENT RECOMMENDATIONS

- Assess fleet age, condition, and usage hours to determine when equipment used for urban forest maintenance will need to be replaced; once identified, begin purchasing process at least one year prior to the projected "aging out" date.

- Consider providing the tree crew with a smaller aerial truck for easier maneuvering around the city.

- Rent or contract for specialty equipment that would not be used often for urban forest management and/or by any other department in the city. Or, consider sharing specialty equipment with other nearby cities.

Table 4.2: List of equipment dedicated to tree maintenance

Type	Brand	Year	Comments
Tree Chipper	Morbark	2008	Replacement Suggested FY / CIP / 20
Tree Chipper	Morbark	2016	Within life expectancy cycle
Stump Grinder	Morbark	2017	Not adequate. Trade towards HD model.
Forestry / 55' Aerial Truck	International	2007	Replacement Suggested FY / CIP / 20
Pickup Truck	Ford	2019	New CIP-19 Acquisition

4. Technology

The Society of Municipal Arborists reports that 6.5 hours per day (or 80% of the workday) is the standard and average time spent performing assigned tree maintenance work. Somerville's Tree Crew spends up to an hour each day traveling to/from the DPW office and to different work sites throughout the City. Adding in the time for the crew to mobilize on the site, Somerville's crews may average about 5.5 hours per day on tree maintenance activities. Efficiency could be improved by providing tree crews with training and access to tablets or similar mobile technology that contains the 311 system, tree inventory data (i.e., TreeKeeper®) and their daily work assignments. This would allow the crew to more efficiently route their work day and would also allow them to see other work orders (not currently assigned to them) that they may be able to complete while in the area.

Maximizing the Use of TreeKeeper® to Increase Efficiency of Urban Forest Operations

The City uses TreeKeeper® software which makes urban forest data, mapping information, and benefit calculations available instantly to staff and residents alike. For managing its urban forestry program, TreeKeeper® also provides tools and functions that can help the City accomplish its tree maintenance and planting goals and better organize work, increase efficiency, and respond to resident requests. Select staff has received TreeKeeper® training and have access to expert technical support. Maximizing the use of TreeKeeper® should significantly enhance the efficiency and effectiveness of the urban forest management program.

Using i-Tree Tools

The U. S. Forest Service's i-Tree Tools (www.itreetools.org) offer a variety of state-of-the-art, peer-reviewed urban forestry analysis and benefits assessment tools, calculators, and reference materials. All i-Tree resources are free and available to the public. Communities of all sizes use i-Tree Tools to strengthen their urban forest management and advocacy efforts by quantifying the composition of trees and forests, and the environmental services they provide. The City can use the information, statistics, and mapping from i-Tree to gauge program success, understand where improvements are needed, and to educate the public and gain support for the urban forestry program.

In particular, i-Tree Canopy can be used to estimate the location, extent, and growth of the city's entire urban tree canopy. i-Tree Canopy uses Google Maps aerial photography within a preselected area boundary and generates random sample points. From these sample points, the type of cover is selected (impervious, grass, tree, etc.) from a pre-defined list (that is determined by the individual using i-Tree Canopy). The more sample points that are generated and completed, the better the canopy cover estimate is for the selected area. Every three years or so, the city could complete an i-Tree Canopy project to gauge the success of tree planting and preservation. Furthermore, i-Tree Streets or i-Tree Eco can use updated inventory data to project the value of ecosystem services, like air and water quality improvements, stormwater management, and energy conservation, that the street trees provide the City and its residents.

TECHNOLOGY RECOMMENDATIONS:

- Provide Tree Crew staff with adequate mobile devices/tablets or similar mobile technology to help coordinate work and efficiently route daily assignments.

- Utilize asset management software (such as TreeKeeper®) to develop work orders that city crews and contractors can access using tablets or smartphones or other mobile technology.
  - *Provide asset management software training to staff.*
  - *Utilize work orders to prioritize and assign work to maximize efficiency.*
  - *Track work activities completed or to be done. Utilize software reporting tools to generate urban forestry updates to share with City managers and Council on work completed or to demonstrate program needs.*
  - *Use data and reports from asset management software to analyze crew productivity and contractual costs to get realistic numbers for refined budget and staffing analyses.*

- Utilize i-Tree Tools every 3-5 years to evaluate the benefits of the urban forest and compare changes over time to management activities completed. Communicate changes to City leadership, Council and the public and explain how the changes (positive or negative) have been affected by urban forest management activities the City has undertaken (or other factors, e.g. invasive species, storms).

- Develop standard operating procedures (SOP) for updating tree inventory data and inputting records and information in the 311 system.

5. Constituent Services

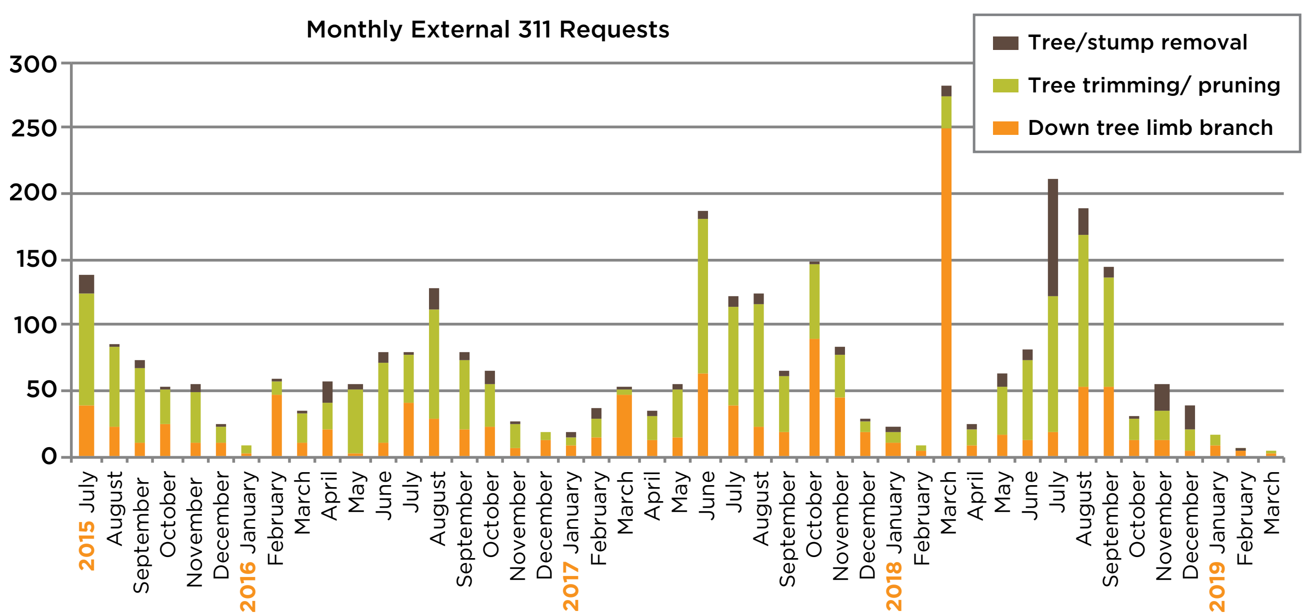
The input and collaboration of residents who care about the urban forest and its impact on the "common" is an essential part of any successful municipal urban forestry program. In Somerville, external stakeholders have helped to improve the urban forest program.

Figures 4.2 and **4.3** show the monthly tree maintenance and planting requests generated from the public using the 311 system from July 2015 to March 2019.

Residents can log 311 service requests by calling 311 (617-666-3311 outside of Somerville), emailing 311requests@somervillema.gov, or inputting their requests directly through the website (www.somervillema.gov/311) or the 311 app. The 311 system has five different types of requests related to trees: Tree trimming/ pruning, Down tree limb branch, Tree/stump removal, Arborist and tree maintenance, and Request tree on public property. The DPW responds to the Tree trimming, Down tree limb branch, and Tree/stump removal requests. The PSUF urban foresters manage the Tree planting requests. Both divisions manage and respond to the Arborist and tree maintenance requests.

The DPW has 2 dedicated fulltime administrative staff whose responsibility includes processing the requests for all DPW services in the city, including requests unrelated to tree maintenance. The DPW Tree Crew aims to respond to each call and close it out within 10 work days. Requests related to public safety are completed as soon as possible. Also, as the 311 system is used as a work-order system for the Tree Crew, work that is requested outside of the 311 system may be entered in on the same day the work is completed. Additionally, because there are multiple steps involved in the use of the 311 system, information is sometimes lost, and in some cases work orders are left open longer than 10 days even when the work has been completed. City staff should consider streamlining this process or standardizing it specifically for tree work.

Figure 4.2: Chart of external 311 requests for tree maintenance



The PSUF urban foresters aim to address urgent Arborist and tree maintenance requests within 10 days or less (depending on the nature of the request), and the remainder within one month. PSUF urban foresters also aim to close out tree planting requests within one year from the initial request (i.e. two planting seasons). Because there is no administrative staff to aid with organizing or closing out these 311 requests, the requests are often left open even when the request has been completed.

While partnerships and goals are discussed in detail in *Section 4.4: Public Engagement*, the following recommendations are suggested actions the City can take in order to improve the efficiency of its operations and responsiveness to constituents to increase the success of its tree management program.

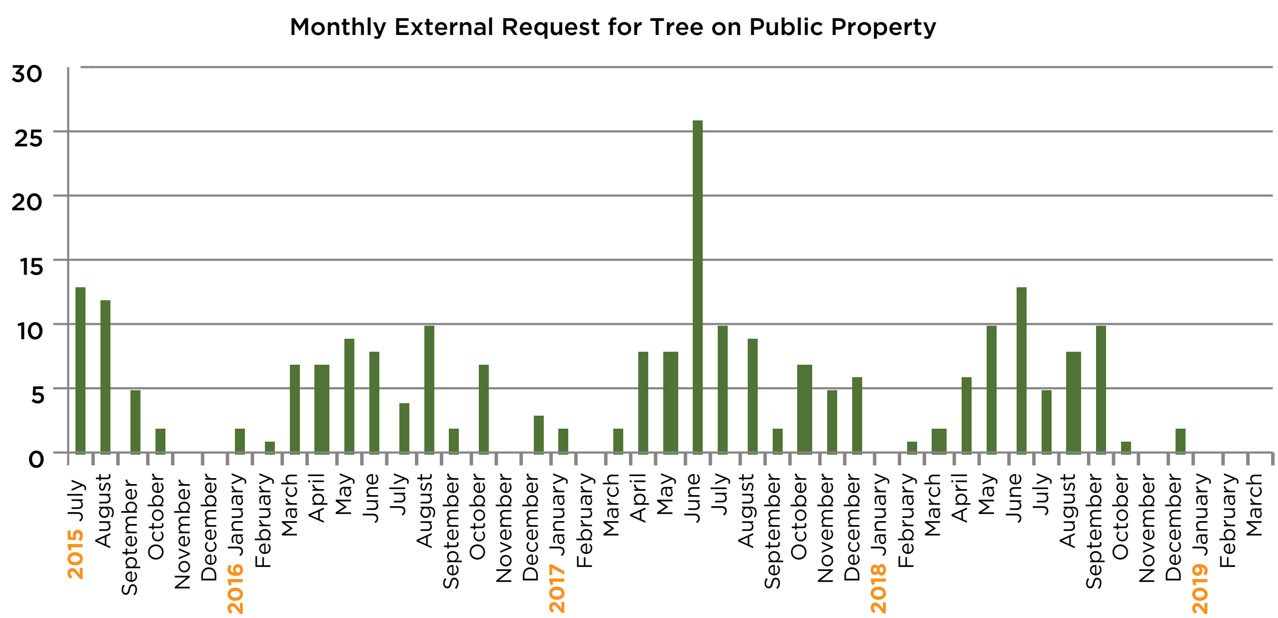
CONSTITUENT SERVICES RECOMMENDATIONS

- Set a target timeframe (i.e. 1, 2, or 3 days) for a response (not a resolution) to a resident 311 request for service. Stick to the agreed upon timeframe for closing out the request (i.e. 10 days for Down limb, Tree trimming, and Stump removal requests, 1 month for Arborist and tree maintenance requests, and 1 year for Planting requests).

- Set standards for entering and closing out a tree maintenance request to ensure consistency and compliance.

- Consider hiring a part-time administrative assistant or intern to help the PSUF urban foresters respond to 311 requests and complete other administrative tasks.

Figure 4.3: Chart of external 311 Tree planting requests



6. Tree Specifications

Well-written specifications are an important tool in assuring the quality of tree work performed. Providing City workers and outside contractors with detailed information on what is required to perform a job to the City's standards is crucial to protecting Somerville's trees. Clear specifications can also help eliminate a wide range of bids from outside contractors, and give the City more accountability over the expenditure of public funds.

Incorporating tree maintenance and planting specifications with bid requests and contracts should be a standard operating procedure and best management practice for a city. Without clear and detailed specifications, a city may receive bids from arborists and landscapers that have distinctly different qualifications and practices from what the city intended. Just like a builder would not consider bidding on the construction of a home without a set of plans, arborists and landscapers also need a set of plans (i.e. specifications) to present a reasonable bid.

With Somerville's reliance on contractors to perform tree maintenance and planting work, there is a great need for a clearly identified scope of work. Specifications communicate needs, form the basis of bids, and serve as a standard for evaluating the quality of the completed work. Inhouse crews also require clearly defined expectations and objective evaluation of their work; specifications will help them too.

Specifications, especially for larger urban forest maintenance and planting projects the City intends to take on in the future, have many benefits, including:

- Promoting proven tree care practices
- Embodying professionalism
- Enhancing communication between the city, field personnel, office staff, contractors, and the public
- Educating the public and decision makers
- Facilitating contractual fulfillment
- Reducing liability exposure

Currently the City includes specifications when it solicits bids for its urban forestry projects. The city should continue making it a practice to use and reference detailed industry-based specifications for all tree removal, pruning, stump removal, tree planting and young trees care bids and contracts.

In collaboration with the PSUF urban foresters, the City's Engineering Division created formal tree protection standards. These standards should be used in all construction projects to ensure that trees are being adequately protected.

SPECIFICATIONS RECOMMENDATIONS:

- Create a library of specifications and details for different types of tree work. These documents can be easily inserted into new bid documents and contracts.
- As new projects and types of work are developed, create new specifications and details to guide that work. Add these new specifications and details to the library.

7. Utility Relations

The residents and businesses of Somerville use a multiplicity of utility services — electricity, gas, water, sewage, telecommunications, cable television, etc. — each of which requires an extensive distribution and transmission network, both above and below ground. These networks also need space, and they are frequently under tight constraints on their placement and alignment.

The space available for both trees and utility services is often very restricted, and they frequently share the same space, above and below ground. Where they are in close proximity, there is the potential for either the tree or the utility service to be damaged by the other. If they are to co-exist, the needs of each must be understood and appropriate planning, precautions, and maintenance must be taken to minimize the risk of damage.

Utility companies are in the business of delivering energy, products, and services to their customers in a safe, efficient, and reliable manner. Cities are in the business of responding to residents' needs, ensuring public safety, and improving the quality of life for all. Over the years, municipalities have experienced conflicts over the design, location, and maintenance of utilities and the location and management of public and private trees.

Trees are a vital component of a city's infrastructure, providing many economic and environmental benefits. However, safe, reliable utility services are also vital to the success of a city on many levels, and trees, particularly those that are not maintained properly, are often the cause of power outages. There are reasonable methods and policies that can help or eliminate most tree/utility conflicts.

Utility companies have a right to prune the branches of public and private trees near their power lines as long as they follow certain rules and restrictions. Massachusetts State Law (M.G.L. Chapter 87, Section 14) states that the utility company, at the request of the tree warden, must submit an annual vegetation management plan and annual hazard tree removal plan prior to completing any work. Every year, the Tree Warden and PSUF Urban Foresters require not only that Eversource submits these documents well in advance of performing their pruning or removal work, but also that they meet with the City staff to discuss additional restrictions to their standard operating procedures. At the onset of the tree pruning work, these City Staff then meet with the tree workers in the field to ensure that they are aware of the Somerville requirements. The Tree Warden and PSUF urban foresters periodically check on utility company's tree work to ensure compliance with the City restrictions. The City's Urban Forestry website has a video explaining this type of work (see the "Tree Trimming Around Power Lines" video, here: www.somervillema.gov/urbanforestry).

Underground utility work includes the repair and replacement of main and service gas, water, and sewer lines. This work is done by Eversource, National Grid, the City of Somerville Water and Sewer Department. If care is not taken, machinery used for this work can damage tree limbs or trunks. Excavation work that is done too close to the tree can result in root damage that can harm or even destabilize the tree. In coordination with the City's Department of Infrastructure and Asset Management, PSUF staff has begun to build relationships with utility partners to ensure that trees are well protected during these utility repairs and upgrades. However, strict tree protection protocols for underground utility should be developed and communicated to formalize the City's tree protection expectations and requirements for underground utility work.

Methane leaks from underground natural gas pipes may be the source of some urban tree death (Schollaert et al. 2020). Methane replaces the oxygen in the soil and deprives tree roots of the oxygen they need. Although utility companies are required to fix large methane leaks, they are not obligated to fix small leaks. However, these small leaks can have a negative impact on tree health. The City should work with local nonprofits (ex.

Mothers Out Front, Heet) and community leaders to convince utility companies to repair natural gas pipes that may be impacting tree health.

UTILITY RELATIONS RECOMMENDATIONS

- Eversource and the City should adopt all applicable arboricultural and utility industry standards and use them for in-house and contractual projects. Examples include: American National Standards Institute standards; American Association of Nurseryman standards; International Society of Arboriculture and Utility Arborist Association standards; Tree Care Industry Association, Inc. standards, and Occupational Safety and Health standards.

- Partner with Eversource to utilize additional arboricultural and utility research and techniques available to provide solutions for tree/utility conflicts. Examples of other solutions include the use of tree growth regulators to reduce growth rates, greater use of directional pruning techniques, conversion of multiple aerial lines into innovative cable designs, and experimentation with different cross-arm dimensions, locations, and construction techniques.

- Analyze existing information and gather new information to plan for better and more efficient tree planting and maintenance activities between the City and Eversource. Examples include maintaining the street and public tree inventory with species, size and condition information, and using it to analyze proposed future work projects; and creating a Master Tree Planting Plan for the city to ensure proper species diversity, ensure appropriate tree planting over and under utilities, and to simplify the species selection decisions for new projects.

- Consider providing education sessions with the support and involvement of the Mayor, City Council, and agency heads explaining that utility service delivery and the presence of quality trees and landscaping are both valuable assets that improve the livability of the community.

- Eversource and the City should hold quarterly or annual meetings involving appropriate staff to discuss upcoming projects, developing issues, and to further strengthen the interagency relationship.

- Discuss and coordinate quarterly or annual work plans with Eversource and other utility companies to discover efficiencies, such as shared tree maintenance contracts, and mutually beneficial tree maintenance and planting projects.

- Create and communicate formal tree protection protocols for underground utility work.

- Work to convince utility companies to repair natural gas pipes that may be impacting tree health.

- In the future, it may be advisable to revise the current tree ordinance specifically relating to utility pruning and maintenance activities.

Table 4.3. Tree Maintenance Production (adapted from SMA standards)

Diameter Class*	Tree Removal Average Labor Hours per Tree	Tree Pruning* Average Labor Hours per Tree	Stump Removal Average Labor Hours per Tree
1–6”	1.0	0.5 (by hand)	1.0
6–12”	2.0	0.8	2.0
12–18”	4.0	1.1	4.0
18–24”	6.0	1.6	6.0
24–30”	10.0	2.1	10.0
30–36”	10.0	2.4	10.0
37”+	10.0	3.4	10.0

*The pruning size provided in the SMA standards was extrapolated to create diameter classes. For example a 6” diameter tree in the SMA production standard equates to a diameter class of 1-6” in Table 4.3.

8. Planning for the Future: Priority and Proactive Pruning Cycles

Section 3.2: Tree Maintenance Program recommends a seven-year tree maintenance and planting program and details the quantities and costs of various maintenance tasks. The tree maintenance activities in Years 1 and 2 will address High and Moderate Risk priority work in anticipation of beginning a proactive, preventive maintenance program in Year 2. For example, in Year 1, approximately 125 trees will require removal and 227 trees will require pruning. In Years 2 – 7, tree and stump removals will occur as needed.

The City already has a tree planting program, and plans to continue to use contractors to plant at least 350 trees per year.

Once the priority work is addressed, the *Tree Maintenance Program* recommends that in Years 2 – 7 the City begin an annual routine pruning program and a young tree training program to provide the City’s trees with proactive maintenance.

Because of the size of the DPW Tree Crew and their workload, their focus is primarily on reactive tree work and not proactive tree work. Currently the DPW Tree Crew and contracted crews managed by DPW’s Superintendent of Highways are focused on responding to 311 work orders for tree pruning, cleaning up storm damage, and performing tree and stump removals. Under the current reactive system, when a pruning work order is issued for a public tree, generally only the specific pruning needs that were requested are addressed. Often a service request requires the removal of only select branches, such as a broken hanging branch, a branch obstructing a sign or building, or a branch hanging over the street or sidewalk, etc. In order to resolve the request as soon as possible, other “routine prune” work may be left incomplete. When planning or monitoring tree maintenance work, it should be noted that a proactive cyclical tree maintenance program addresses the needs of the whole tree.

It is difficult to calculate how much time it would take the Tree Crew to complete routine maintenance because their production rates for proactive cyclical tree maintenance are unknown. For comparison and reference, **Table 4.3** provides average labor hours per tree for basic tree maintenance based on information compiled by Society of Municipal Arborists (SMA) members (Phillips, 2020).

Based on the recommendations provided in *Section 3.2: Tree Maintenance Program*, the City initiated a Young Tree Training program in 2019, with the goal of pruning approximately one-third of the City's young trees each year. Performing a three-year young tree training pruning cycle until the trees require more sophisticated safety and equipment requirements will help reduce the need for the more expensive maintenance requirements of these trees when they are mature. The preventative efforts associated with developing a tree with a strong structure can reduce branch breakage and improve survival in severe storms. Young tree training work can be accomplished throughout the year and since no bucket truck is required, City employees or contractors can perform this work at any time. This type of work is also highly suitable for properly trained summer interns, part-time employees, and/or volunteers.

Although the young tree training program is currently performed by contractors, experience demonstrates that, based on the generally small size of the trees in this category, a crew of two properly trained City personnel would be capable of accomplishing all of the annual young tree training work in less than 20 weeks. In order to perform this work in-house, tree crew personnel would need to obtain proper training in young tree structural pruning. Additionally, workers must have or acquire an understanding of the growth habits of the various species being planted, as well as an understanding of basic tree anatomy and physiology. This training can be received through local urban forestry consultants and/or International Society of Arboriculture Certified Arborists. The tremendous benefits to be gained in the years to come due to proper structural pruning of young trees are a strong incentive for educating tree crew personnel. Also, the added knowledge gained by these individuals could prove to be an incentive in raising the sense of professionalism in their jobs and satisfaction in helping the community.

PLANNING FOR THE FUTURE: PRIORITY AND PROACTIVE PRUNING CYCLES RECOMMENDATIONS

- In FY20 and FY21 the City of Somerville should focus its resources on the high/moderate risk tree removals and tree pruning activities identified in the tree inventory/management program. After these trees are addressed, then the city should move towards establishing a proactive routine tree pruning program.

- In FY21, the DPW Tree Crew and PSUF staff should: 1) develop a 6-year routine pruning cycle plan; 2) identify the areas of the city to be pruned in each cycle year as well as the number of trees to be pruned each cycle year, 3) identify sources of funding and the amount of work to be done in-house and through outside contracts.

- In FY20 the City established a Young Tree Training Program. In FY21, the City should develop a process for adding newly planted trees to the inventory and incorporating them into the young tree training cycle. In general, young tree training for newly planted trees should begin 2 to 3 years after planting.

- In FY21, develop a process for adding older trees from the young tree training cycle into the routine pruning cycle.

- In FY21, develop tree pruning specifications based on *ANSI A300* standards to ensure that tree pruning performed as part of the pruning cycle is done to the highest standards and meets the City's pruning objectives.

- In FY22, begin Year 1 of the 6-year routine pruning cycle.

- Track maintenance activities in the public tree inventory with an asset management software program (the City currently uses TreeKeeper® software). After the first full pruning cycle has been completed, use the maintenance data to determine Somerville's optimal routine pruning cycle.

Operations Review Summary

Somerville's current urban forestry program has a number of **operational strengths**:

1. There is strong support for a safe and sustainable urban forest among City staff, residents, and public officials.

2. The Public Space and Urban Forestry (PSUF) division staff are highly knowledgeable, capable, and responsive to the needs of the residents and elected officials. Their high level of training, as well as familiarity with current City plans such as the Climate Forward Plan, the Open Space and Recreation Plan, the Capital Improvement Plan and others, allows them to integrate tree work into other City work and plan for trees in the future. PSUF staff use data and specialty software to support current work and proactive management.

3. The DPW Tree Crew staff work hard to keep the City's residents safe, and are highly responsive to emergency work needs. The DPW Tree Crew and contractors perform tree removal, pruning, and stump grinding at a production level and a response time which has resulted in very few trees requiring high priority maintenance in the public rights-of-way and City open spaces.

4. The Somerville 311 Service Center gives the public the ability to notify the City about tree work needs (service requests), and also allows the City to notify residents when a work order to address their request is undertaken and completed. The system also provides data on how quickly these work orders are completed and what the work tasks are.

5. In order to assure that work is performed correctly, the City uses specifications based on national arboricultural standards and best management practices in its contractual tree planting and maintenance services.

The following **operational challenges** in the current urban forestry program demonstrate areas that should be improved upon in the future:

1. The City does not currently have a fully operational proactive tree maintenance program. For the most part, tree maintenance activities are completed on a reactive basis (request driven) due to insufficient staff and funding. Reactive management without proactive management can adversely affect the health and condition of the urban forest and lead to residents that are dissatisfied with the care the City provides to the public trees.

1. Current funding and staffing levels are not sufficient to execute a proactive preventive maintenance program as described in *Section 3.2: Tree Maintenance Program* and meet other program needs.

2. Although the type, condition and age of the City's forestry equipment is generally adequate for the current urban forest maintenance work being performed, it is not adequate for carrying out additional maintenance needs.

3. Data entered into the City's 311 system is occasionally incorrect/inaccurate. Data entry issues range from incorrect address of a location to improperly closing work orders.

4. Tree Department crew dispatch and deployment is not systematic leading to inefficiencies and loss in productivity.

5. The urban forestry program is overseen and managed by two divisions under two different departments. The challenge with this arrangement is that miscommunications can occur between the departments/divisions which can lead to inefficient, ineffective, or duplicative services.

6. Staff training and professional development opportunities are not formalized or required on a regular basis.

A number of **recommendations** emerge from this review that vary by the effort of implementation and the level of funding required. The following recommendations can be implemented in the near term, with modest financial investment:

- Provide regular and formal safety, equipment use, and arboricultural training to City staff performing urban forest management tasks.

- Develop standard operating procedures for inputting records and information in the 311 system.

- Train and require tree crews to use tablets (or similar mobile technology) to efficiently map out their day and access the 311 system and the tree inventory in the field.

- Continue to establish a formal communication, coordination and collaboration process between PSUF and DPW Tree Crew staff and managers.

- Discuss and coordinate quarterly or annual work plans with Eversource and other utility companies to discover efficiencies and mutually beneficial projects.

- Create and communicate formal tree protection protocols for underground utility work.

- Create a library of specifications and details for different types of tree work. Include tree protection standards for all construction activities.

- Begin an urban forestry internship program, or fund an administrative to assist the City with tree inventory data management/entry, outreach efforts, planting inspections, and minor tree maintenance tasks.

4.2
Funding Analysis

The City of Somerville's urban forest is an important part of the community that provides numerous benefits. Although planting and caring for an urban forest requires resources, the investment pays off in terms of cleaner air, lower energy costs, increased property values, improved water quality and storm water control, and wildlife habitat, among other ecosystem service benefits. To best care for an urban forest, funding is needed to plant and maintain trees. This funding can be used to hire trained staff and contractors, and to purchase trees and equipment. Additionally, to encourage community members to become stewards of the urban forest, funding may be needed for outreach and public engagement.

This Funding Analysis presents an overview of the City's current budget for urban forestry programs, including details about funding sources and allocation, and compares the current funding level to that of other cities. The amount of funding required to complete Tree Maintenance Program described in *Section 3.2: Tree Maintenance Program* is then discussed, in addition to other suggested program improvements. Finally, potential funding sources are provided.

The information presented in this Funding Analysis was compiled from the City of Somerville's budget as well as interviews with key staff.

Somerville's Funds Spent on Trees

In fiscal year (FY) 2020, Somerville's public tree management budget was $1,061,000 (**Table 4.4**). This included $380,000 for staff salaries (see *Section 4.1: Operations Review* for details on urban forestry personnel). The remaining $681,000 of funding for the urban forestry program is split between tree planting and tree care/maintenance.

Table 4.4: FY20 Somerville Tree Management Budget

Budget Type	Tree Care Activity	FY20 Budget	
		PSUF Public Space and Urban Forestry	DPW Department of Public Works
Salaries	DPW & PSUF staff working on Urban Forestry	$380,000.00	
Tree Planting	Tree Planting (PSUF)	$340,000.00	
Tree Care/Maintenance	Tree Removal, Tree Pruning, Stump Removal, Emergency Tree Care (DPW)		$180,000.00
	Ash Tree Treatments (emerald ash borer; DPW)		$60,000.00
	Young Tree Training (PSUF)	$41,000.00	
	Proactive Parks Tree Health Program (PSUF)	$60,000.00	
	TOTAL	**$1,061,000.00**	

Figure 4.4. FY 2020 Tree Planting Budget Sources

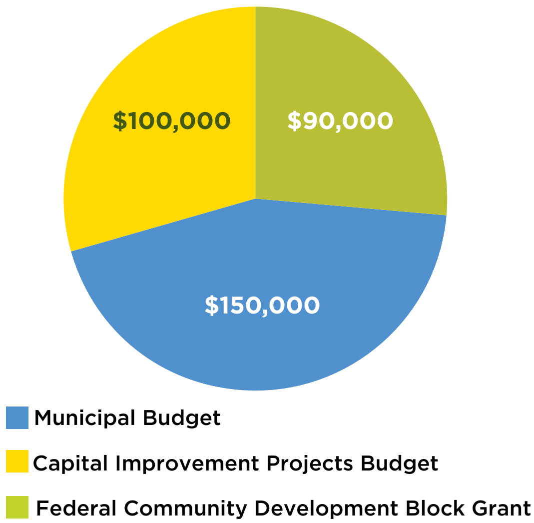
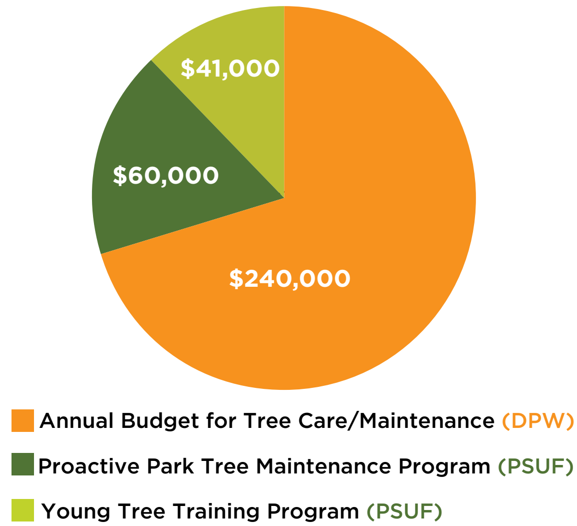


Figure 4.5. Annual Tree Maintenance Budget



PLANTING BUDGET

For FY2020, the City's tree planting budget was $340,000. Tree planting is managed by the Public Space and Urban Forestry (PSUF) Division, and the funds come from the City's municipal budget ($150,000), funds authorized by the City Council for capital improvement projects ($100,000) and a federal community development block grant ($90,000) (**Figure 4.4**). The planting budget for FY2020 was higher than in previous years.

MAINTENANCE BUDGET

The City's FY2020 annual budget for tree care and maintenance was $341,000 (**Figure 4.5**), which is allocated from the City's municipal budget. This included a budget item in the DPW Highway Division for tree care and maintenance (also known as "care of trees") of $240,000, which is primarily used for reactive public tree pruning and maintenance, including emergency response, as well as the treatment of healthy ash trees against the invasive pest, Emerald Ash Borer (EAB).

New for FY2020, in response to a 2019 Program Improvement Request (PIR), the City Council voted to allocate an additional $101,000 from the City's municipal budget to PSUF to start a proactive Park Tree Health Program ($60,000) and a Young Tree Training Program ($41,000). These programs represent the first proactive (vs. reactive) tree maintenance efforts the City has taken.

HOW DOES SOMERVILLE COMPARE?

According to Hauer & Peterson (2016), cities in the United States spent an average of 0.52% of their total 2014 municipal budget on public tree management. Cities with 50,000 to 90,000 residents, or cities of a size similar to Somerville (population 81,360), allocated an average of 0.53% of their 2014 municipal budgets to tree management. Compared to other regions of the US, cities in the northeast spent less, on average, on forestry activities; only 0.34% of their 2014 municipal budget.

Somerville's proposed public tree management budget of $1,061,000 for fiscal year (FY) 2020 represents 0.45% of the City's total municipal budget (note that school budgets were not included in either Hauer & Peterson's numbers or Somerville's budget numbers). Compared to the

2014 nationwide average, Somerville currently spends less of its total municipal budget on public tree management. However, Somerville's public tree management spending is somewhat higher than the average spending of cities in the northeast.

Budget Analysis for UFMP Implementation

The different sections of the Urban Forest Management Plan call for many improvements to Somerville's urban forestry program, many of which will cost money. While some improvements can be implemented by reallocating current funding, other improvements will require new funding.

TREE MAINTENANCE PROGRAM COST

The 2018 inventory included all public street and park trees, stumps and various potential planting sites (see *Section 2: Somerville's Tree Inventory Data*). Based on the inventory, a 7-year tree maintenance program is recommended to remove and prune high/moderate risk trees (Years 1 and 2), begin a routine and young tree pruning cycle (Years 2–7), and mitigate Emerald Ash Borer (Years 1–7) (see *Section 3.2: Tree Maintenance Program*). Completing this annual priority and proactive maintenance work is estimated to cost nearly $300,000 per year for the first few years (**Table 4.7**). After the priority tree removals and prunings are completed, the annual total priority and proactive maintenance cost is projected to decrease. An additional $350,000 should be allocated annually to meet the City's goals of planting 350 trees per year (*Section 3.2: Tree Maintenance Program*).

In addition to the 7-year tree management program, funds should be allocated for storm response and responding to resident requests for tree care (reactive maintenance) (*Section 4.1 Operations Review*). Being prepared financially for severe weather events that affect the urban forest is an important component of a comprehensive urban forestry program's budget. The response activities, such as clearing roads and sidewalks of debris, and hauling, processing, and disposing of the debris, and the recovery activities, such as tree planting, can require significant funds. Storm events happen unexpectedly, but regularly and intensely, in New England. Somerville should have funds earmarked for contractual and in-house staff to perform the required tasks; particularly so the City's overall budget for routine public health and safety services, infrastructure maintenance, and administration are not adversely affected. Moreover, much of the City's current tree work is reactionary, based on constituent requests. Although the number of requests may decrease as the priority and routine maintenance is completed, responding to constituent requests will always be an important part of the urban forestry work in Somerville. Based on the City's current budget allocation and previous work activities, and recognizing that the current high/moderate risk trees will be addressed in Years 1 and 2 of the maintenance plan, the City recommends allocating at least $75,000 annually towards storm response and resident requests for tree care.

COMPARING SOMERVILLE'S CURRENT BUDGET TO COST OF TREE MAINENANECE PROGRAM

Currently, the FY2020 budget of $621,000 for tree maintenance and tree planting is not sufficient to accomplish all recommended priority and proactive maintenance activities and maintain funds for storm response and responding to resident requests. For Somerville to have a proactive and high-quality urban forest management program, a total minimum increase in funding of nearly $100,000 will be required, at least for the next few years (**Table 4.5**). As costs continue to rise on a regular basis, additional funding may be needed to keep pace.

Moreover, this funding estimate does not include equipment purchases, rentals, or other capital expenditures, hiring additional staffing (FTEs/seasonal/interns), or any additional urban forestry activities that may be undertaken in the future such as windshield surveys and subsequent risk assessments, additional tree health care needs (ex. plant health care, invasive pest management (except for EAB), soil amendments and other tree maintenance needs), staff training and development, or expanded public outreach. Additional funding would be required for this other work. Somerville will need to determine the costs for these activities, and seek additional budget resources to implement them.

For Somerville to have a proactive and high-quality urban forest management program, a total minimum increase in funding of nearly $100,000 will be required, at least for the next few years.

Table 4.5. Estimated Costs and funding needs for proactive urban forest management program

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
Estimated Cost **Priority and Proactive Tree Maintenance***	$283,140	$293,855	$261,350	$255,200	$221,400	$215,250	$201,400
Estimated Cost **Storm Response and Resident Requests**	$75,000	$75,000	$75,000	$75,000	$75,000	$75,000	$ 5,000
Estimated Cost **Planting 350 Trees per year**	$350,000	$350,000	$350,000	$350,000	$350,000	$350,000	$350,000
Estimated Cost **TOTAL**	**$708,140**	**$718,855**	**$686,350**	**$680,200**	**$646,400**	**$640,250**	**$626,400**
CURRENT BUDGET for Tree Care and Planting**	**$621,000**	**$621,000**	**$621,000**	**$621,000**	**$621,000**	**$621,000**	**$621,000**
MINIMAL ADDITIONAL Funding needed	**+$87,140**	**+$97,855**	**+$65,350**	**+$59,200**	**+$25,400**	**+$19,250**	**+$5,400**

*Includes cost of tree removals, high/moderate risk tree pruning, routine tree pruning, and young tree training (pruning) based on the budget presented in *Section 3.2 Tree Maintenance Program*.

**Based on FY20 funding levels. This total does not include the $60,000 of funding for the Parks Tree Health program as that work is not included in *Section 3.2 Tree Maintenance Program*.

Funding Needed for Additional Urban Forest Management Activities

This Urban Forest Management Plan recommends a variety of additional projects and programs to enhance the City's urban forestry program with the goal of protecting and even increasing the citywide urban tree canopy. Because these projects and programs are not in the current budget, the implications of these recommendations on future funding should be considered before being implemented. For instance:

- Many planting sites for new trees are restricted and would limit the species selection to small stature trees. These potential tree planting sites would need to be created or redesigned to accommodate larger growing trees. The costs for expanding tree pits, incorporating structural soils, using Silva Cells, or other growing site improvement techniques depends on many factors. However, according to DeepRoot Green Infrastructure, LLC, Silva Cell installation is estimated to cost between $14.00 - $18.00 per square foot (that estimate includes everything except the base course, the final paving, and the tree itself). According to Ecological Landscape Alliance, structural soil projects range from $40.00 - $75.00 per cubic yard. The City of Somerville has begun incorporating silva cells into new, large streetscape improvements projects, such as the Somerville Avenue Utility and Streetscapes Improvement Project. The City's new Zoning Code, adopted in 2019, includes a requirement that trees in newly created streets are planted in silva cells or structural soil. In addition, the expansion of tree wells and the inclusion of permeable pavement around existing trees has recently been incorporated into the Engineering Division's annual street and sidewalk repaving projects. Continuing to follow these types of recommendations requires additional finances.

- If tree planting on public property and in parks increases, it would be fiscally prudent to have adequate funds in place for new tree care. New trees require supplemental watering, mulching, fertilization, and insect and disease control during the first three to five years of establishment. Although the current tree planting contracts include tree care for the first two years of establishment, additional funds would be needed to support these activities in the remaining years. The average cost for these activities is $10 to $20 per tree per occurrence.

- Somerville began a seven-year proactive park tree maintenance program in FY2020. The goal of this program is to assess and maintain the trees in at least six parks throughout the City every year in a seven year cycle. A number of activities should be considered and budgeted for in order to maintain healthy and beneficial park trees. Existing trees should be assessed for hazards and pruned accordingly. New plantings should enter the young tree training cycle (the FY proposed budget includes $40,000 for young tree training). An integrated pest management program should be established to protect against and manage harmful insects and diseases. Soil amendments and decompaction may be needed to ensure adequate soil conditions. Routine watering and annual mulching should also be considered. $60,000 was awarded in FY2020 for this purpose. This budget will likely be inadequate as the established trees are assessed and the number of new plantings in new in renovated parks increases.

- The residents of Somerville are the true owners of the urban forest. As such, the City should invest in public outreach and education about this important natural resource. Activities such as conducting training events and educational programs, issuing timely tree care and planting information through printed and online materials, and holding special events to increase the awareness and appreciation of trees requires some dedicated funding so that consistent and regular messaging is performed.

POTENTIAL FUNDING SOURCES

For many cities, the lack of dedicated and adequate financial resources for their urban forestry programs precludes making significant improvements to comprehensively manage and proactively maintain their urban forests to the level their residents desire and/or as needed to achieve their forest canopy goals. Funding for urban forest management can also be affected by factors such as competing departmental budgetary priorities, changes in public opinion, newly elected leadership, and severe weather events.

While Somerville already has a significant urban forestry budget that supports a basic and reactive approach to managing trees, more funding is needed support a proactive management approach. Program funding currently comes from the City's municipal budget, capital improvement project funds, and a Community Development Block Grant. To achieve many of the additional goals of this Urban Forest Management Plan, additional, new, and creative funding sources should be investigated. Some options to consider include:

1. **Federal and State Government Grants** –As a public agency, Somerville is in a good position to apply for and receive government grants. While U.S. Forest Service grants have become more regional and competitive, other federal grant programs have emerged that can fund tree planting, inventories, Urban Tree Canopy Assessments and even tree maintenance. Some examples include:

    a. Massachusetts Department of Conservation and Recreation Urban and Community Forest Challenge Grants can be used to fund various activities. This is an Annual grant opportunity for municipalities and nonprofit groups in Massachusetts to improve and protect their urban forests. These 50/50 matching grants help develop, grow and sustain programs that plant, protect and maintain a community's public tree resources and develop partnerships with residents and community institutions. The City was awarded one of these grants to fund the creation of the Urban Forest Management Plan you are currently reading.

    b. The U.S. EPA Environmental Justice Small Grants Program supports and empowers communities working on solutions to local environmental and public health issues. The program is designed to help communities understand and address exposure to multiple environmental harms and risks. Environmental Justice Small Grants fund projects up to $30,000, depending on the availability of funds in a given year. All projects are associated with at least one qualified environmental statute.

    c. The National Fish and Wildlife Foundation's Resilient Communities Program is designed to prepare for future environmental challenges by enhancing community capacity to plan and implement resiliency projects and improve the protections afforded by natural ecosystems by investing in green infrastructure and other measures.

    d. For other federal grant opportunities, explore www.grants.gov to see what grants are available for specific projects Somerville wants to undertake.

    e. If environmental disaster events take place within Somerville, FEMA funding may be available (see *Section 3.4: Storm Preparedness Plan*).

2. **Corporate and Private Foundation Grants** – As a public agency with non-profit status, staff, and administrative support systems, Somerville's urban forestry program is in a good position to apply for and receive private grants. For example, the TD Green Streets grant program could fund a targeted planting and outreach project. Partnering with a local non-profit can also reveal private funding sources in the region.

3. **Taxes, Assessments, and Special Tax Districts** – Asking for new taxes to support the urban forestry program is a legal and viable way to fund the program, with the right amount of resident support. Alternatively, consider including urban forestry projects in Tax Increment Financing Districts, Landscape and Lighting Assessment Districts, and other Special Benefit Assessment Districts.

4. **Capital Improvement Project Budgets** – Trees are capital assets; tree planting and sometimes maintenance can be a valid expenditure of large road, utility, or facility improvement projects. Even requiring 0.5% to 1% of the capital budget for tree planting and maintenance can produce a sufficient budget for urban forestry projects related to an infrastructure project. Somerville does currently include tree planting in Capital Improvements projects, and should continue to do so to ensure new buildings and assets contain sufficient tree canopy cover.

5. **Stormwater Utility Fees** – Many communities have established a stormwater utility fee in order to assist with stormwater mitigation efforts. The Massachusetts Division of Local Mandates conducted a Municipal Impact Study and reported their findings in the Local Financial Impact Review issued January 17, 2017 titled "Costs, Regulation, and Financing of Massachusetts Water Infrastructure: Implications for Municipal Budgets" (Bump, 2017). According to these findings, over the next twenty years, municipalities foresee significant increases in capital, operating, and staffing costs—$1.58 billion statewide, including $240 million in additional personnel costs—for implementation of new federal stormwater management regulations. The Study recommends that in order to provide additional funding for stormwater-related capital and operating requirements, Massachusetts municipalities should consider the creation of dedicated stormwater enterprises similar to local water and sewer enterprises in structure, operation, and fee-based revenue streams. Stormwater mitigation is highly affected by the urban forest. Therefore, tree planting programs may be eligible for funding through a municipal stormwater program.

6. **Tree Work and Land Development Permit and Inspection Fees** – To the extent permitted under state and municipal codes, permit and inspection fees can be a source of funding for the urban forestry program. Fees can help offset the personnel costs of City or contracted staff for reviewing development permit applications and plans, and for site inspections.

7. **Compensatory Payment, Land Development Mitigation, and Environmental Fines** – When trees are damaged or removed (whether by an accident or a planned economic development project), municipalities should be compensated. Generally, this requirement and the compensation method should be codified, and should be clear about its applicability to public and/or private trees. Many cities across the U.S. have ordinances that stipulate this, and as a result have "tree funds" where compensatory payments, mitigation or 'in lieu of' fees, and environmental fines are deposited for a variety of uses and urban forest management projects. Currently, Somerville has a Tree Fund. Payments for damages to public trees go into this fund, as do donations for public trees. This fund also receives in-lieu payments for private tree removal (see *Section 4.3: Ordinance/Policy Review*).

8. **Miscellaneous Funding Sources** – While providing smaller amounts to the urban forestry budget, additional miscellaneous funding mechanisms and sources should not be ignored since every little bit of revenue can help Somerville accomplish specific projects. Examples include: Adopt-A-Street and memorial and donor tree programs; wood product sales; utility bill donations; community or organizational fund-raising events; revenues from municipally-owned concessions and recreational facilities; cash and in-kind donations. Somerville does currently have a tree donation program (see https://www.somervillema.gov/departments/ospcd/psuf/public-space) and accepts cash donations to the Tree Fund.

9. **Resource Sharing** – Sharing resources among other city departments and/or regional municipalities can help lower program costs. This is particularly useful for equipment that is not used very often and can be easily transported.

Any or all of these funding methods could be explored by City staff to determine their legality, viability, and practicality, and how one or more of these methods would help increase budgetary resources for the urban forestry program. The City should also continue to collaborate with local and regional non-profit partners to secure funding for tree maintenance and urban forest management activities from sources that are more inclined to provide funding to nonprofit entities as opposed to the municipality directly.

With sufficient financial resources to secure professional services, equipment, and management, Somerville can accomplish its urban forestry goals, better respond to changes and challenges in the urban forest, and best serve the city's residents.

4.3
City of Somerville Tree Ordinance & Policy Review

Tree Preservation Ordinance

A tree ordinance is an important municipal tool that establishes standards and sets guidelines for City management of trees and the treatment of trees by private entities. It is the legal framework within which local tree management activities are conducted for the general welfare. Tree ordinances can enhance the community-wide urban forest and ensure that it is protected to provide public health and safety as well as many other important benefits (see *Section 1: The Importance of Trees in the City*).

Somerville's Tree Preservation Ordinance is found in Article VI, Section 12 of the City's Code of Ordinances. Somerville's Tree Preservation Ordinance was established in 2009. The most recent amendment to the Ordinance was passed by the City Council in June 2019, and went into effect on August 1st, 2019. Somerville's Tree Preservation Ordinance has positioned the City well to protect and expand its urban tree canopy while addressing both public health and climate resiliency. A closer look at the details of Somerville's Tree Preservation Ordinance as it is currently written may help to highlight how its intent and purpose are to be realized and how future alterations to the Ordinance may better serve the public and the environment.

Somerville's Tree Preservation Ordinance text is presented below in *grey italics*, while annotations and descriptions are presented in highlighted black text:

CITY OF SOMERVILLE ORDINANCE NUMBER 2019-15 IN CITY COUNCIL: June 27, 2019 TREE PRESERVATION ORDINANCE

Be it ordained by the City Council, in session assembled, that Chapter 12 of the Code of Ordinances of the City of Somerville, is hereby amended by replacing the existing Article VI with a new Article VI as follows.

ARTICLE VI. - TREE PRESERVATION ORDINANCE

Section 12-100. Intent and purpose.

The preservation of the tree canopy and the planting of replacement trees is intended to enhance the quality of life and the environment of the city; to reduce energy consumption; to protect air quality; to provide protection from glare and heat; to baffle noise; to reduce topsoil erosion and stormwater runoff; to preserve and enhance habitat for wildlife; to protect and increase property values; to combat climate change through carbon sequestration; to provide natural privacy for neighbors; to enhance the overall appearance of the City; and to acknowledge the intrinsic value of the mature trees within our community.

Section 12-101. Applicability.

The terms and provisions of this ordinance shall apply to trees within the City of Somerville that are located on city owned property, on private property, or in the public right of way.

This statement of Applicability allows the City better oversight of its tree canopy by applying this ordinance not only to public trees but to private trees as well.

Section 12-102. Definitions.

Caliper: *A measurement of the tree trunk diameter used when purchasing tree plantings measured at 12" above the ground.*

City Tree: *A tree located on property owned by the City of Somerville, including Public Shade Trees, trees in City parks, and trees on the grounds of City buildings.*

DBH (Diameter at Breast Height): *The diameter of a tree trunk measured in inches at a height of four and a half (4.5) feet above the ground. For multiple trunk trees, DBH is the aggregate diameter of the trunks.*

Invasive Plant: *A plant that is both non-native and able to establish on many sites, grow quickly, and spread to the point of disrupting plant communities or ecosystems, including but not limited to the trees listed on the Massachusetts Prohibited Plant List. However, Norway Maples and other trees larger than 24 inches DBH (diameter at breast height) except for Tree of Heaven (Ailanthus altissima) shall not be considered invasive plants.*

The last sentence of the Invasive Plant definition was inserted by the City Council on October 8th, 2020.

Private Tree: *A tree located on private property.*

Public Shade Tree: *A tree located in the public way, as defined in G.L. c. 87, section 5.*

Removal: *The intentional cutting down of any tree, including all other acts which cause actual or effective removal through damaging, poisoning, or other direct or indirect actions that result in the death of the tree. This includes, but is not limited to, excessive pruning.*

Replacement Caliper: *The replacement caliper for Significant trees shall be at least equal to the DBH of the tree removed.*

Significant Tree: *Any living tree that is not an Invasive Plant and is 8 inches or more in DBH.*

Section 12-103. Tree warden.

The Tree Warden shall be an employee of the City, appointed by the Mayor, subject to confirmation by the City Council, for a term of three years.

1. *The Tree Warden shall be qualified for the role as defined in G.L. c. 41 s. 106, and also according to the standards established and published by the Massachusetts Tree Wardens and Foresters Association.*

Massachusetts General Law, Chapter 41, Section 106 states:

"If the town provides by vote or by-law that the tree warden shall be appointed, such appointment shall be made by the board of selectmen. The term of such appointment shall be for three years.

In any city or in a town which exceeds ten thousand inhabitants and which provides by vote, by-law or by ordinance that the tree warden shall be appointed, such appointment shall be made by the mayor, with the approval of the city council or by the board of selectmen. In such city or town, the tree warden shall exercise the duties of tree warden and of insect pest control. Such tree warden shall be qualified by training and experience in the field of arborculture and licensed with the department of food and agriculture in accordance with the provisions of section ten of chapter one hundred and thirty-two B. The term of such appointment shall be for three years."

2. *The duties and responsibilities of the Tree Warden shall conform to G.L. c. 87 and shall include, but not be limited to, the following:*

   a. *Management of all trees within public rights-of-way and on City property.*

   b. *Granting or denying and attaching reasonable conditions to all permits required under this ordinance.*

   c. *Posting notices and holding public hearings for the Removal of Public Shade Trees and City Trees as required by this ordinance.*

   d. *Enforcement of this ordinance.*

Section 12-104. Senior urban forestry and landscape planner.

The Senior Urban Forestry and Landscape Planner shall be an employee of the city, appointed by the Mayor.

1. *The Senior Urban Forestry and Landscape Planner shall be a Certified Arborist by the Massachusetts Arborist's Association, The International Society of Arboriculture, or any successor of either organization.*

2. *The duties and responsibilities of the Senior Urban Forestry and Landscape Planner shall include, but not be limited to, the following:*

   a. *Seeking grants or other assistance concerning the preservation and maintenance of the City's tree canopy.*

   b. *Develop and publish policies, regulations, tree inventory, manuals, and other data and documents necessary to carry out the purposes and intent of this ordinance.*

   c. *Supervising the planting and care of City Trees to ensure that such planting and care meets these rules, regulations and standards.*

   d. *Assisting and working closely with the Tree Warden to help the Tree Warden fulfill their responsibilities.*

Sec. 12-105. Urban forestry committee.

1. **Purpose:** *The Urban Forestry Committee will be charged with advising with respect to the management and maintenance of all existing and new trees and shrubs on all public grounds and public ways of the City of Somerville.*

2. **Duties:** *The Urban Forestry Committee shall: a. Review planting policies for trees and shrubs on public grounds and public ways of the City of Somerville, appraise the appropriateness of such plantings, their placement, and the type of maintenance necessary. The Urban Forestry Committee shall also review those planting proposals which it deems significant for trees and shrubs on public grounds and public ways of the City of Somerville.*

   b. *This Committee shall have the ability to comment during any City of Somerville permitting review process.*

   c. *This Committee may elect to review issues related to the health, effective maintenance, and protection of existing trees and shrubs on public grounds and public ways of the City of Somerville, recommend solutions to any problems identified with such plantings, update the tree inventory with detailed information, and support all public* *education and outreach by:*

i. Promoting knowledge and awareness of the benefits of trees in the City.

ii. Developing and maintaining a website;

iii. Developing and maintaining a noteworthy tree program;

iv. Developing educational materials regarding best management practices for tree care;

v. Supporting City staff in establishing a volunteer adopt-a-tree program;

vi. Supporting City staff during Arbor Day Celebrations; and

vii. Considering and recommending incentives for tree planting and maintenance.

d. Upon request of the applicant, this Committee shall consider and make recommendations to the Tree Warden on waivers for any required replantings or payments associated with the issuance of a Tree Permit.

e. This Committee may keep records of trees planted and removed within the City of Somerville and may issue regular reports on the overall status of the City's urban canopy.

3. Membership: *This Committee shall consist of the following members:*

a. The Senior Urban Forestry and Landscape Planner

b. The Tree Warden, and

c. Nine members of the public, with at least one member demonstrating expertise in the field of urban forestry, and at least one member demonstrating expertise in the field of landscape design, and two members shall be between the ages of fourteen and seventeen at the time of their appointment or re-appointment, each serving a term of three years, selected by the Mayor, and subject to confirmation by the City Council.

Section 12-106. Criteria for removal of public shade trees.

A public hearing may not be initiated under G.L. c. 87, s. 3 to remove a healthy Public Shade Tree unless the Tree Warden finds in writing that there is a public health, safety, or welfare basis for removing the Public Shade Tree, including but not limited to hardship to a property owner, economic development, facilitating the development of affordable housing, pedestrian access enhancement, transportation improvement, or public project development. Nothing in this section shall be construed to prevent the cutting, trimming, or removal of trees in accordance with G.L. c. 87, s. 5.

Section 12. 107. Notice requirements for removal of public shade trees.

In addition to notice under G.L. c. 87 s. 3 for Removal of a Public Shade Tree, notice shall be given by the City by electronic notification when feasible and first-class mail to all property owners located within 150 feet of the Public Shade Tree proposed to be removed at least 14 days before the public hearing. To the extent feasible, the City shall notify all residents within 150 feet of the Public Shade Tree proposed to be removed by flyering at least 14 days before the public hearing. Notice shall also be given by placing notice on the City website and cable wheel at least 14 days before the public hearing. In the event that a public hearing is initiated under G.L. c. 87 s. 3 at the request of anyone other than the City, the requesting party shall pay for all costs of mailing and advertising, such costs to be determined by the City Clerk. The City Clerk may waive the costs if the *requesting party demonstrates to the City Clerk that payment of the fee would cause financial hardship. Guidelines for determining financial hardship shall be established by the City Clerk. Applications for financial hardship shall be provided by the City Clerk.*

Section 12. 108. Tree replacement for public shade trees.

Any healthy Public Shade Tree removed at the request of a property owner or agent thereof must be replaced within one year from the date of Removal. These replacement trees must be located at or near the location from which the tree was removed, and in no case shall trees planted in a different neighborhood qualify as replacements. The replacement trees must conform to the standards for size, species, and planting established by the Senior Urban Forestry and Landscape Planner.

Section 12. 109. Street tree stabilization fund.

1. **Establishment:** *There shall be established a tree fund which shall be held in a separate identifiable account, and administered in accordance with applicable provisions of General Laws. Any payments required by this article shall be deposited in the Street Tree Fund and shall be used in accordance with subsection (3) below.*

2. **Payment for planting replacement Public Shade Trees:** *Where a healthy Public Shade Tree is removed at the request of a property owner or agent thereof, solely for reasons of private financial gain or personal preference, the requesting party shall make a contribution to the Street Tree Fund in an amount sufficient to pay for replacement trees as described in Section 12.108. This amount will be calculated using the schedule of costs established by the Senior Urban Forestry and Landscape Planner.*

3. **Maintenance of Street Tree Fund:** *The Street Tree Fund shall be maintained in a separate account in accordance with state law. All sums deposited into such Fund shall be used solely for the purpose of buying, planting and maintaining trees in the City. The Senior Urban Forestry and Landscape Planner shall expend these funds for tree planting, transplanting, care, and other tree-related needs.*

Section 12. 110. Compliance with state law.

All public shade tree hearings shall comply with the applicable requirements set forth in G.L. c. 87 s. 3.

Section 12. 111. Criteria for removal of city trees.

1. **Purpose:** *The purpose of this section is to extend the public notice and public hearing requirements of the Massachusetts Public Shade Tree Law G.L. c. 87 to trees on City of Somerville owned property.*

2. **Definitions:** *The following words, terms, and phrases when used in this Section shall have the following meanings ascribed to them:*

   a. ***Capital Improvement Project:*** *A major, non-recurring expenditure that generally meets all of the following criteria: G.L. c 44, ss. 7 and 8 permit the City to issue bonds to finance the expenditure, the expenditure is a facility or object or asset costing more than $50,000, and the expenditure will have a useful life or ten years or more for infrastructure, buildings, and parks.*

   b. ***Park Project:*** *A project involving the renovation and maintenance of existing parks and City-owned open spaces and the development of new parks and open spaces* *within the City of Somerville. The phrase "City-owned open spaces" includes parks, community gardens, playgrounds, school yards, library lawns, cemeteries, public plazas, triangles, and squares.*

c. ***Tree on City-owned property:*** *Any tree located on land owned by the City of Somerville. This does not include any tree that fits the definition of a Public Shade Tree under G.L. c. 87.*

3. Applicability: *This section shall apply exclusively to trees on City-owned property as defined above in section (b). Nothing in this section shall be construed to apply to Public Shade Trees within the City of Somerville, whose care, maintenance, trimming, planting, and Removal are governed by the Public Shade Tree Law, G.L. c. 87, and the City of Somerville Code of Ordinances. The public notice and meeting requirements for Public Shade Trees shall remain in full force and effect and are entirely unaffected by the language of this section.*

4. Cutting down or Removal of trees: *No person, including but not limited to City employees, the Tree Warden, and their deputies shall cut down or remove any tree on City-owned property without the Tree Warden first holding a public hearing.*

a. *The Tree Warden, or his or her designee, shall post notice of the time and place of the public hearing in two or more public places in the City and upon the tree in question at least seven days prior to the public hearing. This notice shall identify the size, type, and location of the tree to be cut down or removed, and include a brief statement of the reason for the proposed action. Notice of this public hearing shall be sent to each City Councilor, all members of the Urban Forestry Committee, and published on the City website.*

b. *No later than 48 hours prior to the cutting down or Removal of any tree on city-owned property, a notice on brightly colored paper will be placed upon the tree stating the anticipated date on which the action is expected to occur.*

c. *Nothing in this section shall prohibit the Tree Warden and his or her designee from cutting down or removing any tree which in their opinion is dead or dying or constitutes a thread to public health or safety.*

5. Exceptions to the public notice and hearing requirements: *No public hearing shall be necessary prior to the Tree Warden, or his or her designee, cutting down or removing trees measuring less than one and one-half inches in diameter one foot from the ground on City-owned property.*

6. The following types of public projects, *which have undergone a public process that includes public notification and public meetings, shall be exempt from the requirements of section (4) above.*

a. *Park projects and*

b. *Capital improvement projects.*

c. *This exemption shall only apply to a public project of the type listed in (a) and (b) if such public process included all of the following:*

i. *All public meetings at which cutting down or Removal of trees is discussed were duly noticed and advertised including but not limited to notice sent to all members of the Urban Forestry Committee.*

ii. *The public was provided reasonable opportunity to provide input regarding tree(s) to be cut down or removed.*

iii. *Reasonable notice was posted on or around any trees to be cut down or removed at least two weeks prior to such action taking place.*

Section 12-112. Removal of private trees.

1. **Permit Required:** *No person may Remove any Significant Tree from private property without first obtaining a Tree Permit from the Tree Warden.*

2. **Application for a Tree Permit:**

   a. *Applications must be made in writing on forms specified by the Tree Warden.*

   b. *The Tree Warden, or his or her designee, will review applications for tree permits in accordance with the provisions of this article. The Tree Warden, or his or her designee, shall date stamp or otherwise record the date of filing of each application for a tree permit. The Tree Warden, or his or her designee, shall complete the review of each Tree Permit application no later than 30 business days after the submission of a completed application. In the event that this review is not completed within the time required by this ordinance, and if the applicant did not request a waiver of fees or replanting, the permit shall be considered issued.*

   c. *The application shall include a plan showing the location, species, and DBH of each tree on the property, and must indicate clearly which trees are to be Removed.*

   d. *If replacement trees are to be planted, the plan shall indicate the planned location, species, and size of any replacement trees to be planted. In order to qualify as replacements, trees must be planted on the same or adjacent lot, and must conform to species and planting standards as defined by the Senior Urban Forestry and Landscape Planner. Trees planted in the adjacent right-of-way or otherwise located on public property shall not be considered suitable for consideration as replacement trees.*

   e. *There shall be no fee or charge to submit an application for a tree permit.*

3. **Conditions for Granting a Tree Permit:**

   a. Removal of Significant Trees: *If any Significant trees are to be removed, the plan must show planting of new trees equal to the total Replacement Caliper of those trees.*

   b. Payment instead of Replacement: *Payment to the Street Tree Fund may be made in lieu of planting some or all of the replacement trees, according to a cost schedule established by the Senior Urban Forestry and Landscape Planner. Such fees shall be based on the actual costs associated with purchasing, planting, and maintaining the City's Public Shade Trees. Payment must be made prior to issuance of the permit.*

   c. Request for Waiver: *The application for a Tree Permit shall allow the applicant to request a waiver of the requirement for replanting or payment.*

   d. Hearing of Request for Waiver: *The Tree Warden, or his or her designee, shall hear requests for such waivers within 60 days of the date the application was received. This hearing may take place at a public meeting of the Urban Forestry Committee. The applicant shall have the opportunity to speak and to answer questions. The Committee may, at the request of the applicant, make a recommendation to approve or deny the waiver. Examples of reasons supporting a waiver include but are not limited to: Financial hardship associated with the care and upkeep of the trees; unreasonably high requirements for replacement or repayment, ongoing or reasonably foreseen damage or risk from the trees, and desire to create a benefit to the public. The Tree Warden shall consider such recommendation in considering whether or not to grant the waiver. If the waiver is approved, a Tree*

Permit will be issued within 10 business days of the close of the hearing.

e. ***Owner-Occupants:*** *The owner-occupant of a lot containing a one, two, or three family dwelling, who resides at that same property as demonstrated by issuance of, or good faith application for, a valid Residential Exemption shall, at their request, be granted a waiver of the requirements for replanting or payment with no need for a hearing.*

f. ***Departure of owner-occupant:*** *If at any point during the 18 consecutive months following the issuance of a Tree Permit the owner no longer resides at that address; and if the requirements for replanting or payment were waived based on said owner-occupancy status as described in section (e) above; said waiver shall be revoked. In this case, the owner or, if the property has been sold, the new owner, shall be required to obtain a tree permit either for a replanting plan or to make full payment within 30 days of the fees that were waived, unless such new owner is eligible for an owner occupant waiver under Section (e) above.*

This section does not make clear why owner-occupants are exempt from replanting or payment requirements. Additionally, it does not make clear that the seller must disclose the obligation of the new owner to obtain a tree permit either for a replanting plan or to make full payment when transferring property.

4. Standards for Replacement Trees:

a. Replacement trees must be planted within 18 months from the date the tree permit is issued, or prior to transfer of property ownership, whichever comes first.

b. Replacement trees must be of the same or similar species and size as described in the application for the Tree Permit, and must be planted according to standards established by the Senior Urban Forestry and Landscape Planner.

c. In the event that trees of the size and species that were described in the application for the Tree Permit cannot be obtained at the time of planting, multiple smaller replacement trees may be planted with the authorization of the Tree Warden.

d. If a replacement tree dies within 18 months from the date of planting, it must be replaced. The person planting the tree shall provide documentation as to the date of the planting and file the same with the Tree Warden within 15 days of the planting of said replacement tree.

5. Exceptions to the Tree Permit Requirement:

a. ***Emergencies:*** *If any tree shall be determined to be in a hazardous condition so as to immediately endanger the public health, safety, or welfare or cause an immediate disruption of public services and require immediate Removal without delay, verbal authorization may be given by the Tree Warden to remove such tree, and the tree may be removed without obtaining a written permit as otherwise required by this ordinance. The Tree Warden shall record in writing each such verbal authorization, and shall present these written notes at the next meeting of the Urban Forestry Committee.*

b. ***Waiver:*** *The requirements of this article may be waived by the Tree Warden during the period of an emergency such as a hurricane, tornado, windstorm, flood, or similar threat to life and property.*

6. Enforcement:

a. *If a Significant tree is Removed without a Tree Permit, the property owner must apply for a Tree Permit within 30 days of the Removal. Each business day thereafter, until an application is filed, shall constitute a separate violation of this ordinance.*

b. ***Stop work order:*** *Upon notice that trees are being removed without a Tree Permit, such work shall be immediately stopped by the Director of Inspectional Services or designee. The stop work order shall be in writing and shall be mailed to the owner of record of the property and posted at the front of the property in a conspicuous location, and if possible, given to the owner of the lot involved, or to the owner's agent, or to the person doing the work, and shall state the conditions under which work will be permitted to resume.*

c. ***Injunctive relief:*** *Whenever there exists reasonable cause to believe that a person is violating any applicable provision of this article, the city may institute a civil action for a mandatory or prohibiting injunction in a court of competent jurisdiction ordering the defendant to correct the unlawful condition or to cease the unlawful use of the property.*

7. Penalties:

a. *For each offense under this ordinance the person in violation shall be subject to a fine as established in section 1-11 of the Somerville Code of Ordinances.*

b. *Failure to make payment of any fines may result in the revocation, suspension, or denial of any local license or permit, including renewals and transfers, pursuant to section 8-3 of the Code of Ordinances and / or a municipal charges lien being placed on the violator's property located within the city pursuant to the authority and provisions of Chapter 252 of the Acts of 1996.*

8. Safety of Life and Property:

Nothing in this ordinance shall be construed to prevent a property owner from acting to Remove any Significant Tree, with written or oral authorization from the Tree Warden, that is an immediate and pressing health or safety hazard; that is dead or dying; or that is damaging existing structures or property; or could do so if it were to fall. In such cases, the Tree Warden may authorize immediate removal in writing or verbally, with written record to the Urban Forestry Committee as soon as practicable.

The City maintains a website to help residents navigate the private tree removal permit process: https://www.somervillema.gov/departments/tree-removal-guidelines. This website should be updated as needed.

Section 12-113. Effective date.

This ordinance shall take effect on August 1, 2019.

TREE PRESERVATION ORDINANCE RECOMMENDATIONS:

The following recommendations may allow Somerville to better protect both its public and private tree assets in the future.

1. Include acceptable and unacceptable basic performance standards for the treatment of public trees. The language used to define these practices should be clear and quantifiable so that the ordinance will be enforceable.

2. At a minimum, make reference to these current national arboricultural industry standards: *ANSI A300 Tree, Shrub, and other Woody Plant Management – Standard Practices, ANSI Z133 American National Standards for Arboricultural Operations – Safety Requirements, and ANSI Z60.1 – American Standard for Nursery Stock*. Somerville does require contractors to follow these standards. However, reference to these standards within the tree ordinance could require, or at least advise, residents who are replacing lost trees per the ordinance to follow appropriate arboriculture practices. Per the current tree ordinance, replacement trees that die within 18 months of planting are required to be replaced. Following ANSI standards can reduce the number of trees that die within this time period.

3. At the same time, be cautious of including too many details, as materials and methods of tree care, planting, and management often change, and this would render the ordinance out-of-date. Specific details about items such as allowed species, soil volumes, plant sizes, clearance requirements over streets and sidewalks, etc. should be included in a separate manual or best practices guidance document that be updated more easily than the ordinance.

4. Include a section on "Prohibitions," such as "No person shall damage, prune, remove, or plant any tree or shrub in any public street or other public place without having first obtained a permit from the City. Damage to public trees includes, but is not limited to, construction and excavations, vehicular accidents, vandalism, adhering advertisements or electrical wires, allowing toxic substances to come in contact with soil within the dripline (e.g., gas, brine water, oil, liquid dye, or other substance deleterious to tree life)." Somerville's current ordinance does include a section prohibiting the removal of shade trees on City-owned property, but it does not establish prohibitions for damaging, pruning, or planting trees.

5. Include a clear and concise Tree Preservation Bylaw requiring residents to protect established and mature trees during construction. This bylaw could allow residents the alternative of replacing any trees removed during construction or landscaping activities. Additionally, residents could be required to pay into the Street Tree Stabilization Fund if they do not wish to plant replacement trees. Somerville has established tree protection standards for contractors. These standards could be extended to the citizenry at large.

6. Create an approved tree species list that will inform residents of ecologically appropriate species to plant in the city and refer to it in the Ordinance. This list should be placed in a separate manual or best practices guidance document so that it can more easily change over time as the effects of climate change impact best management practices.

7. Require tree plantings in new developments and parking lots.

8. Include a provision that prohibits tree topping.

9. Establish a disease and insect control plan.

10. Any fine resulting from the violation of this ordinance should be deposited into the Street Tree Stabilization Fund or other appropriate fund.

Somerville may also want to include additional provisions that are needed to reach the community's goals and address unique, local issues, such as:

- Promote tree planting on private property if adequate space does not exist on the right-of-way (i.e. a back of sidewalk tree planting program).

- Define requirements and responsibilities for utility tree trimming.

- Set basic standards for species diversity with specific guidelines provided in a separate manual.

- Provide an invasive insect and disease response that defines the City's authority to direct removal or treatment of trees on both public and private property if a significant insect or disease threat exists in the city.

- As dying and infested ash trees on private property pose a threat to human and public safety, Somerville's ordinance could be amended to specifically acknowledge EAB as a public nuisance and treat it in similar fashion as Dutch elm disease and other insect pests or plant diseases. The ordinance could encourage private property owners to treat their ash trees, and remove any barriers to the removal of potentially infested ash trees. For more information on Emerald Ash Borer, please refer to *Section 3.3: Invasive Insect and Disease Management Strategy*.

The City of Somerville's Tree Preservation Ordinance serves as a good starting point for addressing the concerns and issues of a public tree management program. Only through a strong, properly enforced ordinance will the City achieve its stated objectives. According to a 2014 Urban & Community Forestry Census of Tree activities, only 64% of communities with tree ordinances actively enforce the ordinance (Hauer and Peterson, 2016). Somerville should regularly review its City ordinances pertaining to street, park, and private property trees, and make updates as needed. This includes a review of permitted pruning, removal, and planting practices.

Tree Planting & Maintenance Policies

Having a set of overarching guidelines for tree planting and maintenance is essential for ensuring that best practices are being consistently followed. These plans and policies can be used not only for City staff, but also for directing contractors, developers, utility companies, and even homeowners who may impact the city's urban forest.

Tree Planting Policy

The City has an established policy to guide the planting of trees on public property. This should be reviewed periodically and updated as needed. Somerville's Tree Planting Policy text is presented below in *grey italics,* while recommendations are presented in highlighted black text.

Trees provide countless benefits to the residents of the City of Somerville (hereafter referred to as "the City"). In order the increase the city's tree canopy cover in accordance with the City's Urban Forest Management Plan, the City aims to plant at least 350 trees per year on public property. The locations of new tree plantings on City-owned rights-of-way are based on the following:

- *Constituent requests (i.e., 311)*
- *Replacement of dead or dying trees*
- *Where the City cannot replace a tree in the same location, new plantings may be located somewhere near where the tree was removed*
- *Increasing canopy cover in a specific area*
- *Project-specific plantings (ex. streetscape improvements)*

When would the City NOT plant a tree in a location that was requested?

- *The stump and/or roots of a tree that was previously in that location could not be removed, and thus there is no space available to plant a new tree.*
- *Planting a tree in that location would inhibit accessibility of the sidewalk. All new tree plantings must adhere to ADA requirements.*
- *There is not enough space to plant a tree at the location due to the location of driveways, doorways, underground utilities, utility poles, etc. To encourage the healthy growth of new trees, new tree wells provide a minimum of 18 square feet of open soil (ex. a 3' x 6' tree well). In addition to maintaining a 3 foot wide clear walkway (for ADA), minimum distances of new trees/tree wells to other infrastructure include:*

  - 3 feet from any walkway/driveway

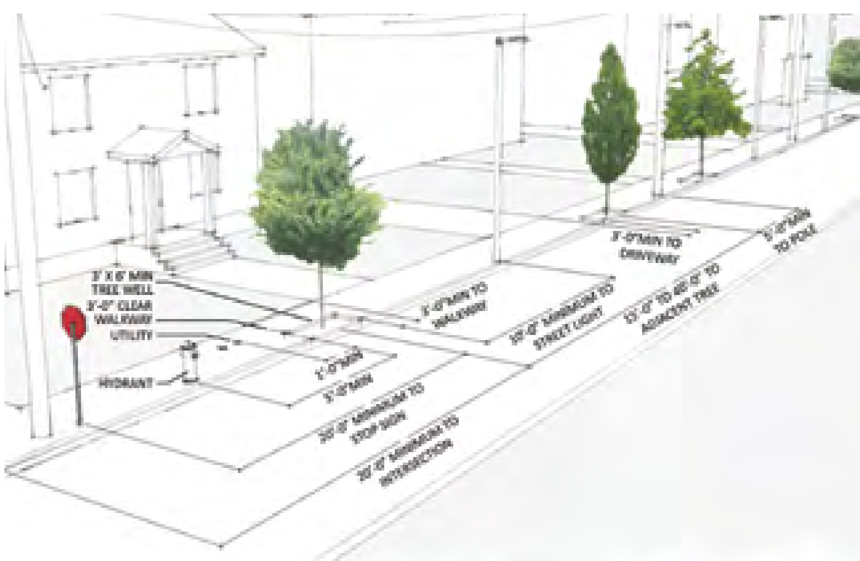
  - 1 foot from edge of well to underground utilities

  - 5 feet from any fire hydrant or utility pole

  - 20 feet from any intersection, crosswalk, or stop sign

  - 10 feet from any street light

  - 15-40 feet from any adjacent tree(s) (varies with species)



Why would the City plant a tree where it has NOT been specifically requested?

- *To achieve the goal of increasing canopy cover in a specific area.*
- *To coordinate planting with another project (e.g., streetscape improvements).*
- *To replace canopy that was lost but which cannot be replaced in the exact same spot.*

When a tree has been designated for a specific location, in what instances would the City NOT plant that tree?

- *If DigSafe reveals underground utilities that would conflict with the tree planting.*
- *If the tree planting would cause accessibility issues.*
- *If the space for the new tree well has not yet been cut, then the planting may be canceled or postponed, at the discretion of the City Urban Forester.*

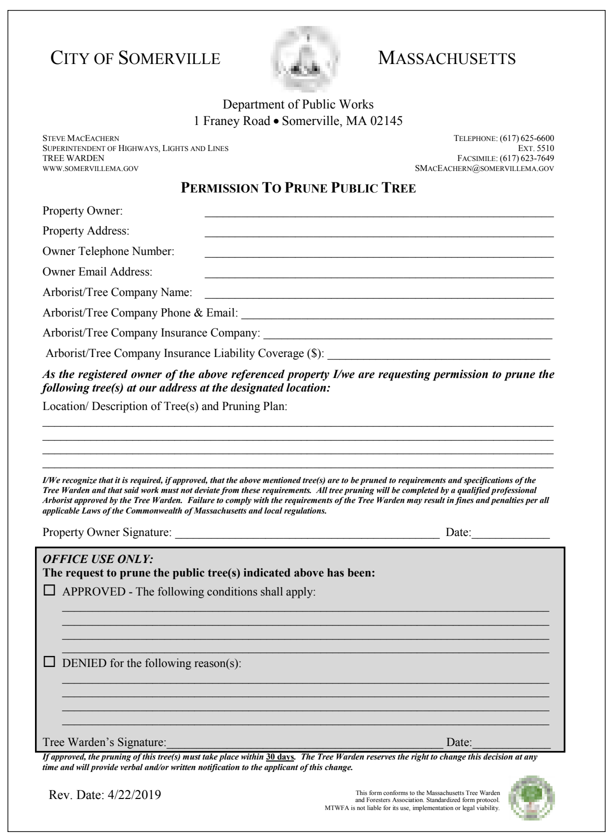
The City also has specific tree planting details and specifications that are included in tree planting contracts. The City should consider making these documents publicly available such that private property owners and developers can utilize the best management practices for tree planting. The technical specification and details that are provided in the City's current planting contracts can be found in *Appendix E.*

Public Shade Tree Pruning Policy

Per Massachusetts General Law, Chapter 87, section 3, trees along the right-of-way (ROW) can only be pruned or removed by the Tree Warden or his/her deputy, unless explicit permission is granted by the Tree Warden. If a private property owner would like to hire an arborist to prune a public shade tree in Somerville, they can apply for permission from the Tree Warden. Please contact the Urban Forestry division for the most recent version of the permission form.

TREE PLANTING & MAINTENANCE POLICIES RECOMMENDATIONS:

The City's current policies for public planting and public tree pruning are useful for ensuring consistency in decisions about planting locations and protecting the City's trees from improper pruning. The City should consider creating and adopting additional policies to guide other types of tree work or work around trees, most importantly in order to protect trees from construction and underground utility work.



CITY OF SOMERVILLE MASSACHUSETTS

Department of Public Works
1 Franey Road • Somerville, MA 02145

STEVE MACEACHERN
SUPERINTENDENT OF HIGHWAYS, LIGHTS AND LINES
TREE WARDEN
WWW.SOMERVILLEMA.GOV

TELEPHONE: (617) 625-6600
EXT. 5510
FACSIMILE: (617) 623-7649
SMACEACHERN@SOMERVILLEMA.GOV

PERMISSION TO PRUNE PUBLIC TREE

Property Owner: ______

Property Address: ______

Owner Telephone Number: ______

Owner Email Address: ______

Arborist/Tree Company Name: ______

Arborist/Tree Company Phone & Email: ______

Arborist/Tree Company Insurance Company: ______

Arborist/Tree Company Insurance Liability Coverage ($): ______

As the registered owner of the above referenced property I/we are requesting permission to prune the following tree(s) at our address at the designated location:

Location/ Description of Tree(s) and Pruning Plan:

I/We recognize that it is required, if approved, that the above mentioned tree(s) are to be pruned to requirements and specifications of the Tree Warden and that said work must not deviate from these requirements. All tree pruning will be completed by a qualified professional Arborist approved by the Tree Warden. Failure to comply with the requirements of the Tree Warden may result in fines and penalties per all applicable Laws of the Commonwealth of Massachusetts and local regulations.

Property Owner Signature: ______ Date: ______

OFFICE USE ONLY:
The request to prune the public tree(s) indicated above has been:

☐ APPROVED - The following conditions shall apply:

☐ DENIED for the following reason(s):

Tree Warden's Signature: ______ Date: ______

If approved, the pruning of this tree(s) must take place within 30 days. The Tree Warden reserves the right to change this decision at any time and will provide verbal and/or written notification to the applicant of this change.

Rev. Date: 4/22/2019

This form conforms to the Massachusetts Tree Warden and Foresters Association. Standardized form protocol. MTWFA is not liable for its use, implementation or legal viability.

City of Somerville 2019 Application Form for Permission to Prune a Public Tree. Please contact the Urban Forestry division for the most recent version.

4.4
Public Engagement

The urban forest is a resource that benefits and belongs to the city's residents. In order to care for it, the passion that is so frequently used to talk about trees can be harnessed to build stewardship around Somerville's trees. Approximately 66% of Somerville's tree canopy is located on private lands (see *Section 1.1: Somerville's Tree Canopy*). Thus success in improving or maintaining tree canopy must include not only the municipal government, but also a populace that understands: 1) the value of trees and tree canopy to the community and the environment; and 2) how to plant and care for trees.

There are multiple ways to engage the public to improve the care of and expanse of local tree canopy. First, topics or messages must be defined, prioritized, and limited in number. More effective communication occurs through choosing a few strong messages and repeating them over and over. After messages are chosen, avenues of targeted communication to deliver those messages can be determined and implemented.

Important topics and messages that should be considered for Somerville are as follows:

- **Current Canopy Extent and Value of Somerville Trees.** The message should present the current canopy level and benefits the canopy provides. This is typically the first message to send out to the public, as all other messages should connect back to this one. This can also be a way to "roll out" the Urban Forest Management Plan to the public. Include information such as why Somerville needs tree canopy, what the current canopy level is, and the plans to improve the management of the trees that comprise the canopy. Educating local business owners on the impact that a shady commercial district can have on sales and educating property owners about the impact that trees have on property values are other useful methods for boosting the desire for increased canopy along main thoroughfares and neighborhood streets while also engaging the public. The important value of mature trees could be also highlighted, as people often do not realize that the large tree they have is a value to their property, the community, wildlife, and the environment.

- **How You Can Get Involved.** What are the next steps you want people to take? The City should decide the answer and insert this "ask" in every outreach piece or effort. Some potential options include:
    - *Give residents the choice to opt-in for a tree. The City already accepts tree planting requests through 311, but this option could be more widely promoted and expanded to include the option to request a back of sidewalk tree (aka setback tree, or a tree within 20' of the right-of-way). Alternatively, the City could organize a tree giveaway (usually saplings) at Arbor Day for people to plant on private property. The City has done this during previous Arbor Day events.*

- *Join the Adopt-A-Tree program established by the Urban Forestry Committee, whereby residents sign up to take care of a street tree, including providing regular water and mulch.*
- *Create a Heritage Tree program where residents are encouraged to find and nominate the largest or otherwise significant trees in the City.*
- *Donate funds for an upcoming planting.*
- *Volunteer at a tree planting event (one Saturday morning commitment).*

- **Tree Threats.** Public and private trees can die, decline, or become safety risks as a result of insect and disease infestation as well as inadequate maintenance. With education, the residents of Somerville can become aware of the common threats to the tree canopy and what they can do to help. Particularly for Emerald Ash Borer (EAB), the City should provide education on what to expect, how to identify ash trees, what the City is doing about these threats on public land, and options for management on their own land. Since the majority of the trees that comprise the City's urban tree canopy are on private property, it is vital for the City to educate the public on how to detect insect and disease threats, provide information about management and treatment options, and relay the importance of reforestation in the event trees are removed. For more information on potential insects and diseases in Somerville, see *Section 3.3: Invasive Insect and Disease Management Strategy.* Informing residents about tree removals and other significant tree work is essential for maintaining the City's relationship with the community. When an established public tree has to be removed, the City should continue its current practice of notifying abutters of the pending removal.

- **General Tree Care Education for Property Owners.** There are several actions people take that are detrimental to trees at all stages of life, including improper mulching and pruning. Easy tips and tidbits of information to share with residents for trees on their own properties can help improve tree maintenance and increase tree health and survival rates. Some examples include:
  - *Demonstrate how to properly mulch a tree. Too often mulch is placed around tree trunks in a "mulch volcano", which is extremely detrimental to the tree. A simple message of how to mulch properly can improve tree health and longevity.*
  - *Provide guidance on how and when to prune trees. Incorrect pruning can lead to poor tree structure or wounds that may never heal.*
  - *Explain proper tree planting and tree care techniques. This could be especially helpful for homeowners who are considering planting a tree in their yard but are unsure where to start.*
  - *Encourage recycling or composting leaves on-site. An example of an educational effort the City may want to adopt or adapt is the successful "Love 'Em and Leave 'Em" public outreach campaign developed by Westchester County, New York (http://www.leleny.org). A fact-sheet such as this one created by the Greater Victoria Compost Education Centre (*http://compost.bc.ca/wp-content/uploads/2015/02/FactSheet-6-Urban-Leaves_Revised-Feb-2015.pdf*) can be developed and distributed.*

Use Multiple Avenues of Communication

There are numerous avenues to convey urban forestry messages and accomplishments of the program to the residents, such as:

- **Social Media.** Social media sites such as Facebook, Instagram, and Twitter can create buzz and promote involvement in the current urban forestry activities occurring locally. The Public Space and Urban Forestry Division (PSUF) has an Instagram account (@somervilleparks) and posts regularly about urban forestry topics. To reach even more people, the City should consider coordinating with allied Community gardens, non-profits, educational institutions, and business to get messages posted on their social media sites as well.

- **Website.** The City of Somerville's Urban Forestry webpage (https://www.somervillema.gov/urbanforestry) contains important information about the urban forestry program, including details about tree planting, the tree inventory, emerald ash borer, and the tree preservation ordinance, among other things. The website also contains staff-created videos showing various urban forestry practices. The website should be maintained regularly to make sure information is up to date.

- **Presentations to City leadership and local business and neighborhood groups.** Identify key audiences, partners, and potential champions for the urban forestry program. Making short presentations at regular or special meetings where they are relieves individuals from having to go to yet another meeting in the evenings. PSUF staff regularly present at meetings of the Somerville Garden Club, but there are various other groups who may be interested in urban forestry matters. Initial outreach could be based on letting the audience know about Somerville's urban forest and the work called for in this plan. Be sure to have an "ask" at the end of the presentation. What do you want them to do next? This work often unearths new partners and funding sources that can otherwise go untapped.

- **Do a survey.** Once a year, create a short online survey to identify what urban forestry issues people in Somerville are concerned or care about. The survey can also be used to gauge people's reactions to new urban forest management procedures and regulations, and their willingness to participate in volunteer work or to donate funds or other resources. Questions about public trees and tree canopy can be part of the annual public survey. The City can use the new SomerVoice platform to elicit feedback about specific urban forestry topics.

- **Cultivate partnerships for communication.** Partnerships can be initiated with organizations that can help promote, enhance, and preserve Somerville's urban forest. Organizations can include local businesses, local utilities, regional non-profits, homeowner associations, neighborhood associations, and schools and other educational institutions. Other audiences to engage can include youth groups, landscape architect firms, faith-based groups, and nurseries and landscape contractors. Actions that can be taken by each partner should be defined before approaching them for support.

- **Encourage Tufts University to become a Tree Campus USA.** Tufts University borders the City of Somerville and has some land within city boundaries. The University is not yet a Tree Campus, USA. If they were to pursue this distinction and join the City's Tree City, USA legacy, then two powerful entities would be supporting Somerville's urban forest. One standard the University would need to achieve annually is for students to participate in one or more Service Learning Projects. These projects are intended to provide an opportunity to engage the student population with trees and can be part of a larger community initiative. University students could help the City's urban forestry program perform many tasks, such as tree planting, tree care, and public outreach.

- *Publish and Promote an Annual State of the Urban Forest Report.* An annual "State of the Urban Forest Report" can be produced using updated tree inventory data, tree planting statistics, i-Tree tools, and other program information. It should provide information on the number and condition of public trees, as well as maintenance, planting, and management accomplishments. It should also present a summary of the current year's annual work plan and identify emerging issues and budget or resource needs.

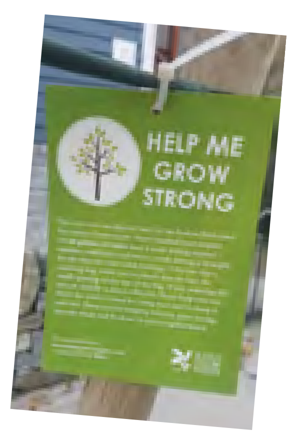
- *Add signage to the landscape.* Signs placed in high traffic areas can spark interest in trees and the urban forest. Something as simple as species name or a notable fact about a tree can encourage people to learn more and to get more involved.

Create a Volunteer Corps

Consider implementing a "Young Tree Care" volunteer program to assist with new tree planting and new tree care such as watering, mulching, and pruning. This type of program is more involved than an "Adopt-A-Tree" program, as the young tree care volunteers are specially trained to care for young trees. As such, this type of program involves initial and continuing training, frequent mentoring, and overall coordination of the process and volunteers. It also provides yet another engagement opportunity and encourages partnership opportunities with a variety of groups, such as neighborhood associations, master gardeners, scout troops, church affiliated groups, high school community service programs, etc., to accomplish new and young tree care tasks.

Trees to include in a "Young Tree Care" program are generally less than 8 inches in caliper. These are the same trees recommended to be part of the young tree training program (see *Section 3.2: Tree Maintenance Program*). These younger trees sometimes have branch structures that can lead to potential problems as the tree ages, such as codominant leaders, multiple limbs attaching at the same point on the trunk or crossing/interfering limbs. If these problems are not corrected, they may worsen as the tree grows, which increases risk and creates potential liability. With direction from City staff, young tree care volunteers could be trained to carry out the young tree training program. Beyond pruning, young trees need watering and mulching to become established, and may require fertilization and other Plant Health Care (PHC) treatments until they reach maturity. This program can create "tree stewards" for Somerville and be modeled after similar and successful programs like those found in other municipalities or states, such as the Virginia Tree Stewards (https://treesvirginia.org/outreach/tree-stewards) and the Vermont Tree Stewards (https://vtcommunityforestry.org/get-involved/tree-stewards).

The "tree stewards" or a volunteer corps could also be used to support the urban forest management program in other ways. Volunteers could develop and/or staff Arbor Day and Earth Day events, post and manage tree messages on social media, help update the inventory, and/or locate planting sites in neighborhoods.



Boston Parks and Recreation Department uses tree tags for newly planted trees to inform the public of how much water new trees need. Somerville should consider creating a similar tag to place on newly planted trees or on the doors of residences next to the newly planted trees.

The Urban Forestry Committee started the Adopt-A-Tree program in 2020. This adopted tree was named 'Treezus'.

Explore Partnerships

Utility companies may be able to assist the City in completing the High Priority needs (see *Section 3.2: Tree Maintenance Program*). The City should present Eversource and National Grid with the inventory data for high priority trees under utility lines so they can consider assisting in high-priority maintenance work during their annual line clearance schedule/program.

Establish partnerships to fund and accomplish the young tree training program and some mature tree care activities (*Section 3.2: Tree Maintenance Program*). For instance, the utility companies may support tree growth regulator applications for trees under their lines; businesses or developers may pay into a fund to "adopt" or maintain trees in parks, commercial areas, and newly built streets; residents may help water mature street trees during times of drought.

Public Education

Public education is one of the true keys to reaching the goals of an urban forestry program. Only by educating the public, City officials, developers, and contractors working within City limits will a community be able to achieve urban forest protection and planting goals. Ordinances and guidelines alone will not guarantee success since builders, contractors, and others often have their own priorities and agendas, and trees and ordinances are often nothing more than a nuisance to them.

Cooperation from all concerned parties can be improved by requesting various community stakeholders, such as City Council members and neighborhood groups, to attend educational sessions to learn about the current state of Somerville's urban forest, plans for urban forest management and planting, and the importance of all of it to the future of the community.

To gain support for Somerville's urban forestry program, various public outreach campaigns aimed at educating the residents of Somerville should be established. Where there is understanding and acceptance of the urban forestry program as a whole, there will be increased support for the planting portion of the program. Based on examples of public relations efforts by urban foresters in other communities, the following types of activities are suggested for the City to undertake:

- Hold a seminar or public meeting to discuss the tree inventory project, its results, and its importance for the City.
- Develop monthly evening or weekend seminars related to tree care and landscaping; bring in guest experts from various disciplines in the green industry.
- Write a monthly "Tree Talk" article for local newspapers or social media.
- Develop a Tree Care door hanger brochure to go to each residence where new trees are planted; educating residents about proper tree care could help eliminate trunk damage and improper mulching and pruning of new trees.
- The City could start giving away one-gallon tree seedlings to any volunteers who get involved with City projects. This is a great reward and a way to spread the word about trees. Somerville could capitalize on the idea and attach the same Tree Care door hanger brochure or a different informational brochure to each of these trees.
- Co-host tree planting programs with the local garden club, local non-profits, or groups like the D.A.R. (Daughters of the American Revolution). The City of Somerville recently partnered with the Mystic River Watershed Association to plant 100 bare root trees in Somerville with volunteers. This successful program could be a model for future collaborations.

- Map the locations of fruit-bearing trees in the city and coordinate with groups that harvest the fruit for homeless and food insecure organizations.

- Embrace story telling within the urban treescape. Connect the trees to the history of the area through complementary art, placards, or signage.

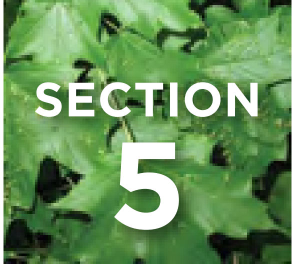
- Encourage citizen science activities that involve the urban forest. For example, the Nature Conservancy's "Healthy Trees Healthy Cities" app can be used to monitor tree health and check trees for pests. Local professors and non-profit groups that work with citizen science may be able to help plan projects and recruit citizen scientists.

- Expand the annual Arbor Day celebration to help it become a community tradition. From 2017 through 2019 Somerville staff ran half-day events for Arbor Day. The celebration involved tree planting, a seedling give away (with information on how to properly plant and care for the tree), information about urban forest programs, and activities for kids. The Arbor Day celebration could be further developed as an all-day Saturday event, preferably held in a popular park/public space setting in the City. Expanding on short programs on planting and pruning trees and including children's programs about trees can help increase public interest in the City's tree programs. Additionally, the City could invite contractors to conduct demonstrations on tree planting, trimming, landscaping, species selection, etc. Organizers could also set up booths with tree information. Refer to the National Arbor Day Foundation (visit www.arborday.org) for publications that provide great Arbor Day ideas to assist in planning of this event.

PUBLIC ENGAGEMENT CONCLUSIONS

Somerville can help residents become more involved in the City's urban forestry program by expanding upon its public engagement. To ensure that public outreach is effective, Somerville should determine which communication channels and tools are most used by community members. This is essential in making sure that Somerville gets the word out about its urban forestry plans, polices, and programs to the public at large.

A select group of residents can be responsible for organizing and implementing a campaign of public relations, education, and community financial support. One of the purviews of the recently formed Urban Forestry Committee is to support all public education and outreach; thus, they would be an ideal group to spearhead outreach programs. This Committee is comprised of a dedicated group of local activists, landscape professionals, and community partners, and they will be a great resource to help support and guide plans and polices related to the urban forest. In their first year, the Committee started the City's first Adopt-A-Tree program and began developing important tree fact sheets for the community, as well as providing advice on various tree related projects. In the future, the Urban Forestry Committee can help to recruit volunteer groups to aid with any planting activities the City may hold. Volunteer organizations, such as a garden club, service organization, Groundwork Somerville, or Boy/Girl Scout troop, could be recruited to do the actual planting and follow-up watering and other maintenance activities.



ACTION PLAN

Every hour of every day, public trees in Somerville are supporting and improving the quality of life. When properly maintained, trees provide numerous environmental, economic, and social benefits that far exceed the time and money invested in planting, pruning, protection, and removal.

Somerville's Urban Forest Management Plan (UFMP) is a comprehensive document that describes the current state of the city's urban forest and presents numerous recommendations for improvement.

This Action Plan is a summary of the recommendations made throughout the UFMP. It organizes the UFMP recommendations into short-term goals (1-2 years), medium-term goals (2-5 years), and long-term goals (more than 5 years). Further details about each goal can be found in the listed UFMP section(s). As different divisions of the City are responsible for different aspects of the urban forest, the Action Plan includes details about the entity(-ies) that are primarily responsible for completing each goal (i.e., *Program Leader(s)*). The *Recommendation Type* is described as *Practice* if it impacts the day-to-day care of trees, *Policy* if it involves strategies to improve procedures, planning, or the legal framework relating to our urban forest, and *Outreach & Education* if the recommendation pertains to communication strategies and public engagement. Finally, each recommendation was assessed in terms of its impact on growing the canopy in the city, increasing the survival of the current tree population, improving safety of the public and City personnel, and improving equity in the distribution of tree canopy across the city.

URBAN FOREST MANAGEMENT PLAN - ACTION PLAN

Recommendation	UFMP Section(s)	Program Leader(s)	RECOMMENDATION TYPE: Practice	RECOMMENDATION TYPE: Policy	RECOMMENDATION TYPE: Outreach & Education	RECOMMENDATION IMPACT: Grow Canopy	RECOMMENDATION IMPACT: Increase Survival	RECOMMENDATION IMPACT: Safety	RECOMMENDATION IMPACT: Equity
SHORT-TERM GOALS (1-2 years)									
Tree Removals									
Remove City-owned high and moderate risk trees (11 High Risk, 200 Moderate Risk), and complete high and moderate risk prunings (8 High Risk, and 325 Moderate Risk) as quickly as possible. Prioritize removal of moderate and high risk trees that are along priority streets and public spaces.	3.2, 3.4	DPW	✓					✓	
Promptly remove any trees found to be infested with EAB to reduce preventable damage.	3.4	DPW	✓					✓	
Work with State entities to remove State-owned high and moderate risk trees as quickly as possible (1 High Risk tree, 31 Moderate Risk trees) and complete high and moderate risk prunings (2 High Risk and 32 Moderate Risk)	3.2	DPW, PSUF, MassDOT, MBTA, DCR	✓					✓	
Proactively remove ash trees that are in Poor condition or are in poor locations during road reconstruction projects and other public works associated activities.	3.3	PSUF	✓	✓				✓	
Tree Care									
In order to work toward an ideal distribution of trees, the City should promote tree preservation and proactive tree care to ensure the long-term survival of the older trees. Continue to implement proactive maintenance programs that take a holistic approach to tree health to improve the condition of Somerville's trees.	2	DPW, PSUF	✓	✓			✓		
Create and communicate formal tree protection protocols for construction and underground utility work.	4.1, 4.3	PSUF		✓			✓		

View UFMP Action Plan online

			RECOMMENDATION TYPE			RECOMMENDATION IMPACT			
Recommendation	UFMP Section(s)	Program Leader(s)	Practice	Policy	Outreach & Education	Grow Canopy	Increase Survival	Safety	Equity
SHORT-TERM GOALS (1-2 years)									
Tree Care, continued									
Ensure tree roots are not severed in the process of fixing damaged hardscapes. When performing sidewalk repair/replacement, work around the existing roots, particularly the structural roots, instead of cutting them.	2	DPW	✓				✓		
Prune trees to avoid clearance issues and raise tree crowns following *ANSI A300 (Part 9)* standards. Minimum clearance distance guidelines are as follows: 14 feet over streets; 8 feet over sidewalks; and 5 feet from buildings, signs, signals, or lights.	2	DPW	✓				✓		
Perform ground level maintenance on trees that have numerous suckers growing out of their base or which are surrounded by excessive weeds to increase tree vitality while also improving accessibility and the tree's appearance.	2	DPW	✓				✓		
For small trees already in the landscape, consider replanting the trees with no visible root flair. Otherwise, if possible, carefully scrape away the soil from around the trunk until the root flare is visible.	2	DPW, PSUF	✓				✓		
To reduce the possibility of an oak tree contracting oak wilt, do not prune oak trees during the growing season.	3.3	DPW, PSUF	✓				✓		
Continue 3-year Young Tree Training (YTT) cycle, adding newly planted trees to cycle after establishment period, and removing trees that graduate out of YTT cycle.	3.2	PSUF	✓				✓		
Practicing proper pruning techniques, eliminating codominant stems, and keeping trees as healthy as possible, all helps in the creation of a more wind resistant urban forest. This is an important facet of the Young Tree Training Program.	3.4	DPW, PSUF	✓				✓	✓	

			RECOMMENDATION TYPE			RECOMMENDATION IMPACT			
Recommendation	UFMP Section(s)	Program Leader(s)	Practice	Policy	Outreach & Education	Grow Canopy	Increase Survival	Safety	Equity
SHORT-TERM GOALS (1-2 years)									
Tree Care, continued									
The City should assess trees and apply the following types of maintenance as needed: water, mulch, protections, soil amendments, root pruning, soil decompaction, pest management, and cabling and/or bracing.	3.2	PSUF	✓				✓		
For Somerville to have a proactive and high-quality urban forest management program, a total minimum increase in funding of nearly $100,000 will be required, at least for the next few years. Additional funding will be required for additional work.	4.2	DPW, PSUF		✓		✓	✓		
Regularly inspect trees along the street ROW and attend to them as needed. In particular, unless already slated for removal, trees identified as having Poor wood condition in the tree inventory (1,777 City-owned trees and 276 State-owned trees) should be inspected on a yearly basis or after major storm events.	3.2	PSUF	✓					✓	
Have a qualified arborist inspect all of the trees in the tree inventory that need multi-annual checks and Level III assessments and recommend appropriate action. Monitor any tree that shows possible symptoms of Emerald Ash Borer (EAB) closely.	2	PSUF	✓					✓	
Adapt the current EAB mitigation strategy for public trees by treating all large, healthy ash trees, and by removing smaller ash trees and those in poor/dead condition. Trees that are removed should be replaced as soon as possible to reduce impact to the city's tree canopy.	3.3	PSUF	✓	✓				✓	
Remain aware of the signs and symptoms of potential pest infestations and be prepared to act if a significant threat is observed in the Somerville tree population or in a nearby community.	2	PSUF	✓				✓	✓	

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Recommendation	UFMP Section(s)	Program Leader(s)	Practice	Policy	Outreach & Education	Grow Canopy	Increase Survival	Safety	Equity
SHORT-TERM GOALS (1-2 years)									
Tree Care, continued									
Discuss and coordinate quarterly or annual work plans with Eversource and other utility companies to discover efficiencies, such as shared tree maintenance contracts, and mutually beneficial tree maintenance and planting projects.	4.1	DPW, PSUF		✓		✓	✓	✓	
Partner with Eversource to utilize additional arboricultural and utility research and techniques available to provide solutions for tree/utility conflicts. Examples of other solutions include the use of tree growth regulators to reduce growth rates, greater use of directional pruning techniques, conversion of multiple aerial lines into innovative cable designs, and experimentation with different cross-arm dimensions, locations, and construction techniques.	4.1	DPW, PSUF		✓			✓		
Work to convince utility companies to repair natural gas pipes that may be impacting tree health.	4.1	DPW, PSUF		✓					

Tree Planting									
Support a strong planting and maintenance program to ensure that young, healthy trees are in place to fill in gaps in tree canopy and replace older declining trees and trees that are lost to natural mortality and other threats.	2	PSUF	✓	✓		✓			
Create an approved tree species list that will inform residents of ecologically appropriate species to plant in the city and refer to it in the Tree Preservation Ordinance.	4.3	PSUF		✓		✓			
The Urban Forestry department should plant at least 350 trees per year; additional trees should be planted through other projects.	3.1	PSUF	✓			✓			

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Recommendation	UFMP Section(s)	Program Leader(s)	Practice	Policy	Outreach & Education	Grow Canopy	Increase Survival	Safety	Equity
SHORT-TERM GOALS (1-2 years)									
Tree Planting, continued									
Plant trees in the 567 currently available planting sites along the City-owned rights-of-way (ROW) that were identified during the 2018 tree inventory. Replace dead and dying trees to ensure the ROW is at least 90% stocked. Continue to plant trees in other areas of the city, both by continuing to fulfill resident requests and by focusing tree planting efforts in high priority planting areas identified by the canopy analysis.	3.1	PSUF	✓			✓			✓
To determine the appropriate species to plant in each location, use the "right tree, right place" best practice, taking into account species and site characteristics. Species diversity, climatic conditions, and public needs are also important factors to consider. Plant native species in areas where they can survive and thrive to elevate ecosystem functioning.	2, 3.1	PSUF	✓	✓		✓			
The City should severely limit the number of maple trees it plants. Continuing to plant a diversity of tree species will ensure Somerville's urban forest is sustainable and resilient to future invasive pest infestations.	2	PSUF	✓	✓		✓			
To increase the benefits the urban forest provides, the City should plant young, large-statured tree species that are low emitters of BVOCs wherever possible.	1.2	PSUF	✓	✓		✓			
Fast-growing, weak-wooded species have the highest potential to create the largest amount of debris after storms; when planting new trees, these species should be avoided when possible. Special consideration should be given to planting tree species with high or medium-high wind resistance and moderate to low ice storm susceptibility to increase the resilience of Somerville's urban forest to storms.	3.4	PSUF	✓	✓		✓	✓	✓	

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Recommendation	UFMP Section(s)	Program Leader(s)	Practice	Policy	Outreach & Education	Grow Canopy	Increase Survival	Safety	Equity
SHORT-TERM GOALS (1-2 years)									
Tree Planting, continued									
Plant small-growing trees within 20 feet of overhead utilities, medium-size trees within 20–40 feet of overhead utilities, and large-growing trees 40 feet or more from overhead utilities to improve future tree conditions, minimize future utility line conflicts, and reduce the costs of maintaining trees under utility lines.	2	PSUF	✓	✓		✓			
Give the tree enough growing room above ground when planting in hardscape such as sidewalks; create tree wells/ lawns that are minimum dimensions of 3 x 6 feet for small-growing tree species, 3 x 8 feet for medium-size tree species, and 3 x 10 feet for large-growing tree species.	2	PSUF	✓	✓		✓			
Use best practices to carefully plant trees to give them the best chance of success. Proper planting techniques include choosing quality tree stock, handling trees with care, properly preparing the site for a new tree, planting trees at the proper depth, and protecting the roots and soil with mulch and organic matter when necessary. Improve the health and longevity of newly planted trees by watering them regularly throughout the establishment period, replenishing mulch as needed, and adding trees to the Young Tree Training pruning cycle.	3.1	PSUF	✓	✓		✓			
Install stakes only only when necessary to keep trees from leaning (windy sites) or to prevent damage from pedestrians and/or vandals. Stakes should only be attached to trees with a loose, flexible material. Remove all hardware that has been attached to any tree for more than one year.	2, 3.1	PSUF	✓			✓	✓		
Inspect all newly planted trees to ensure they are planted at correct depth and that root flare is visible at the time of planting.	2, 3.1	PSUF	✓			✓	✓		

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Recommendation	UFMP Section(s)	Program Leader(s)	Practice	Policy	Outreach & Education	Grow Canopy	Increase Survival	Safety	Equity
SHORT-TERM GOALS (1-2 years)									
Education									
Educate the public on how to detect EAB, provide information about treatment options, and relay the importance of reforestation to allow the public to make informed and proactive choices about managing infested ash trees.	3.3	PSUF			✓		✓	✓	
Create public educations campaigns to inform the public about EAB, ALB, SLF, Oak Wilt, and other invasive insects and diseases.	3.3	PSUF			✓		✓	✓	
Work with the Urban Forestry Committee to help residents become more involved in the City's urban forestry program through public engagement. Expand up upon current public outreach campaigns and develop new ones. Examples include: arbor day celebrations, tree care door hangers and brochures, and a heritage tree program. Consider implementing a "Young Tree Care" volunteer program to assist with new tree planting and new tree care such as watering, mulching, and pruning. Establish partnerships to fund and accomplish the young tree training program and some mature tree care activities (e.g. with Eversource).	4.4	PSUF			✓		✓		
Create a library of specifications and details for different types of tree work. These documents can be easily inserted into new bid documents and contracts. Make these documents publicly available such that private property owners and developers can utilize the best management practices for tree planting and care.	4.1, 4.3	PSUF		✓	✓	✓	✓		✓

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Recommendation	UFMP Section(s)	Program Leader(s)	Practice	Policy	Outreach & Education	Grow Canopy	Increase Survival	Safety	Equity
SHORT-TERM GOALS (1-2 years)									
Education, continued									
Develop tree pruning specifications based on *ANSI A300* standards to ensure that tree pruning performed as part of the pruning cycle is done to the highest standards and meets the City's pruning objectives.	4.1	PSUF		✓			✓		
Eversource and the City should adopt all applicable arboricultural and utility industry standards and use them for in-house and contractual projects.	4.1	DPW, PSUF		✓			✓		

Data Analysis									
Determine mechanisms for reaching the city-wide tree canopy goal of 16%. Develop realistic Ward-specific goals to increase equity across the city.	1.1	PSUF		✓		✓			✓
Explore and understand other patterns in the canopy data. For example, it may be interesting to explore how tree canopy cover relates to environmental problems such as flooding or excessive heat. Additionally, assessing how tree canopy cover varies in relation to the people who reside/work throughout the metropolitan area (socio-economics and demographics) would provide useful insight for tree planting equity.	1.1	PSUF		✓		✓			✓
Use data and reports from asset management software to analyze crew productivity and contractual costs to get realistic numbers for refined budget and staffing analyses.	4.1	DPW, PSUF		✓					
Analyze past storm events (hurricanes) and provide for sufficient regular funding and contingency funding to support an adequate response for various levels of storm damage.	3.4	DPW		✓				✓	

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Recommendation	UFMP Section(s)	Program Leader(s)	Practice	Policy	Outreach & Education	Grow Canopy	Increase Survival	Safety	Equity
SHORT-TERM GOALS (1-2 years)									
Staffing & Management									
Strengthen the formal communication, coordination and collaboration process between PSUF and DPW Tree Crew staff and managers.	4.1	DPW, PSUF		✓			✓	✓	
Hire operational staff with arboricultural certifications or provide incentives for current staff to obtain certifications.	4.1	DPW		✓			✓	✓	
Evaluate compensation and training package for DPW Tree Crew workers and identify ways to make it more attractive for both recruitment and retention of qualified department employees.	4.1	DPW		✓				✓	
Provide staff with regular and formal safety and technical training through in-the-field and classroom methods. To ensure safe and effective work, staff should receive regular and updated training sessions for first-aid, CPR, chainsaw use, tree risk assessment, and minimum approach distances for energized electric lines.	3.4, 4.1	DPW		✓				✓	
Provide additional training for key personnel in topics that include electric hazard assessment (EHAP), aerial lift training, advanced climbing, crane operations, and aerial rescue. Consider having key staff members receive training to become ISA Certified Arborists. Develop annual "scenario training" with tree emergency response topics and situations.	3.4	DPW		✓				✓	
Staff should be encouraged to attend at least 1-2 trainings or conferences per year. Such trainings and conferences are offered by the Massachusetts Arborists Association, the Massachusetts Department of Conservation and Recreation, the New England Chapter of the International Society of Arboriculture, and other local and regional professional organizations.	4.1	DPW, PSUF		✓			✓	✓	

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Recommendation	UFMP Section(s)	Program Leader(s)	Practice	Policy	Outreach & Education	Grow Canopy	Increase Survival	Safety	Equity
SHORT-TERM GOALS (1-2 years)									
Staffing & Management, continued									
Assess opportunities to expand the capacity of current staff, or supplement with contractual staff for specific time periods or specific projects.	4.1	DPW, PSUF		✓			✓	✓	
Explore hiring part-time/seasonal employees to provide urban forest management support.	4.1	DPW		✓					
Consider the establishment of an internship program to assist with the urban forestry program as needed; students could come from University of Massachusetts, Tufts University, Essex North Shore Agricultural Technical School, Norfolk County Agricultural School, and/or various vocational schools in the region.	4.1	DPW, PSUF		✓					
Provide Tree Crew staff with adequate mobile devices/tablets or similar mobile technology to help coordinate work and efficiently route daily assignments.	4.1	DPW	✓						
Utilize asset management software (such as TreeKeeper®) to develop work orders that city crews and contractors can access using tablets or smartphones or other mobile technology. Provide training to staff, utilize work orders to prioritize and assign work to maximize efficiency, track work activites completed or to be done and create reports to share with City managers and Council.	4.1	DPW, PSUF	✓						
Assess fleet age, condition, and usage hours to determine when equipment used for urban forest maintenance will need to be replaced; once identified, begin purchasing process at least one year prior to the projected "aging out" date.	4.1	DPW	✓					✓	
Consider providing the tree crew with a smaller aerial truck for easier maneuvering around the city.	4.1	DPW	✓					✓	

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Recommendation	UFMP Section(s)	Program Leader(s)	Practice	Policy	Outreach & Education	Grow Canopy	Increase Survival	Safety	Equity
SHORT-TERM GOALS (1-2 years)									
Staffing & Management, continued									
Rent or contract for specialty equipment that would not be used often for urban forest management and/or by any other department in the city. Or, consider sharing specialty equipment with other nearby cities.	4.1	DPW	✓						
Keep the tree inventory data and maintenance plan up to date. Perform routine inspections of public trees as needed, and complete windshield surveys. Continuously update the tree inventory as work is completed. Schedule and prioritize work based on risk.	3.2, 3.4	PSUF		✓				✓	
Develop standard operating procedures for updating tree inventory data and inputting records and information in the 311 system.	4.1	DPW, PSUF		✓					
Set a target timeframe (i.e. 1, 2, or 3 days) for a response (not a resolution) to a resident 311 request for service. Stick to the agreed upon timeframe for closing out the request (i.e. 10 days for Down limb, Tree trimming, and Stump removal requests, 1 month for Arborist and tree maintenance requests, and 1 year for Planting requests).	4.1	DPW, PSUF		✓					
Eversource and the City should hold quarterly or annual meetings involving appropriate staff to discuss upcoming projects, developing issues, and to further strengthen the interagency relationship.	4.1	DPW, PSUF		✓			✓	✓	
Establish pre-qualifications for contractors as prerequisites to working for the City during storm emergencies.	3.4	DPW		✓				✓	
Grow and foster relationships with contractors, arborists, utility companies, and others to support storm response operations.	3.4	DPW		✓				✓	

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SHORT-TERM GOALS (1-2 years)									
Staffing & Management, continued									
Consider establishing a Mutual Aid Agreement with other cities in the region.	3.4	DPW		✓				✓	
Identify an individual to serve as a Safety Officer in preparation of an emergency to act as point person for effective and uniform communication.	3.4	DPW		✓				✓	
Ensure all staff are signed up for the Emergency Alert System through www.mass.gov/alerts.	3.4	DPW		✓				✓	
Complete the Tree Emergency Plan Worksheet (Appendix H) and distribute appropriately. Review the Worksheet annually and update information as needed.	3.4	DPW		✓				✓	
Communicate to all appropriate Somerville staff and partners the procedures for prioritizing and managing urban forest damage after storms per the three storm categories.	3.4	DPW		✓				✓	
Commit to providing residents with timely messaging about Somerville's response and recovery activities and about tree damage and correction topics. Prepare public relations materials ahead of time so that they are easily accessible when the storm strikes.	3.4	DPW		✓				✓	

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Recommendation	UFMP Section(s)	Program Leader(s)	Practice	Policy	Outreach & Education	Grow Canopy	Increase Survival	Safety	Equity
MEDIUM-TERM GOALS (2 - 5 YEARS)									
Remove Low Risk but storm prone species from the population when their service lives are over and replace with more resilient species.	3.4	DPW, PSUF	✓	✓				✓	
Create programs and policies that encourage tree maintenance and tree planting on private property to help increase tree canopy levels across the City. While significant improvement to Somerville's tree cover can be made by planting on public property, the greatest opportunities for substantial and long-term canopy gains will come through planting efforts on privately-held lands.	1.1	PSUF		✓	✓	✓			
Promote tree planting on private property if adequate space does not exist on the right-of-way (i.e. a back of sidewalk tree planting program).	4.3	PSUF		✓		✓			
Require tree plantings in new developments and parking lots.	1.1, 4.3	PSUF		✓		✓			
Amend Tree Preservation Ordianance to better protect public and private trees. Include acceptable and unacceptable basic performance standards for the treatment of public trees, a prohibitions section, a Tree Preservation Bylaw pertaining to the protection of established and mature trees during construction, adding details about utility pruning and maintenance activities, and reference to current national arboricultural industry standards. Also consider acknowledging Emerald Ash Borer as a public nuisance and treat it in similar fashion as Dutch elm disease and other insect pests or plant diseases. The ordinance could encourage private property owners to treat their ash trees, and remove any barriers to the removal of potentially infested ash trees.	3.3, 4.1, 4.3	PSUF		✓			✓	✓	

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Recommendation	UFMP Section(s)	Program Leader(s)	Practice	Policy	Outreach & Education	Grow Canopy	Increase Survival	Safety	Equity
MEDIUM-TERM GOALS (2–5 YEARS)									
Unless slated for removal, inspect all trees noted in the inventory as having girdling roots to determine if corrective actions are possible and warranted. Where indicated, perform corrective actions.	2	PSUF	✓				✓		
Establish an integrated pest management plan to identify and monitor threats to the urban forest.	2	PSUF		✓			✓	✓	
As new projects and types of work are developed, create new specifications and details to guide that work. Add these new specifications and details to the City's specification library.	4.1	PSUF		✓			✓		
Utilize i-Tree Tools every 3-5 years to evaluate the benefits of the urban forest and compare changes over time to management activities completed. Communicate changes to City leadership, Council and the public and explain how the changes (positive or negative) have been affected by urban forest management activities the City has undertaken (or other factors, e.g. invasive species, storms).	4.1	PSUF		✓					

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Recommendation	**UFMP Section(s)**	**Program Leader(s)**	**Practice**	**Policy**	**Outreach & Education**	**Grow Canopy**	**Increase Survival**	**Safety**	**Equity**
LONG-TERM GOALS (>5 years)									
Re-inventory the street ROW every seven years (or re-inventory 1/7th of the population each year over 7 years), and revise the Tree Maintenance Program after the re-inventory has been completed.	3.2	PSUF		✓				✓	
Consider combining the PSUF Urban Foresters and the DPW Tree Crew staff into one centralized facility.	4.1	DPW, PSUF		✓					

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GLOSSARY

address number (tree inventory data field): The address number was recorded based on the visual observation by the Davey Resource Group arborist at the time of the inventory of the actual address number posted on a building at the inventoried site. In instances where there was no posted address number on a building or sites were located by vacant lots with no GIS parcel addressing data available, the address number assigned was matched as closely as possible to opposite or adjacent addresses by the arborist(s) and an "X" was added to the number in the database to indicate that the address number was assigned.

adventitious root: A root growing from a location other than the underground, descending portion of the axis of a plant, as from a stem or leaf.

aesthetic/other report: The i-Tree Streets aesthetic/other report presents the tangible and intangible benefits of trees reflected by increases in property values in dollars ($).

air quality report: The i-Tree Streets air quality report quantifies the air pollutants (ozone [O_3], nitrogen dioxide [NO_2], sulfur dioxide [SO_2], and coarse particulate matter less than 10 micrometers in diameter [PM_{10}]) deposited on tree surfaces and reduced emissions from power plants (NO_2, PM_{10}, Volatile Oxygen Compounds [VOCs], SO_2) due to reduced electricity use measured in pounds (lbs.). Also reported are the potential negative effects of trees on air quality due to biogenic volatile organic compound (BVOC) emissions.

American National Standards Institute (ANSI): ANSI is a private, nonprofit organization that facilitates the standardization work of its members in the United States. ANSI's goals are to promote and facilitate voluntary consensus standards and conformity assessment systems, and to maintain their integrity.

ANSI A300: Tree care performance parameters established by ANSI that can be used to develop specifications for tree maintenance.

arboriculture: The art, science, technology, and business of commercial, public, and utility tree care.

ash treatment candidate (tree inventory data field): For all ash trees, the tree inventory recorded whether or not the tree was a candidate for Emerald Ash Borer treatment based on tree health and location.

benefit-cost ratio (BCR): The i-Tree Streets BCR is the ratio of the cumulative benefits provided by the landscape trees, expressed in monetary terms, compared to the costs associated with their management, also expressed in monetary terms.

biogenic volatile organic compounds (BVOC): Gases emitted from trees, like pine trees, which create the distinct smell of a pine forest. When exposed to sunlight in the air, BVOCs react to form tropospheric ozone, a harmful gas that pollutes the air and damages vegetation.

caliper: The measure of a plant's trunk diameter. Caliper measurement of the trunk is taken six inches above the ground for trees up to and including four-inch caliper size. If the caliper at six inches above the ground exceeds four inches, the caliper should be measured at 12 inches above the ground.

canopy: Branches and foliage that make up a tree's crown.

canopy cover: As seen from above, it is the area of land surface that is covered by tree canopy.

canopy thinning: In pruning, the selective removal of live branches to provide light or air penetration through the tree or to lighten the weight of the remaining branches.

canopy cleaning: In pruning, the selective removal of dead, diseased, detached, infested, and damaged branches.

carbon dioxide report: The i-Tree Streets Carbon Dioxide Report presents annual reductions in atmospheric CO_2 due to sequestration by trees and reduced emissions from power plants due to reduced energy use in pounds. The model accounts for CO_2 released as trees die and decompose and CO_2 released during the care and maintenance of trees.

City-owned tree: A tree in the City of Somerville that is on land owned by the City. This includes trees along the City-owned rights-of-way and in City-owned open spaces.

City-owned open spaces: All city-owned public spaces, including parks, playgrounds, land around City buildings, and other civic spaces.

city open space tree: A tree growing in a City-owned park or public space, or on City-owned property such as municipal building lots or other facilities.

civic space: An open space designed to support civic, cultural, ecological, recreational, or social activities. Civic space types are defined by a combination of characteristics, including the interrelationship between the intended uses, size, landscape design, and abutting real property.

community forest: See **urban forest**.

condition (tree inventory data field): The general condition of each tree rated during the inventory according to the following categories adapted from the International Society of Arboriculture's rating system: Good (80%), Fair (60%), Poor (40%), Dead (0%). The condition of the canopy and the wood were rated separately, and combined to give an overall condition rating.

crown raising: In pruning, the selective removal of lower branches from a tree crown to provide clearance.

crown reducing: In pruning, a safe technique to remove weight from the tips of the branches.

cycle: Planned length of time between vegetation maintenance activities.

defect: See **structural defect.**

diameter at breast height (DBH): A tree's diameter measured at 4.5 feet above ground, also known as diameter. This is a standard forestry measurement.

ecosystem services: Services provided by nature that directly or indirectly benefit humans or enhance social welfare.

emerald ash borer (EAB): Emerald ash borer (*Agrilus planipennis*) is a small insect native to Asia. In North America, EAB is an invasive species that is highly destructive to all ash tree species in its introduced range, including all ash species that are native to the United States.

energy report: The i-Tree Streets energy report presents the contribution of the urban forest toward conserving energy in terms of reduced natural gas use in winter measured in therms (th) and reduced electricity use for air conditioning in summer measured in megawatt-hours (MWh).

epicormic shoot: A sprout that arises from latent or adventitious buds, generally from the trunks of trees or the base of branches.

extreme risk tree: Applies in situations where tree failure is imminent, there is a high likelihood of impacting the target, and the consequences of the failure are "severe." In some cases, this may mean immediate restriction of access to the target zone area in order to prevent injury.

failure: In terms of tree management, failure is the breakage of stem or branches, or loss of mechanical support of the tree's root system.

fiscal year: A year as reckoned for accounting and budgeting purposes. In Somerville the fiscal year starts on July 1st and ends on June 30th.

further inspection (tree inventory data field): Notes that a specific tree may require an annual inspection for several years to make certain of its maintenance needs. A healthy tree obviously impacted by recent construction serves as a prime example. This tree will need annual evaluations to assess the impact of construction on its root system. Another example would be a tree with a defect requiring additional equipment for investigation.

genus: A taxonomic category ranking below a family and above a species and generally consisting of a group of species exhibiting similar characteristics. In taxonomic nomenclature, the genus name is used, either alone or followed by a Latin adjective or epithet, to form the name of a species.

geographic information system (GIS): A technology that is used to view and analyze data from a geographic perspective. The technology is a piece of an organization's overall information system framework. GIS links location to information (such as people to addresses, buildings to parcels, or streets within a network) and layers that information to provide a better understanding of how it all interrelates.

girdling root: Girdling roots are lateral roots that emerge at or slightly below the soil surface and cut into at least one side of the main trunk. Includes any root currently touching the trunk, or with the potential to touch the trunk, above the root collar approximately tangent to the trunk circumference or circling the trunk.

Global Positioning System (GPS): GPS is a system of earth-orbiting satellites that make it possible for people with ground receivers to pinpoint their geographic location.

grow space size (tree inventory data fields): Identifies the width and length the tree grow space for root development.

grow space type (tree inventory data field): Best identifies the type of location where a tree is growing. During the inventory, grow space types were categorized as island, median, open/restricted, open/unrestricted, raised planter, tree lawn/parkway, unmaintained/natural area, or well/pit.

hardscape damage (tree inventory data field): Indicates trees damaged by hardscape or hardscape damaged by trees (for example, damage to curbs, cracking, lifting of sidewalk pavement 1 inch or more).

high risk tree (tree inventory risk rating data field): The High Risk category applies when consequences are "significant" and likelihood is "very likely" or "likely," or consequences are "severe" and likelihood is "likely." In a population of trees, the priority of High Risk trees is second only to Extreme Risk trees.

impervious surface: Surfaces that are impermeable to water, such as buildings, roads, and parking lots.

importance value (IV): A calculation in i-Tree Streets displayed in table form for all species that make up more than 1% of the population. The i-Tree Streets IV is the mean of three relative values (percentage of total trees, percentage of total leaf area, and percentage of canopy cover) and can range from 0 to 100, with an IV of 100 suggesting total reliance on one species. IVs offer valuable information about a community's reliance on certain species to provide functional benefits. For example, a species might represent 10% of a population, but have an IV of 25% because of its great size, indicating that the loss of those trees due to pests or disease would be more significant than their numbers suggest.

invasive, exotic tree: A tree species that is out of its original biological community and its introduction into an area causes or is likely to cause economic or environmental harm, or harm to human health. An invasive, exotic tree has the ability to thrive and spread aggressively outside its natural range. An invasive species that colonizes a new area may gain an ecological edge since the insects, diseases, and foraging animals that naturally keep its growth in check in its native range are not present in its new habitat.

inventory: See **tree inventory**.

i-Tree Streets: i-Tree Streets is a street tree management and analysis tool that uses tree inventory data to quantify the dollar value of annual environmental and aesthetic benefits: energy conservation, air quality improvement, CO2 reduction, stormwater management, and property value increase.

i-Tree Tools: State-of-the-art, peer-reviewed software suite from the USDA Forest Service that provides urban forestry analysis and benefits assessment tools. The i-Tree Tools help communities of all sizes to strengthen their urban forest management and advocacy efforts by quantifying the structure of community trees and the environmental services that trees provide.

location (tree inventory data fields): A collection of data fields collected during the inventory to aid in finding trees, including address number, street name, site number, and side.

low risk tree (tree inventory risk rating data field): The Low Risk category applies when consequences are "negligible" and likelihood is "unlikely"; or consequences are "minor" and likelihood is "somewhat likely." Some trees with this level of risk may benefit from mitigation or maintenance measures, but immediate action is not usually required.

maintain ground (tree inventory data field): The inventory notes which sitest require ground maintenance (e.g. weeding or pruning suckers).

management costs: Used in i-Tree Streets, they are the expenditures associated with street tree management presented in total dollars, dollars per tree, and dollars per capita.

mapping coordinate (tree inventory data field): Helps to locate a tree; X and Y coordinates were generated for each tree using GPS.

moderate risk tree (tree inventory risk rating data field): The Moderate Risk category applies when consequences are "minor" and likelihood is "very likely" or "likely"; or likelihood is "somewhat likely" and consequences are "significant" or "severe." In populations of trees, Moderate Risk trees represent a lower priority than High or Extreme Risk trees.

monoculture: A population dominated by one single species or very few species.

net annual benefits: Specific data field for i-Tree Streets. Citywide benefits and costs are calculated according to category and summed. Net benefits are calculated as benefits minus costs.

new sidewalk (tree inventory data field): The appearance of a new sidewalk around the tree is noted in the inventory.

nitrogen dioxide (NO_2): Nitrogen dioxide is a compound typically created during the combustion processes and is a major contributor to smog formation and acid deposition.

none (tree inventory risk rating data field): Tree associated risk is equal to zero. It is used only for planting sites and stumps.

notes (tree inventory data field): Describes additional pertinent information.

on center: In planting, it refers to the spacing of plants, and is measured as the distance between the center of one plant to the center of another.

open space: A ground level or upper story outdoor landscaped area including, but not limited to, natural woodlands, yards, forecourts, courtyards, green roofs and civic spaces.

ordinance: See **tree ordinance.**

overhead utilities (tree inventory data field): The presence of overhead utility lines above a tree or planting site.

ownership (tree inventory data field): The ownership of each tree in the inventory was designated as City, State, Private, or Other.

ozone (O_3): A strong-smelling, pale blue, reactive toxic chemical gas with molecules of three oxygen atoms. It is a product of the photochemical process involving the Sun's energy. Ozone exists in the upper layer of the atmosphere as well as at the Earth's surface. Ozone at the Earth's surface can cause numerous adverse human health effects. It is a major component of smog.

park name (tree inventory data field): for trees in the inventory that are located in parks or other civic space, the name of that space is provided. For a complete list of Parks and Public Areas that were included in the inventory, see *Appendix C*.

particulate matter (PM_{10}): A major class of air pollutants consisting of tiny solid or liquid particles of soot, dust, smoke, fumes, and mists.

plant tree (tree inventory primary maintenance need data field): This data field identifies planting sites as small, medium, or large (indicating the ultimate size that the tree will attain), depending on the growing space available and the presence of overhead wires.

primary maintenance need (tree inventory data field): The type of tree work needed to reduce immediate risk.

pruning: The selective removal of plant parts to meet specific goals and objectives.

removal (tree inventory primary maintenance need data field): Data field collected during the inventory identifying the need to remove a tree. Trees designated for removal have defects that cannot be cost-effectively or practically treated. Most of the trees in this category have a large percentage of dead branches.

right-of-way (ROW): A strip of land generally owned by a public entity over which facilities, such as highways, railroads, or power lines, are built.

risk: Combination of the probability of an event occurring and its consequence.

risk assessment (tree inventory data fields): See *Appendix C*.

risk rating: A tree's risk based on a Level 2 qualitative risk assessment performed in accordance with *ANSI A300 (Part 9)* standards and the companion publication *Best Management Practices: Tree Risk Assessment*, published by International Society of Arboriculture (2011). Trees can have multiple failure modes with various risk ratings. One risk rating per tree was assigned during the inventory. The failure mode having the greatest risk serves as the overall tree risk rating. The specified time period for the risk assessment is one year.

root collar: The area on the tree where the majority of the structural roots join the main stem or trunk. There is often a flare at this junction, which is referred to as a "root flare" or "trunk flare".

root pruning: 1) Pruning of girdling roots or circling roots that have the potential to become girdling. 2) In tree conservation and preservation, the process of cutting roots at the line of a planned excavation to prevent tearing and splintering of remaining roots. 3) In tree disease management, severing tree roots to prevent disease transmission through root grafts.

runner root: A runner root is a root that contains adventitious buds. These adventitious buds can form into a new tree, and can sometimes be far from the parent stem.

side value (tree inventory data field): Each site is assigned a side value to aid in locating the site. Side values include: *front, side, median* (includes islands), and *rear* based on the site's location in relation to the lot's street frontage. The front side is the side that faces the address street. *Side* is the name of the street the arborist is collecting on, away or to the current addressed street. *Median* indicates a median or island. The *rear* is the side of the lot opposite the front.

site number (tree inventory data field): All sites at an address are assigned a *site number*. Sites numbers are not unique; they are sequential to the side of the address only (the only unique number is the tree identification number assigned to each site). Site numbers are collected in the direction of vehicular traffic flow. The only exception is a one-way street. Site numbers along a one-way street are collected as if the street were actually a two-way street, so some site numbers will oppose traffic.

species (tree inventory data field): Fundamental category of taxonomic classification, ranking below a genus or subgenus, and consisting of related organisms capable of interbreeding.

State-owned property: Includes ROW and open spaces that are owned by state entities such as the Massachusetts Department of Conservation and Recreation, the Massachusetts Bay Transportation Authority, and Massachusetts Department of Transportation.

State-owned tree: A tree in the City of Somerville that is on State-owned property.

stem: A woody structure bearing buds and foliage, and giving rise to other stems.

stems (tree inventory data field): Identifies the number of stems or trunks splitting less than 1 foot above ground level.

stocking: A traditional forestry term used to measure the density and distribution of trees. In urban forestry it refers to the density of trees planted compared to the density of available planting sites.

stomata: Plural form of the word stomate, aka stoma. A stomate is a tiny pore in the surface of a leaf, stem, or other plant tissue that functions in gas exchange.

stored carbon report: While the i-Tree Streets carbond dioxide report quantifies annual CO2 reductions, the i-Tree Streets stored carbon report tallies all of the carbon (C) stored in the urban forest over the life of the trees as a result of sequestration measured in pounds as the CO_2 equivalent.

stormwater report: A report generated by i-Tree Streets that presents the reductions in annual stormwater runoff due to rainfall interception by trees measured in gallons (gals.).

street name (tree inventory data field): The name of a street right-of-way or road identified using posted signage or parcel information.

street right-of-way (ROW): See **right-of-way**.

street tree: A tree growing within the public right-of-way.

structural defect: A feature, condition, or deformity of a tree or tree part that indicates weak structure and contributes to the likelihood of failure.

structural pruning: Pruning to develop strong tree structure. This includes maintaining a dominant leader by reducing the length or removing any competing leaders, suppressing growth on branches with bark inclusions, ensuring appropriate spacing of main branches along a dominant trunk, and keeping all branches less than one-half the trunk diameter.

stump removal (tree inventory primary maintenance need data field): Indicates a stump that should be removed.

sulfur dioxide (SO_2): A strong-smelling, colorless gas that is formed by the combustion of fossil fuels. Sulfur oxides contribute to the problem of acid rain.

summary report: A report generated by i-Tree Streets that presents the annual total of energy, stormwater, air quality, carbon dioxide, and aesthetic/other benefits. Values are reflected in dollars per tree or total dollars.

topping: Characterized by reducing tree size using internodal cuts without regard to tree health or structural integrity; this is not an acceptable pruning practice.

tree: A tree is defined as a perennial woody plant that may grow more than 20 feet tall. Characteristically, it has one main stem, although many species may grow as multi-stemmed forms.

tree benefit: An economic, environmental, or social improvement that benefits the community and results mainly from the presence of a tree. The benefit received has real or intrinsic value associated with it.

tree clean (tree inventory primary maintenance need data field): Based on *ANSI A300 Standards*, these trees require selective removal of dead, dying, broken, and/or diseased wood to minimize potential risk.

tree inventory: Comprehensive database containing information or records about individual trees typically collected by an arborist.

tree ordinance: Tree ordinances are policy tools used by communities striving to attain a healthy, vigorous, and well-managed urban forest. Tree ordinances simply provide the authorization and standards for management activities. The City of Somerville's Tree Preservation Ordinance can be found on the City of Somerville website (https://www.somervillema.gov/sites/default/files/tree-preservation-ordinance.pdf).

tree size (tree inventory data field): The size of each tree was measured as the diameter at breast height (see **diameter at breast height (DBH)**).

urban forest: All of the trees within a municipality or a community. This can include the trees along streets or rights-of-way, in parks and greenspaces, in forests, and on private property.

urban tree canopy (UTC) assessment: A study performed of land cover classes to gain an understanding of the tree canopy coverage, particularly as it relates to the amount of tree canopy that currently exists and the amount of tree canopy that could exist. UTC assessments are typically performed using aerial photographs, GIS data, or Lidar.

visible root flare (tree inventory data field): The presence or absence of a visible root flare was noted for each tree.

volatile organic compounds (VOCs): Hydrocarbon compounds that exist in the ambient air and are by-products of energy used to heat and cool buildings. Volatile organic compounds contribute to the formation of smog and/or are toxic. Examples of VOCs are gasoline, alcohol, and solvents used in paints.

young tree train (tree inventory primary maintenance need data field): Data field based on *ANSI A300* standards, this maintenance activity is characterized by pruning of young trees to correct or eliminate weak, interfering, or objectionable branches to improve structure. These trees can be up to 20 feet tall and can be worked with a pole pruner by a person standing on the ground.Glossary

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URBAN TREE CANOPY ASSESSMENT METHODOLOGY

Davey Resource Group Classification Methodology for Urban Tree Canopy

Davey Resource Group utilized an object-based image analysis (OBIA) semi-automated feature extraction method to process and analyze current high-resolution color infrared (CIR) aerial imagery and remotely-sensed data to identify tree canopy cover and land cover classifications. The use of imagery analysis is cost-effective and provides a highly accurate approach to assessing your community's existing tree canopy coverage. This supports responsible tree management, facilitates community forestry goal-setting, and improves urban resource planning for healthier and more sustainable urban environments.

Advanced image analysis methods were used to classify, or separate, the land cover layers from the overall imagery. The semi-automated extraction process was completed using Feature Analyst, an extension of ArcGIS®. Feature Analyst uses an object-oriented approach to cluster together objects with similar spectral (i.e., color) and spatial/contextual (e.g., texture, size, shape, pattern, and spatial association) characteristics. The land cover results of the extraction process was post-processed and clipped to each project boundary prior to the manual editing process in order to create smaller, manageable, and more efficient file sizes. Secondary source data, high-resolution aerial imagery provided by each Urban Tree Canopy (UTC) city, and custom ArcGIS® tools were used to aid in the final manual editing, quality checking, and quality assurance processes (QA/QC). The manual QA/QC process was implemented to identify, define, and correct any misclassifications or omission errors in the final land cover layer.

CLASSIFICATION WORKFLOW

1. Prepare imagery for feature extraction (resampling, rectification, etc.), if needed.

2. Gather training set data for all desired land cover classes (canopy, impervious, grass, bare soil, shadows). Water samples are not always needed since hydrologic data are available for most areas. Training data for impervious features were not collected because the City maintained a completed impervious layer.

3. Extract canopy layer only; this decreases the amount of shadow removal from large tree canopy shadows. Fill small holes and smooth to remove rigid edges.

4. Edit and finalize canopy layer at 1:2000 scale. A point file is created to digitize-in small individual trees that will be missed during the extraction. These points are buffered to represent the tree canopy. This process is done to speed up editing time and improve accuracy by including smaller individual trees.

5. Extract remaining land cover classes using the canopy layer as a mask; this keeps canopy shadows that occur within groups of canopy while decreasing the amount of shadow along edges.

6. Edit the impervious layer to reflect actual impervious features, such as roads, buildings, parking lots, etc. to update features.

7. Using canopy and actual impervious surfaces as a mask; input the bare soils training data and extract them from the imagery. Quickly edit the layer to remove or add any features. Davey Resource Group tries to delete dry vegetation areas that are associated with lawns, grass/meadows, and agricultural fields.

8. Assemble any hydrological datasets, if provided. Add or remove any water features to create the hydrology class. Perform a feature extraction if no water feature datasets exist.

9. Use geoprocessing tools to clean, repair, and clip all edited land cover layers to remove any self-intersections or topology errors that sometimes occur during editing.

10. Input canopy, impervious, bare soil, and hydrology layers into Davey Resource Group's Five-Class Land Cover Model to complete the classification. This model generates the pervious (grass/low-lying vegetation) class by taking all other areas not previously classified and combining them.

11. Thoroughly inspect final land cover dataset for any classification errors and correct as needed.

12. Perform accuracy assessment. Repeat Step 11, if needed.

AUTOMATED FEATURE EXTRACTION FILES

The automated feature extraction (AFE) files allow other users to run the extraction process by replicating the methodology. Since Feature Analyst does not contain all geoprocessing operations that Davey Resource Group utilizes, the AFE only accounts for part of the extraction process. Using Feature Analyst, Davey Resource Group created the training set data, ran the extraction, and then smoothed the features to alleviate the blocky appearance. To complete the actual extraction process, Davey Resource Group uses additional geoprocessing tools within ArcGIS®. From the AFE file results, the following steps are taken to prepare the extracted data for manual editing.

1. Davey Resource Group fills all holes in the canopy that are less than 30 square meters. This eliminates small gaps that were created during the extraction process while still allowing for natural canopy gaps.

2. Davey Resource Group deletes all features that are less than 9 square meters for canopy (50 square meters for impervious surfaces). This process reduces the amount of small features that could result in incorrect classifications and also helps computer performance.

3. The Repair Geometry, Dissolve, and Multipart to Singlepart (in that order) geoprocessing tools are run to complete the extraction process.

4. The Multipart to Singlepart shapefile is given to GIS personnel for manual editing to add, remove, or reshape features.

Urban Tree Canopy Accuracy Assessment Protocol

Determining the accuracy of spatial data is of high importance to Davey Resource Group and our clients. To achieve to best possible result, Davey Resource Group manually edits and conducts thorough QA/QC checks on all urban tree canopy and land cover layers. A QA/QC process will be completed using ArcGIS® to identify, clean, and correct any misclassification or topology errors in the final land cover dataset. The initial land cover layer extractions will be edited at a 1:2000 quality control scale in the urban areas and at a 1:2500 scale for rural areas utilizing the most current high-resolution aerial imagery to aid in the quality control process.

To test for accuracy, random plot locations are generated throughout the city area of interest and verified to ensure that the data meet the client standards. Each point will be compared with the most current NAIP high-resolution imagery (reference image) to determine the accuracy of the final land cover layer. Points will be classified as either correct or incorrect and recorded in a classification matrix. Accuracy will be assessed using four metrics: overall accuracy, kappa, quantity disagreement, and allocation disagreement. These metrics are calculated using a custom Excel® spreadsheet.

Table 1. Land Cover Classification Code Values

Land Cover Classification	Code Value
Tree Canopy	1
Impervious	2
Pervious (Grass/Vegetation)	3
Bare Soil	4
Open Water	5

LAND COVER ACCURACY

The following describes Davey Resource Group's accuracy assessment techniques and outlines procedural steps used to conduct the assessment.

1. *Random Point Generation*—Using ArcGIS, 1000 random assessment points are generated.

2. *Point Determination*—Each point is carefully assessed by the GIS analyst for likeness with the aerial photography. To record findings, two new fields, CODE and TRUTH, are added to the accuracy assessment point shapefile. CODE is a numeric value (1–5) assigned to each land cover class (Table 1) and TRUTH is the actual land cover class as identified according to the reference image. If CODE and TRUTH are the same, then the point is counted as a correct classification. Likewise, if the CODE and TRUTH are not the same, then the point is classified as incorrect. In most cases, distinguishing if a point is correct or incorrect is straightforward. Points will rarely be misclassified by an egregious classification or editing error. Often incorrect points occur where one feature stops and the other begins.

3. *Classification Matrix*—During the accuracy assessment, if a point is considered incorrect, it is given the correct classification in the TRUTH column. Points are first assessed on the NAIP imagery for their correctness using a "blind" assessment—meaning that the analyst does not know the actual classification (the GIS analyst is strictly going off the NAIP imagery to determine cover class). Any incorrect classifications found during the "blind" assessment are scrutinized further using sub-meter imagery provided by the client to determine if the point was incorrectly classified due to the fuzziness of the NAIP

Table 2. Classification Matrix

Reference Data

Classes	Tree Canopy	Impervious Surfaces	Grass & Low-Lying Vegetation	Bare Soils	Open Water	Row Total	Producer's Accuracy	Errors of Omission
Tree Canopy	153	10	2	0	0	165	92.73%	7.27%
Impervious	7	752	5	3	0	767	98.04%	1.96%
Grass/Vegetation	0	8	37	0	0	45	82.22%	17.78%
Bare Soils	0	0	0	6	0	6	100.00%	0.00%
Water	0	0	0	0	17	17	100.00%	0.00%
Column Total	160	770	44	9	17	1000		
User's Accuracy	95.63%	97.66%	84.09%	66.67%	100.00%		Overall Accuracy	96.50%
Errors of Commission	4.38%	2.34%	15.91%	33.33%	0.00%		Kappa Coefficent	0.9081

imagery or an actual misclassification. After all random points are assessed and recorded; a classification (or confusion) matrix is created. The classification matrix for this project is presented in **Table 2**. The table allows for assessment of user's/producer's accuracy, overall accuracy, omission/commission errors, kappa statistics, allocation/quantity disagreement, and confidence intervals (**Table 3**).

4. Following are descriptions of each statistic as well as the results from some of the accuracy assessment tests.

   Overall Accuracy – Percentage of correctly classified pixels; for example, the sum of the diagonals divided by the total points ((153+752+37+6+17)/1000 = 96.50%).

   User's Accuracy – Probability that a pixel classified on the map actually represents that category on the ground (correct land cover classifications divided by the column total [153/160 = 95.63%]).

   Producer's Accuracy – Probability of a reference pixel being correctly classified (correct land cover classifications divided by the row total [153/165 = 92.73%]).

   Kappa Coefficient – A statistical metric used to assess the accuracy of classification data. It has been generally accepted as a better determinant of accuracy partly because it accounts for random chance agreement. A value of 0.80 or greater is regarded as "very good" agreement between the land cover classification and reference image.

   Errors of Commission – A pixel reports the presence of a feature (such as trees) that, in reality, is absent (no trees are actually present). This is termed as a false positive. In the matrix below, we can determine that 4.38% of the area classified as canopy is most likely not canopy.

   Errors of Omission – A pixel reports the absence of a feature (such as trees) when, in reality, they are actually there. In the matrix below, we can conclude that 7.27% of all canopy classified is actually classified as another land cover class.

Allocation Disagreement – The amount of difference between the reference image and the classified land cover map that is due to less than optimal match in the spatial allocation (or position) of the classes.

Quantity Disagreement – The amount of difference between the reference image and the classified land cover map that is due to less than perfect match in the proportions (or area) of the classes.

Confidence Intervals – A confidence interval is a type of interval estimate of a population parameter and is used to indicate the reliability of an estimate. Confidence intervals consist of a range of values (interval) that act as good estimates of the unknown population parameter based on the observed probability of successes and failures. Since all assessments have innate error, defining a lower and upper bound estimate is essential.

Table 3. Accuracy of Results

Confidence Intervals

Class	Acreage	Percentage	Lower Bound	Upper Bound
Tree Canopy	394.6	14.6%	13.9%	15.3%
Impervious Surfaces	2,098.5	77.6%	76.8%	78.4%
Grass & Low-Lying Vegetation	139.9	5.2%	4.7%	5.6%
Bare Soils	12.2	0.5%	0.3%	0.6%
Open Water	58.0	2.1%	1.9%	2.4%
Total	2703.2	100.00%		

Accuracy Assessment

Class	User's Accuracy	Lower Bound	Upper Bound	Producer's Accuracy	Lower Bound	Upper Bound
Tree Canopy	95.6%	94.0%	97.2%	92.7%	90.7%	94.7%
Impervious Surfaces	97.7%	97.1%	98.2%	98.0%	97.5%	98.5%
Grass & Low-Lying Vegetation	84.1%	78.6%	89.6%	82.2%	76.5%	87.9%
Bare Soils	66.7%	51.0%	82.4%	100.0%	100.0%	100.0%
Open Water	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Statistical Metrics Summary

Overall Accuracy =	96.5%
Kappa Coefficient =	0.9081
Allocation Disagreement =	5%
Quantity Disagreement =	1%

Urban Tree Canopy Ecosystem Benefits Calculations

AIR QUALITY

The i-Tree Canopy v6.1 Model was used to quantify the value of ecosystem services for air quality. i-Tree Canopy was designed to give users the ability to estimate tree canopy and other land cover types within any selected geography. The model uses the estimated canopy percentage and reports air pollutant removal rates and monetary values for carbon monoxide (CO), nitrogen dioxide (NO_2), ozone (O_3), sulfur dioxide (SO_2), and particulate matter (PM) (Hirabayashi 2014).

Within the i-Tree Canopy application, the U.S. EPA's BenMAP Model estimates the incidence of adverse health effects and monetary values resulting from changes in air pollutants (Hirabayashi 2014; US EPA 2012). Different pollutant removal values were used for urban and rural areas. In i-Tree Canopy, the air pollutant amount removed annually by trees and the associated monetary value can be calculated with tree cover in areas of interest using BenMAP multipliers for each county in the United States.

To calculate ecosystem services for the study area, canopy percentage metrics from UTC land cover data performed during the assessment were transferred to i-Tree Canopy. Those canopy percentages were matched by placing random points within the i-Tree Canopy application. Benefit values were reported for each of the five listed air pollutants.

CARBON STORAGE AND SEQUESTRATION

The i-Tree Canopy v6.1 Model was used to quantify the value of ecosystem services for carbon storage and sequestration. i-Tree Canopy was designed to give users the ability to estimate tree canopy and other land cover types within any selected geography. The model uses the estimated canopy percentage and reports carbon storage and sequestration rates and monetary values. Methods on deriving storage and sequestration can be found in Nowak et al. 2013.

To calculate ecosystem services for the study area, canopy percentage metrics from UTC land cover data performed during the assessment were transferred to i-Tree Canopy. Those canopy percentages were matched by placing random points within the i-Tree Canopy application. Benefit values were reported for carbon storage and sequestration.

STORMWATER

The i-Tree Hydro v6.0 Model was used to quantify the value of ecosystem services for stormwater runoff. i-Tree Hydro was designed for users interested in analysis of vegetation and impervious cover effects on urban hydrology. This most recent version (v6.0) allows users to report hydrologic data on the city level rather than just a watershed scale giving users more flexibility. For more information about the model, please consult the i-Tree Hydro v6.0 manual (http://www.itreetools.org).

To calculate ecosystem services for the study area (City of Somerville), land cover percentages derived for the project area were used as inputs into the model. Precipitation data from 2005-2012 was modeled within the i-Tree Hydro to best represent the average conditions over an eight year time period. Model simulations were run under a Base Case as well as an Alternate Case. The Alterative Case set tree canopy equal to 0% and assumed that impervious and vegetation cover would increase based on the removal of tree canopy. Impervious surface was increased 0.7% based on a percentage of the amount of impervious surface under tree canopy and the rest was added to the vegetation cover class. This process was completed to assess the runoff reduction volume associated with tree canopy since i-Tree Hydro does not directly report the volume of runoff reduced by tree canopy. The volume (in cubic meters) was converted to gallons to retrieve the overall volume of runoff avoided by having the current tree canopy.

Through model simulation, it was determined that tree canopy decreases the runoff volume in the project area by 4,361,443 gallons per year using precipitation data from 2005-2012. This equates to approximately 11,052 gallons per acre of tree canopy (4,361,443 gals/11,052 acres).

To place a monetary value on storm water reduction, the cost to treat a gallon of storm/waste water was taken from McPherson et al. 1999. This value was $0.04 per gallon. Tree canopy was estimated to contribute roughly $174,458 to avoided runoff annually to the project area.

Zoning Classifications

To assess tree canopy coverage in different zoning types, the eighteen zoning types in the 2019 Somerville Zoning Ordinance (https://www.somervillezoning.com/) were condensed into six broader categories as shown in **Table 4.**

Table 4. Zoning Classifications

Zoning Classification from Zoning Code	Zoning Classification for Urban Forest Management Plan
Assembly Square	Other Special Districts
Civic	Civic Special Districts
Commercial Business	Commercial Districts
Commercial Core 3	Commercial Districts
Commercial Core 4	Commercial Districts
Commercial Core 5	Commercial Districts
Commercial Industry	Commercial Districts
Fabrication	Commercial Districts
High Rise	Mid & High-Rise Districts
Mid Rise 3	Mid & High-Rise Districts
Mid Rise 4	Mid & High-Rise Districts
Mid Rise 5	Mid & High-Rise Districts
Mid Rise 6	Mid & High-Rise Districts
Neighborhood Residential	Residential Districts
not applicable	Rights-Of-Way (ROW)
Powderhouse School	Other Special Districts
Tufts University	Other Special Districts
Urban Residential	Residential Districts

Prioritized Planting Locations based on Tree Canopy Data

The following methodology was used to identify and prioritize planting locations throughout the City of Somerville as part of the Tree Planting Plan (*Section 3.1*).

PRIORITIZED PLANTING – PLANTING LOCATION

A geographic information system (GIS) based planting prioritization scheme was created as part of the urban tree canopy analysis. The planting location polygons (representations) were created by taking all grass/open space and bare ground areas and combining them into one dataset. Non-feasible planting areas such as agricultural fields, recreational fields, and major utility corridors were removed from consideration. The remaining planting space was then converted to multipart features creating separate, distinct polygons for each location. Using zonal statistics, the priority grid raster was used to calculate an average value for each planting location polygon. The averages were binned into five (5) classes (Very Low, Low, Moderate, High, and Very High) with the higher numbers indicating higher priority for planting.

HOW SITES WERE PRIORITIZED

To identify and prioritize planting potential, the analysis assessed a number of environmental and demographic data, including proximity to hardscape, canopy fragmentation, floodplain proximity, soil permeability, slope, soil erosion factor (K-factor), urban heat island index, and proximity to bus routes and bike lanes (**Table 5**). In addition, planting potential was prioritized in Environmental Justice areas (which include parameters of income, minority populations and English language isolation) and where there are vulnerable populations (elderly housing, schools, child care and medical centers) (**Table 5**). Each factor was assessed using data from various sources and analyzed using separate grid maps. Values between zero and four (with zero having the lowest priority) were assigned to each grid assessed. The grids were overlaid and the values were averaged to determine the priority levels at an area on the map. A priority level ranging from Very Low to Very High was assigned to each area on the map based on the calculated average of all grid maps. Once the process of identifying priority was completed, the development of planting strategies followed. All potential planting sites were not treated equally as some sites were considered to be more suitable than others. Through prioritization, sites were ranked based on a number of factors pertaining to storm water

Table 5: Priority Ranking Variables

Dataset	Source	Weight
Urban Heat Island Index	Urban Tree Canopy Assessment	0.20
Proximity to Hardscape	Urban Tree Canopy Assessment	0.15
Floodplain Proximity	National Hydrologic Dataset	0.10
Soil Permeability	Natural Resource Conservation Service	0.10
Slope	National Elevation Dataset	0.10
Soil Erosion (K-factor)	Natural Resource Conservation Service	0.05
Canopy Fragmentation	Urban Tree Canopy Assessment	0.15
Equity	Massachusetts GIS Dataset	0.05
Vulnerable Population	Somerville GIS Dataset	0.05
Bus Routes and Bike Lanes	Somerville GIS Dataset	0.05

reduction and a relative urban heat island index. While available planting sites may ultimately be planted over the next several decades, the trees that are planted in the next several years should be planned for areas in most need, and where they will provide the most benefits and return on investment.

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I-TREE STREETS INPUTS AND REPORTS

i-Tree Streets Inputs

The i-Tree Streets model (https://www.itreetools.org/tools/i-tree-streets) uses specific inputs to calculate the ecosystem service benefits of trees. If no community-specific information is available, then the model uses a set of standard values based on the region the city is located. The following default regional economic inputs were used to run Somerville's i-Tree Streets model:

Benefit Prices	
Electricity ($/Kwh)	0.1401
Natural Gas ($/Therm)	1.408
CO2 ($/lb)	0.0033
PM10 ($/lb)	8.31
NO2 ($/lb)	4.59
SO2 ($/lb)	3.48
VOC ($/lb)	2.31
Stormwater Interception ($/gallon)	0.008
Average Home Resales Value ($)	291,000.00

i-Tree Streets Reports

The following i-Tree Streets reports were generated as part of Somerville's inventory analysis.

Somerville

Annual Benefits of Public Trees by Species ($/tree)

7/29/2020

Species	Energy	CO_2	Air Quality	Stormwater	Aesthetic/Other	Total ($)	Standard Error
maple, Norway	53.40	1.49	9.46	10.09	48.49	122.94	(N/A)
pear, callery	36.47	1.21	7.39	8.77	88.80	142.64	(N/A)
maple, red	31.41	0.61	5.09	7.23	46.37	90.70	(N/A)
honeylocust	72.06	1.42	12.49	14.25	65.78	166.01	(N/A)
linden, littleleaf	49.69	0.94	8.27	9.76	30.54	99.19	(N/A)
ash, green	62.87	1.21	11.01	12.58	48.10	135.77	(N/A)
zelkova, Japanese	56.03	1.10	9.01	9.92	77.02	153.08	(N/A)
planetree, London	53.25	1.05	8.48	10.48	44.35	117.62	(N/A)
plum	18.38	0.42	2.86	2.52	11.07	35.25	(N/A)
Japanese tree lilac	10.19	0.20	1.53	1.26	9.25	22.41	(N/A)
cherry, kwanzan	15.64	0.33	2.41	2.06	10.46	30.91	(N/A)
oak, northern red	66.14	1.65	11.66	16.29	46.90	142.64	(N/A)
elm, hybrid	14.96	0.35	2.34	3.20	57.90	78.74	(N/A)
sweetgum	27.27	0.49	3.22	4.81	34.80	70.58	(N/A)
ash, white	48.91	0.93	8.47	9.97	44.71	112.99	(N/A)
oak, pin	34.95	1.01	6.17	8.92	50.42	101.47	(N/A)
Vacant (Do Not Plant)	2.22	0.03	0.38	0.19	4.29	7.11	(N/A)
maple, hedge	19.94	0.46	3.24	3.18	19.81	46.63	(N/A)
elm, american	42.95	1.23	8.46	11.89	74.31	138.84	(N/A)
goldenrain tree	9.59	0.18	1.43	1.18	9.12	21.50	(N/A)
Japanese pagodatree	40.31	0.77	6.65	9.12	46.04	102.89	(N/A)
ginkgo	6.96	0.13	1.07	0.99	10.84	19.99	(N/A)
maple, silver	82.49	1.85	15.86	24.96	44.34	169.50	(N/A)
elm, Siberian	25.83	0.70	4.79	6.77	65.40	103.50	(N/A)
hornbeam, European	14.55	0.29	2.14	3.42	47.09	67.49	(N/A)
maple, freeman	45.69	0.95	7.75	10.36	41.60	106.34	(N/A)
maple, amur	28.22	0.62	4.56	4.30	25.22	62.91	(N/A)
apple	17.90	0.31	2.87	2.73	13.71	37.53	(N/A)
serviceberry	17.35	0.36	2.65	2.24	10.74	33.33	(N/A)
elm, Chinese	15.75	0.38	2.50	3.49	59.73	81.85	(N/A)
cherry, higan	4.13	0.07	0.58	0.48	8.02	13.28	(N/A)
basswood, American	48.92	1.12	8.53	12.32	59.50	130.38	(N/A)
linden, silver	4.93	0.13	0.80	1.18	28.73	35.78	(N/A)
oak, swamp white	14.87	0.34	2.17	2.98	39.43	59.78	(N/A)
sycamore, American	81.81	1.80	13.73	18.94	57.66	173.95	(N/A)
tree-of-heaven	81.75	1.62	15.64	21.87	85.88	206.76	(N/A)
maple, sugar	62.03	1.46	10.46	15.97	54.67	144.60	(N/A)
oak, scarlet	61.77	2.04	11.84	17.84	65.67	159.15	(N/A)
maackia, amur	1.34	0.04	0.18	0.23	47.34	49.12	(N/A)
hornbeam, American	27.03	0.51	4.11	6.09	46.80	84.53	(N/A)
chokecherry, common	3.46	0.05	0.47	0.40	7.89	12.27	(N/A)
cherry, yoshino flower	3.46	0.05	0.47	0.40	7.89	12.27	(N/A)
serviceberry, downy	12.57	0.25	1.90	1.57	9.74	26.03	(N/A)
serviceberry, Alleghen	2.42	0.04	0.34	0.29	7.50	10.59	(N/A)
oak, shingle	49.05	1.39	8.43	11.31	59.29	129.47	(N/A)
parrotia, persian	3.46	0.05	0.47	0.40	7.89	12.27	(N/A)
maple, sycamore	27.11	0.70	4.57	4.72	26.56	63.65	(N/A)
serviceberry, eastern	19.19	0.40	2.93	2.47	11.11	36.09	(N/A)
cedar, northern white	11.04	0.31	2.47	2.05	13.48	29.34	(N/A)
maple: Shangtung	2.22	0.03	0.38	0.19	4.29	7.11	(N/A)
maple, Japanese	16.03	0.34	2.54	2.41	16.53	37.86	(N/A)
katsura tree	21.93	0.41	3.79	5.15	46.35	77.64	(N/A)
hophornbeam, eastern	1.34	0.04	0.18	0.23	47.34	49.12	(N/A)

Annual Benefits of Public Trees by Species ($/tree)

7/29/2020

Species	Energy	CO_2	Air Quality	Stormwater	Aesthetic/Other	Total ($)	Standard Error
tupelo, black	1.34	0.04	0.18	0.23	47.34	49.12	(N/A)
coffeetree, Kentucky	27.24	0.49	3.73	3.45	55.45	90.35	(N/A)
plum, cherry	3.46	0.05	0.47	0.40	7.89	12.27	(N/A)
catalpa, northern	64.00	1.18	11.44	16.55	43.04	136.20	(N/A)
unknown tree	13.12	0.25	2.25	4.93	36.11	56.65	(N/A)
pine, eastern white	54.93	0.97	10.69	16.02	18.49	101.10	(N/A)
mulberry, white	28.01	0.54	4.45	6.21	46.63	85.84	(N/A)
baldcypress	19.15	0.27	1.98	1.24	48.86	71.50	(N/A)
elm, slippery	61.31	1.79	12.40	17.26	85.35	178.09	(N/A)
maple, trident	1.22	0.03	0.18	0.26	6.20	7.88	(N/A)
beech, American	111.66	2.34	23.86	38.00	94.02	269.88	(N/A)
oak, English	44.02	0.83	6.55	8.05	39.02	98.47	(N/A)
boxelder	32.20	0.69	5.16	4.83	27.72	70.61	(N/A)
maple, miyabei	3.46	0.05	0.47	0.40	7.89	12.27	(N/A)
hardy rubber tree	12.31	0.16	1.09	0.47	44.18	58.22	(N/A)
tulip tree	32.83	0.50	3.77	2.76	58.22	98.07	(N/A)
spruce, Norway	59.35	1.04	11.61	17.12	16.78	105.90	(N/A)
cherry, black	34.39	0.98	5.52	5.31	15.21	61.41	(N/A)
birch, paper	58.24	1.19	9.48	10.04	79.51	158.47	(N/A)
cherry, sargent	3.46	0.05	0.47	0.40	7.89	12.27	(N/A)
spruce, Colorado	22.51	0.41	3.95	6.76	24.77	58.41	(N/A)
hawthorn	18.17	0.39	2.77	2.38	10.93	34.64	(N/A)
hackberry, northern	12.31	0.16	1.09	0.47	44.18	58.22	(N/A)
snowbell, Japanese	1.34	0.04	0.18	0.23	47.34	49.12	(N/A)
rose-of-sharon	6.59	0.12	0.96	0.79	8.51	16.97	(N/A)
yew	8.74	0.19	1.46	2.88	42.25	55.52	(N/A)
magnolia, Chinese ; m	8.16	0.15	1.21	0.98	8.82	19.31	(N/A)
juniper spp.	6.07	0.16	1.27	0.95	12.48	20.93	(N/A)
viburnum: spp.	4.15	0.09	0.83	0.57	8.39	14.02	(N/A)
birch, river	12.31	0.16	1.09	0.47	44.18	58.22	(N/A)
spruce, white	35.77	0.69	6.72	10.07	24.40	77.65	(N/A)
elm, rock	85.94	2.06	15.34	19.07	94.25	216.67	(N/A)
oak, white	43.35	1.21	7.33	9.96	56.56	118.40	(N/A)
hawthorn: cockspur	6.07	0.16	1.27	0.95	12.48	20.93	(N/A)
ash: European	38.43	1.17	9.05	7.61	27.78	84.06	(N/A)
spruce	7.13	0.13	0.98	2.60	23.75	34.60	(N/A)
hemlock, eastern	6.07	0.16	1.27	0.95	12.48	20.93	(N/A)
pear, common	19.06	0.62	3.51	4.17	64.49	91.86	(N/A)
maple	16.71	0.36	2.67	2.54	16.96	39.24	(N/A)
dogwood, flowering	3.46	0.05	0.47	0.40	7.89	12.27	(N/A)
beech, European	71.88	1.77	12.34	14.50	86.09	186.57	(N/A)
horsechestnut	72.69	2.83	12.60	19.90	82.71	190.73	(N/A)
pine: Japanese red	38.43	1.17	9.05	7.61	27.78	84.06	(N/A)
larch, European	97.63	2.06	18.95	25.98	108.40	253.01	(N/A)
cedar, atlantic white	6.07	0.16	1.27	0.95	12.48	20.93	(N/A)
sourwood	6.07	0.16	1.27	0.95	12.48	20.93	(N/A)
oak, sawtooth	6.70	0.10	0.89	0.96	31.51	40.16	(N/A)
unknown shrub	6.07	0.16	1.27	0.95	12.48	20.93	(N/A)
cherry, cornelian	12.85	0.24	1.94	1.56	9.76	26.36	(N/A)
ash	15.33	0.24	2.29	2.96	35.97	56.78	(N/A)
fringetree, White	27.00	0.45	4.29	3.99	17.97	53.70	(N/A)
hawthorn, Washington	3.46	0.05	0.47	0.40	7.89	12.27	(N/A)
Paradise apple	2.42	0.04	0.34	0.29	7.50	10.59	(N/A)
dogwood	12.85	0.24	1.94	1.56	9.76	26.36	(N/A)

Annual Benefits of Public Trees by Species ($/tree)

7/29/2020

Species	Energy	CO_2	Air Quality	Stormwater	Aesthetic/Other	Total ($)	Standard Error
oak	14.24	0.32	2.03	2.81	39.48	58.88	(N/A)
magnolia: cucumbertre	108.34	3.78	32.46	25.48	7.60	177.67	(N/A)
peach	3.46	0.05	0.47	0.40	7.89	12.27	(N/A)
mountainash: spp.	15.54	0.43	3.50	3.14	21.12	43.74	(N/A)
corktree, amur	63.59	1.25	10.80	14.07	45.17	134.88	(N/A)
magnolia, sweetbay	3.46	0.05	0.47	0.40	7.89	12.27	(N/A)
mulberry: spp.	60.11	1.62	14.83	13.26	27.75	117.57	(N/A)
birch, European white	63.59	1.25	10.80	14.07	45.17	134.88	(N/A)
magnolia, star	25.52	0.55	3.92	3.37	12.46	45.83	(N/A)
redbud, eastern	3.46	0.05	0.47	0.40	7.89	12.27	(N/A)
Citywide Total	43.43	1.00	7.54	8.91	50.40	111.29	(N/A)

Somerville

5/23/2019

Stored CO2 Benefits of All Trees by Species

Species	Total stored CO2 (lbs)	Total ($)	Standard Error	% of Total Tree Numbers	% of Total $	Avg. $/tree
maple, Norway	5,248,484.07	17,320.00	(N/A)	14.13	26.75	13.02
pear, callery	1,945,443.88	6,419.96	(N/A)	13.70	9.92	4.98
maple, red	1,124,177.06	3,709.78	(N/A)	11.35	5.73	3.47
honeylocust	2,525,343.15	8,333.63	(N/A)	9.64	12.87	9.19
linden, littleleaf	1,980,023.71	6,534.08	(N/A)	7.03	10.09	9.87
ash, green	1,128,673.21	3,724.62	(N/A)	6.95	5.75	5.70
zelkova, Japanese	667,851.04	2,203.91	(N/A)	5.11	3.40	4.58
planetree, London	660,535.55	2,179.77	(N/A)	4.46	3.37	5.19
plum	361,627.12	1,193.37	(N/A)	3.45	1.84	3.67
Japanese tree lilac	47,736.00	157.53	(N/A)	2.51	0.24	0.67
cherry, kwanzan	137,174.39	452.68	(N/A)	2.16	0.70	2.23
oak, northern red	870,975.13	2,874.22	(N/A)	1.48	4.44	20.68
elm, hybrid	38,486.35	127.00	(N/A)	1.46	0.20	0.93
sweetgum	67,960.01	224.27	(N/A)	1.34	0.35	1.78
ash, white	185,155.77	611.01	(N/A)	1.30	0.94	5.01
oak, pin	322,169.00	1,063.16	(N/A)	1.10	1.64	10.22
maple, hedge	66,986.51	221.06	(N/A)	0.85	0.34	2.76
elm, american	325,120.86	1,072.90	(N/A)	0.80	1.66	14.31
goldenrain tree	10,884.73	35.92	(N/A)	0.68	0.06	0.56
Japanese pagodatree	74,432.48	245.63	(N/A)	0.55	0.38	4.72
ginkgo	5,961.40	19.67	(N/A)	0.52	0.03	0.40
maple, silver	613,624.40	2,024.96	(N/A)	0.49	3.13	44.02
elm, Siberian	87,263.43	287.97	(N/A)	0.49	0.44	6.26
hornbeam, European	11,282.16	37.23	(N/A)	0.45	0.06	0.89
maple, freeman	106,706.79	352.13	(N/A)	0.44	0.54	8.59
maple, amur	32,806.99	108.26	(N/A)	0.34	0.17	3.38
apple	21,210.94	70.00	(N/A)	0.33	0.11	2.26
serviceberry	16,801.47	55.44	(N/A)	0.31	0.09	1.91
elm, Chinese	7,773.81	25.65	(N/A)	0.30	0.04	0.92
cherry, higan	605.41	2.00	(N/A)	0.30	0.00	0.07
basswood, American	103,239.73	340.69	(N/A)	0.28	0.53	13.10
linden, silver	6,587.41	21.74	(N/A)	0.27	0.03	0.87
oak, swamp white	5,728.28	18.90	(N/A)	0.24	0.03	0.82
sycamore, American	105,470.45	348.05	(N/A)	0.24	0.54	15.13
tree-of-heaven	118,269.07	390.29	(N/A)	0.24	0.60	16.97
maple, sugar	129,920.76	428.74	(N/A)	0.22	0.66	20.42
oak, scarlet	138,435.39	456.84	(N/A)	0.18	0.71	26.87
maackia, amur	184.40	0.61	(N/A)	0.13	0.00	0.05
hornbeam, American	6,614.65	21.83	(N/A)	0.12	0.03	1.98

chokecherry, common	108.34	0.36	(N/A)	0.12	0.00	0.03
cherry, yoshino flowering	98.49	0.33	(N/A)	0.11	0.00	0.03
serviceberry, downy	3,046.53	10.05	(N/A)	0.11	0.02	1.01
serviceberry, Allegheny	137.84	0.45	(N/A)	0.11	0.00	0.05
oak, shingle	27,723.08	91.49	(N/A)	0.11	0.14	9.15
parrotia, persian	88.64	0.29	(N/A)	0.10	0.00	0.03
maple, sycamore	13,980.69	46.14	(N/A)	0.10	0.07	5.13
serviceberry, eastern	4,985.97	16.45	(N/A)	0.08	0.03	2.06
cedar, northern white	2,970.36	9.80	(N/A)	0.08	0.02	1.23
maple: Shangtung	21.18	0.07	(N/A)	0.07	0.00	0.01
maple, Japanese	3,570.93	11.78	(N/A)	0.07	0.02	1.68
katsura tree	7,491.19	24.72	(N/A)	0.07	0.04	3.53
hophornbeam, eastern	107.57	0.35	(N/A)	0.07	0.00	0.05
tupelo, black	92.20	0.30	(N/A)	0.06	0.00	0.05
coffeetree, Kentucky	2,243.12	7.40	(N/A)	0.06	0.01	1.23
plum, cherry	59.09	0.20	(N/A)	0.06	0.00	0.03
catalpa, northern	25,896.83	85.46	(N/A)	0.06	0.13	14.24
unknown tree	1,785.29	5.89	(N/A)	0.06	0.01	0.98
pine, eastern white	13,417.37	44.28	(N/A)	0.06	0.07	7.38
mulberry, white	4,775.34	15.76	(N/A)	0.06	0.02	2.63
baldcypress	182.62	0.60	(N/A)	0.06	0.00	0.10
elm, slippery	38,272.48	126.30	(N/A)	0.06	0.20	21.05
maple, trident	84.19	0.28	(N/A)	0.05	0.00	0.06
beech, American	56,112.32	185.17	(N/A)	0.05	0.29	37.03
oak, English	5,123.13	16.91	(N/A)	0.05	0.03	3.38
boxelder	5,503.26	18.16	(N/A)	0.05	0.03	3.63
maple, miyabei	49.24	0.16	(N/A)	0.05	0.00	0.03
hardy rubber tree	15.15	0.05	(N/A)	0.04	0.00	0.01
tulip tree	334.94	1.11	(N/A)	0.04	0.00	0.28
spruce, Norway	9,644.46	31.83	(N/A)	0.04	0.05	7.96
cherry, black	16,071.04	53.03	(N/A)	0.04	0.08	13.26
birch, paper	4,842.15	15.98	(N/A)	0.04	0.02	3.99
cherry, sargent	39.40	0.13	(N/A)	0.04	0.00	0.03
spruce, Colorado	1,078.89	3.56	(N/A)	0.03	0.01	1.19
hawthorn	2,153.50	7.11	(N/A)	0.03	0.01	2.37
hackberry, northern	11.36	0.04	(N/A)	0.03	0.00	0.01
snowbell, Japanese	46.10	0.15	(N/A)	0.03	0.00	0.05
rose-of-sharon	194.36	0.64	(N/A)	0.03	0.00	0.21
yew	363.12	1.20	(N/A)	0.03	0.00	0.40
magnolia, Chinese ; magnoli	184.51	0.61	(N/A)	0.02	0.00	0.30
juniper spp.	143.37	0.47	(N/A)	0.02	0.00	0.24
viburnum: spp.	74.71	0.25	(N/A)	0.02	0.00	0.12
birch, river	7.57	0.02	(N/A)	0.02	0.00	0.01
spruce, white	1,768.57	5.84	(N/A)	0.02	0.01	2.92
elm, rock	8,992.92	29.68	(N/A)	0.02	0.05	14.84
oak, white	4,520.48	14.92	(N/A)	0.02	0.02	7.46
hawthorn: cockspur	143.37	0.47	(N/A)	0.02	0.00	0.24

ash: European	3,724.82	12.29	(N/A)	0.02	0.02	6.15
spruce	106.98	0.35	(N/A)	0.02	0.00	0.18
hemlock, eastern	143.37	0.47	(N/A)	0.02	0.00	0.24
pear, common	1,085.70	3.58	(N/A)	0.02	0.01	1.79
maple	1,117.49	3.69	(N/A)	0.02	0.01	1.84
dogwood, flowering	9.85	0.03	(N/A)	0.01	0.00	0.03
beech, European	2,729.87	9.01	(N/A)	0.01	0.01	9.01
horsechestnut	0.00	0.00	(N/A)	0.01	0.00	0.00
pine: Japanese red	1,862.41	6.15	(N/A)	0.01	0.01	6.15
larch, European	5,203.13	17.17	(N/A)	0.01	0.03	17.17
cedar, atlantic white	71.69	0.24	(N/A)	0.01	0.00	0.24
sourwood	71.69	0.24	(N/A)	0.01	0.00	0.24
oak, sawtooth	10.83	0.04	(N/A)	0.01	0.00	0.04
unknown shrub	71.69	0.24	(N/A)	0.01	0.00	0.24
cherry, cornelian	174.67	0.58	(N/A)	0.01	0.00	0.58
ash	89.37	0.29	(N/A)	0.01	0.00	0.29
fringetree, White	907.91	3.00	(N/A)	0.01	0.00	3.00
hawthorn, Washington	9.85	0.03	(N/A)	0.01	0.00	0.03
Paradise apple	13.78	0.05	(N/A)	0.01	0.00	0.05
dogwood	174.67	0.58	(N/A)	0.01	0.00	0.58
oak	171.55	0.57	(N/A)	0.01	0.00	0.57
magnolia: cucumbertree	14,495.33	47.83	(N/A)	0.01	0.07	47.83
peach	9.85	0.03	(N/A)	0.01	0.00	0.03
mountainash: spp.	477.75	1.58	(N/A)	0.01	0.00	1.58
corktree, amur	2,398.14	7.91	(N/A)	0.01	0.01	7.91
magnolia, sweetbay	9.85	0.03	(N/A)	0.01	0.00	0.03
mulberry: spp.	4,499.23	14.85	(N/A)	0.01	0.02	14.85
birch, European white	2,398.14	7.91	(N/A)	0.01	0.01	7.91
magnolia, star	1,071.83	3.54	(N/A)	0.01	0.01	3.54
redbud, eastern	9.85	0.03	(N/A)	0.01	0.00	0.03
Citywide total	19,619,708.03	64,745.04	(N/A)	100.00	100.00	6.88

Stored CO2 Benefits of All Trees by Zone

Zone	Total stored CO2 (lbs)	Total ($)	Standard Error	% of Total Tree Numbers	% of Total $	Avg. $/tree
Somerville, MA	19,619,708.03	64,745.04	(N/A)	100.00	100.00	6.88
Citywide total	19,619,708.03	64,745.04	(N/A)	100.00	100.00	6.88

Somerville

Replacement Value of Public Trees

7/29/2020

Species	DBH Class (in) 0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	> 42	Total	Standard Error	% of Total
maple, Norway	538	7,780	562,687	1,580,961	969,318	628,216	181,925	52,425	20,675	4,004,524	(±0)	17.05
honeylocust	2,366	62,041	279,937	1,770,127	1,030,586	144,607	0	21,550	0	3,311,213	(±0)	14.10
linden, littleleaf	2,318	46,397	117,152	1,068,245	1,210,440	529,661	235,407	24,596	0	3,234,216	(±0)	13.77
maple, red	13,643	173,704	581,241	1,040,618	370,660	90,760	12,180	0	0	2,282,806	(±0)	9.72
ash, green	0	5,518	304,752	1,112,913	411,092	117,941	0	0	0	1,952,217	(±0)	8.31
pear, callery	5,394	110,823	498,887	762,933	158,060	6,493	0	0	0	1,542,589	(±0)	6.57
planetree, London	1,386	32,652	189,264	780,015	440,278	56,370	26,328	0	0	1,526,292	(±0)	6.50
zelkova, Japanese	6,595	67,539	152,865	570,242	574,089	14,330	0	0	0	1,385,661	(±0)	5.90
oak, northern red	1,804	15,549	27,749	117,796	344,999	348,431	168,021	30,690	34,310	1,089,348	(±0)	4.64
sweetgum	1,456	26,181	73,778	156,668	26,062	0	0	0	0	284,146	(±0)	1.21
maple, silver	328	908	11,116	13,148	11,954	43,826	86,984	56,877	27,715	252,856	(±0)	1.08
plum	15,428	36,997	77,460	67,142	24,240	3,787	0	0	0	225,055	(±0)	0.96
oak, pin	4,843	13,184	11,824	29,276	50,473	68,174	26,644	0	0	204,418	(±0)	0.87
ash, white	0	8,466	41,279	75,908	23,244	7,575	13,322	0	13,858	183,651	(±0)	0.78
elm, american	4,274	6,973	16,568	26,296	11,290	6,493	9,404	44,467	53,121	178,886	(±0)	0.76
cherry, kwanzan	7,816	34,335	51,180	50,991	0	0	0	0	0	144,321	(±0)	0.61
sycamore, American	0	370	3,296	30,696	67,456	9,628	13,994	18,503	0	143,942	(±0)	0.61
oak, scarlet	381	1,186	2,092	11,290	21,949	61,687	44,913	0	0	143,499	(±0)	0.61
Japanese pagodatree	897	1,625	22,052	82,789	26,062	0	0	0	0	133,424	(±0)	0.57
basswood, American	254	1,186	7,137	31,214	7,747	43,607	37,170	0	0	128,314	(±0)	0.55
maple, hedge	3,907	6,314	59,068	11,954	0	12,763	0	0	0	94,006	(±0)	0.40
Japanese tree lilac	17,783	33,837	34,605	0	0	0	0	0	0	86,225	(±0)	0.37
elm, hybrid	9,504	26,703	22,728	11,921	0	0	0	0	0	70,856	(±0)	0.30
maple, sugar	0	187	5,240	8,941	23,244	32,464	0	0	0	70,075	(±0)	0.30
maple, freeman	0	4,328	16,922	23,316	7,969	6,493	5,485	0	0	64,514	(±0)	0.27
beech, American	0	0	0	3,514	0	17,726	32,579	0	0	53,819	(±0)	0.23
tree-of-heaven	386	702	1,072	3,005	13,849	13,431	4,813	6,316	0	43,574	(±0)	0.19
maple, amur	298	2,163	30,026	7,969	0	0	0	0	0	40,456	(±0)	0.17
oak, shingle	0	0	5,661	34,534	0	0	0	0	0	40,195	(±0)	0.17
pine, eastern white	0	0	1,870	8,493	16,449	11,195	0	0	0	38,007	(±0)	0.16
spruce, Norway	0	0	0	11,290	7,747	18,081	0	0	0	37,118	(±0)	0.16
apple	1,697	2,365	18,589	10,543	0	0	0	0	0	33,194	(±0)	0.14
elm, Siberian	467	9,506	2,055	3,974	0	3,358	4,813	0	7,040	31,213	(±0)	0.13
ginkgo	3,427	7,792	11,162	6,311	0	0	0	0	0	28,692	(±0)	0.12
goldenrain tree	4,318	14,303	9,845	0	0	0	0	0	0	28,466	(±0)	0.12
serviceberry	745	3,837	21,289	0	0	0	0	0	0	25,871	(±0)	0.11
hornbeam, European	1,257	11,093	13,290	0	0	0	0	0	0	25,641	(±0)	0.11

Species	DBH Class (in) 0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	> 42	Total	Standard Error	% of Total
elm, slippery	0	1,263	0	4,313	8,310	0	0	10,793	0	24,679	(±0)	0.11
catalpa, northern	0	0	2,549	0	7,969	0	9,404	0	0	19,922	(±0)	0.08
elm, Chinese	0	12,167	2,811	4,313	0	0	0	0	0	19,290	(±0)	0.08
hornbeam, American	149	488	13,660	0	0	0	0	0	0	14,297	(±0)	0.06
oak, swamp white	469	7,919	5,661	0	0	0	0	0	0	14,049	(±0)	0.06
linden, silver	3,083	1,430	0	0	7,747	0	0	0	0	12,260	(±0)	0.05
katsura tree	505	0	0	821	9,628	0	0	0	0	10,954	(±0)	0.05
maple, sycamore	0	2,218	1,163	3,044	3,422	0	0	0	0	9,847	(±0)	0.04
oak, English	0	0	9,845	0	0	0	0	0	0	9,845	(±0)	0.04
oak, white	0	0	2,536	6,977	0	0	0	0	0	9,514	(±0)	0.04
elm, rock	0	0	0	3,044	5,866	0	0	0	0	8,910	(±0)	0.04
cherry, black	0	0	991	2,104	5,645	0	0	0	0	8,740	(±0)	0.04
serviceberry, eastern	0	1,849	6,522	0	0	0	0	0	0	8,371	(±0)	0.04
cedar, northern white	359	1,012	2,953	3,985	0	0	0	0	0	8,309	(±0)	0.04
magnolia: cucumbertree	0	0	0	0	0	0	8,163	0	0	8,163	(±0)	0.03
coffeetree, Kentucky	512	628	0	6,311	0	0	0	0	0	7,451	(±0)	0.03
cherry, higan	5,967	641	0	0	0	0	0	0	0	6,608	(±0)	0.03
Vacant (Do Not Plant)	6,600	0	0	0	0	0	0	0	0	6,600	(±0)	0.03
horsechestnut	0	0	0	0	0	6,493	0	0	0	6,493	(±0)	0.03
corktree, amur	0	0	0	6,311	0	0	0	0	0	6,311	(±0)	0.03
beech, European	0	0	0	6,311	0	0	0	0	0	6,311	(±0)	0.03
ash: European	0	0	0	6,088	0	0	0	0	0	6,088	(±0)	0.03
larch, European	0	0	0	0	5,866	0	0	0	0	5,866	(±0)	0.02
maple, Japanese	359	419	5,045	0	0	0	0	0	0	5,823	(±0)	0.02
birch, paper	232	0	1,204	4,207	0	0	0	0	0	5,643	(±0)	0.02
spruce, white	0	0	1,477	3,985	0	0	0	0	0	5,461	(±0)	0.02
serviceberry, downy	447	1,221	3,569	0	0	0	0	0	0	5,236	(±0)	0.02
spruce, Colorado	0	0	5,060	0	0	0	0	0	0	5,060	(±0)	0.02
pine: Japanese red	0	0	0	4,313	0	0	0	0	0	4,313	(±0)	0.02
boxelder	0	0	4,248	0	0	0	0	0	0	4,248	(±0)	0.02
mulberry: spp.	0	0	0	0	3,422	0	0	0	0	3,422	(±0)	0.01
mulberry, white	467	0	1,832	678	0	0	0	0	0	2,977	(±0)	0.01
yew	0	1,186	1,477	0	0	0	0	0	0	2,663	(±0)	0.01
chokecherry, common	2,553	0	0	0	0	0	0	0	0	2,553	(±0)	0.01
cherry, yoshino flowering	2,253	0	0	0	0	0	0	0	0	2,253	(±0)	0.01
parrotia, persian	2,089	0	0	0	0	0	0	0	0	2,089	(±0)	0.01
maackia, amur	2,037	0	0	0	0	0	0	0	0	2,037	(±0)	0.01
hawthorn	134	0	1,842	0	0	0	0	0	0	1,976	(±0)	0.01
fringetree, White	0	0	1,870	0	0	0	0	0	0	1,870	(±0)	0.01
serviceberry, Allegheny	1,697	0	0	0	0	0	0	0	0	1,697	(±0)	0.01
plum, cherry	1,642	0	0	0	0	0	0	0	0	1,642	(±0)	0.01
baldcypress	381	1,186	0	0	0	0	0	0	0	1,567	(±0)	0.01

Species	DBH Class (in) 0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	> 42	Total	Standard Error	% of Total
magnolia, star	0	0	1,477	0	0	0	0	0	0	1,477	(±0)	0.01
tulip tree	0	1,412	0	0	0	0	0	0	0	1,412	(±0)	0.01
maple: Shangtung	1,334	0	0	0	0	0	0	0	0	1,334	(±0)	0.01
pear, common	0	321	850	0	0	0	0	0	0	1,170	(±0)	0.00
maple, miyabei	1,161	0	0	0	0	0	0	0	0	1,161	(±0)	0.00
maple, trident	953	0	0	0	0	0	0	0	0	953	(±0)	0.00
hophornbeam, eastern	911	0	0	0	0	0	0	0	0	911	(±0)	0.00
juniper spp.	0	893	0	0	0	0	0	0	0	893	(±0)	0.00
tupelo, black	850	0	0	0	0	0	0	0	0	850	(±0)	0.00
spruce	0	837	0	0	0	0	0	0	0	837	(±0)	0.00
hardy rubber tree	783	0	0	0	0	0	0	0	0	783	(±0)	0.00
hemlock, eastern	0	739	0	0	0	0	0	0	0	739	(±0)	0.00
hawthorn: cockspur	0	739	0	0	0	0	0	0	0	739	(±0)	0.00
magnolia, Chinese ; magı	170	558	0	0	0	0	0	0	0	728	(±0)	0.00
unknown tree	0	198	179	0	351	0	0	0	0	727	(±0)	0.00
rose-of-sharon	396	321	0	0	0	0	0	0	0	717	(±0)	0.00
cherry, sargent	706	0	0	0	0	0	0	0	0	706	(±0)	0.00
mountainash: spp.	0	0	679	0	0	0	0	0	0	679	(±0)	0.00
birch, European white	0	0	0	678	0	0	0	0	0	678	(±0)	0.00
hackberry, northern	634	0	0	0	0	0	0	0	0	634	(±0)	0.00
cedar, atlantic white	0	593	0	0	0	0	0	0	0	593	(±0)	0.00
unknown shrub	0	524	0	0	0	0	0	0	0	524	(±0)	0.00
viburnum: spp.	134	370	0	0	0	0	0	0	0	504	(±0)	0.00
cherry, cornelian	0	443	0	0	0	0	0	0	0	443	(±0)	0.00
snowbell, Japanese	384	0	0	0	0	0	0	0	0	384	(±0)	0.00
birch, river	381	0	0	0	0	0	0	0	0	381	(±0)	0.00
sourwood	0	370	0	0	0	0	0	0	0	370	(±0)	0.00
maple	66	0	194	0	0	0	0	0	0	260	(±0)	0.00
dogwood, flowering	232	0	0	0	0	0	0	0	0	232	(±0)	0.00
magnolia, sweetbay	232	0	0	0	0	0	0	0	0	232	(±0)	0.00
peach	232	0	0	0	0	0	0	0	0	232	(±0)	0.00
hawthorn, Washington	191	0	0	0	0	0	0	0	0	191	(±0)	0.00
redbud, eastern	164	0	0	0	0	0	0	0	0	164	(±0)	0.00
Paradise apple	164	0	0	0	0	0	0	0	0	164	(±0)	0.00
oak, sawtooth	149	0	0	0	0	0	0	0	0	149	(±0)	0.00
dogwood	0	74	0	0	0	0	0	0	0	74	(±0)	0.00
oak	0	70	0	0	0	0	0	0	0	70	(±0)	0.00
ash	0	66	0	0	0	0	0	0	0	66	(±0)	0.00
Citywide Total	155,673	818,699	3,365,430	9,592,518	5,907,482	2,303,588	921,550	266,216	156,719	23,487,874	(±0)	100.00

TREE INVENTORY DATA COLLECTION AND SITE LOCATION METHODS

Data Collection Methods

Davey Resource Group (DRG) collected tree inventory data using Rover mobile mapping software. Rover is a GIS field data collection system built by DRG.

The software both collects data and processes data validations. Rover spatially joins features such as points, lines or polygons with GIS layers in order to derive data. The tool's GPS capabilities allow it to merge nearby camera hardware with the tablet computer to attach photos to features and render data on top of Google Terrain Maps, Google Hybrid Maps and Open Street Maps (when Internet connection is available).

Rover's online and offline functionality gives field technicians the ability to directly distribute information to clients. Data uploads or electronic forms are transmitted to clients in real-time. The knowledge and professional judgment of DRG's arborists ensure the high quality of inventory data.

Data fields are defined in the glossary of the management plan. At each site, the following data fields were collected:

- address
- ash treatment candidate
- condition wood
- condition canopy
- gridling root
- grow space size – width
- grow space size – length
- grow space type
- further inspection
- hardscape damage
- location
- overhead utilities
- ownership
- park name
- primary maintenance need
- mapping coordinates
- maintain ground
- new sidewalk
- notes
- risk assessment
- risk rating
- species
- stems
- tree size*
- visible root flare

* measured in inches in diameter at 4.5 feet above ground (or diameter at breast height [DBH])

Tree Inventory Input Fields and Definitions

The data fields definitions that were collected for each tree, stump, and planting site during the inventory are defined as follows:

- **Mapping coordinate.** X and Y coordinate locations.
- **Location.** The tree's location in relation to public ROW and/or public space.
- **Address.** The location of each street tree and planting site so that they can easily be identified for future maintenance work. Street trees and planting sites will be located using an address number, street name, side of address, and on street.
- **Species.** Trees were identified by genus and species, with the exception of genera such as *Amelanchier, Crataegus, Malus*, or *Prunus* where field identification of species is often not practical.
- **Diameter.** Diameter is measured in inches to the nearest tenth at 4-1/2 feet above the ground, or diameter-breast-height (DBH). If a tree was marked as a multi-stem the largest leader was measured. In some cases where the tree forked before 4.5 ft, DBH was measured at the narrowest point of the trunk.
- **Multi-stem.** Trees were identified if they have multiple stems or are a single stem. Typically if the tree splits lower than 1.5ft from the ground, then it would be marked as a multi-stemmed tree. In these cases the DBH of the largest stem was recorded.
- **Condition - canopy.** In general, the health and structure of each tree was recorded in one of the following categories based on visible twig and foliage conditions at the time of the inventory and adapted from the rating system established by the International Society of Arboriculture:
  - *Good—80% condition rating*
  - *Fair—60% condition rating*
  - *Poor—40% condition rating*
  - *Dead—0% condition rating*
- **Condition - wood.** In general, the health and structure of each tree was be recorded in one of the following categories based on visible root, trunk, and scaffold branch conditions at the time of the inventory and adapted from the rating system established by the International Society of Arboriculture:
  - *Good—80% condition rating*
  - *Fair—60% condition rating*
  - *Poor—40% condition rating*
  - *Dead—0% condition rating*
- **Growing Space Type.** Growing space locations are categorized as:
  - ***Island****—Sites surrounded by pavement or hardscape (e.g., parking lot, cul-de-sac).*
  - ***Median****—Sites located between opposing lanes of traffic.*
  - ***Natural Area****—Sites developed through natural growth instead of design or planning.*
  - ***Open/Restricted****—Open sites with restricted growing space on 2 or 3 sides.*
  - ***Open/Unrestricted****—Open sites with unrestricted growing space on at least 3 sides.*
  - ***Raised Planter****—Sites located in an above-grade or elevated planter.*
  - ***Tree Lawn/Parkway****—Sites located between the street curb and the public sidewalk.*

- *Unmaintained Area—Sites located in areas that do not appear to be regularly maintained.*
- *Well/Pit—Sites at grade level and completely surrounded by sidewalk.*

- **Growing Space Size - Width.** The minimum dimension of the Growing Space Type recorded in feet. In areas where the width or length would not restrict the growth of the tree, 99' was used as a default number.

- **Growing Space Size - Length.** The maximum dimension of the Growing Space Type recorded in feet. In areas where the width or length would not restrict the growth of the tree, 99' was used as a default number.

- **Maintain Ground.** Sites that require ground maintenance (e.g. weeding).

- **New Sidewalk**—Sidewalks that appear new is noted.

- **Visible Root Flare**—Root flares that are visible is noted.

- **Girdling Roots**—Girdling roots that are visible is noted.

- **Sidewalk Deflection**—Where trees are present, cracking or lifting of sidewalk pavement one inch or more is noted.

- **Primary Maintenance Need.** The following primary maintenance needs were determined based on ANSI A300 standard specifications:

  - ***Removal****—Trees designated for removal have defects that cannot be cost-effectively or practically treated. The majority of the trees in this category have a large percentage of dead crown. All trees with safety risks that could be seen as potential threats to persons or property and seen as potential liabilities to the client would be in this category. This category includes large dead and dying trees that are high-liability risks as well as those that pose minimal liability to persons or property (such as trees in poor locations or undesirable species).*
  - ***Tree Clean****—These trees require selective removal of dead, diseased, dying, and/or broken wood to minimize potential risk. Priority of work should be dependent upon the Risk associated with the individual trees.*
  - ***Young Tree Train****—These are young trees that must be pruned to correct or eliminate weak, interfering, or objectionable branches in order to minimize future maintenance requirements. Generally, these trees may be up to 20 feet in height and can be worked with a pole pruner by a person standing on the ground.*
  - ***Stump Removal****—This category indicates a stump that should be removed. Lacking specific information on stump removal required by local code requirements per the client.*
  - ***Plant Tree****—During the inventory, vacant planting sites will be identified by street, address, and site number. The size of the site is designated as small, medium, or large (indicating the ultimate size that the tree will attain), depending on the growing space available and the presence of overhead wires. Lacking local code definitions, planting sites are determined based on standard specifications set forth in accepted technical journals and by the arboriculture industry.*

- **Ash Treatment Candidate.** Condition of ash trees were judged as suitable for possible treatment against Emerald Ash Borer (EAB).

- **Overhead Utilities.** The inventory indicates whether overhead conductors or other utilities are present at the tree site that could result in conflicts with the tree.

- **Risk Assessment.** A Level 2 qualitative risk assessment was performed based on the ANSI A300 (Part 9) and the companion publication *Best Management Practices: Tree Risk Assessment,* published by the International Society of Arboriculture (2011). Trees can have multiple failure modes with various risk ratings. One risk rating per tree will be assigned during the inventory. The failure mode having the greatest risk will serve as the overall tree risk rating. The specified time period for the risk assessment is one year.
  - ***Likelihood of Failure****—Identifies the most likely failure and rates the likelihood that the structural defect(s) will result in failure based on observed, current conditions.*
    - » **Improbable**—The tree or branch is not likely to fail during normal weather conditions and may not fail in many severe weather conditions within the specified time period.
    - » **Possible**—Failure could occur, but it is unlikely during normal weather conditions within the specified time period.
    - » **Probable**—Failure may be expected under normal weather conditions within the specified time period.
    - » **Imminent**—Failure has started or is most likely to occur in the near future, even if there is no significant wind or increased load. The tree may require immediate action.
  - ***Likelihood of Impacting a Target****—The rate of occupancy of targets within the target zone and any factors that could affect the failed tree as it falls toward the target.*
    - » **Very low**—The chance of the failed tree or branch impacting the target is remote.
      - Rarely used sites
      - Examples include rarely used trails or trailheads
      - Instances where target areas provide protection
    - » **Low**—It is not likely that the failed tree or branch will impact the target.
      - Occasional use area fully exposed to tree
      - Frequently used area partially exposed to tree
      - Constant use area that is well protected
    - » **Medium**—The failed tree or branch may or may not impact the target.
      - Frequently used areas that is partially exposed to tree on one side
      - Constantly occupied area partially protected from tree
    - » **High**—The failed tree or branch will most likely impact the target.
      - Fixed target is fully exposed to tree or tree part
  - ***Categorizing Likelihood of Tree Failure Impacting a Target****—The likelihood for failure and the likelihood of impacting a target are combined in the matrix below to determine the likelihood of tree failure impacting a target.*

Likelihood of Failure	Likelihood of Impacting Target			
	Very Low	Low	Medium	High
Imminent	Unlikely	Somewhat likely	Likely	Very Likely
Probable	Unlikely	Unlikely	Somewhat likely	Likely
Possible	Unlikely	Unlikely	Unlikely	Somewhat likely
Improbable	Unlikely	Unlikely	Unlikely	Unlikely

- ***Consequence of Failure****—The consequences of tree failure are based on the categorization of target and potential harm that may occur. Consequences can vary depending upon size of defect, distance of fall for tree or limb, and any other factors that may protect a target from harm. Target values are subjective and should be assessed from the client's perspective.*

  » **Negligible**—Consequences involve low value damage and do not involve personal injury

  - small branch striking a fence
  - medium-sized branch striking a shrub bed
  - large tree part striking structure and causing monetary damage
  - disruption of power to landscape lights

  » **Minor**—Consequences involve low to moderate property damage, small disruptions to traffic or communication utility, or very minor injury.

  - small branch striking a house roof from a high height
  - medium-sized branch striking a deck from a moderate height
  - a large tree part striking a structure, causing moderate monetary damage
  - short-term disruption of power at service drop to house
  - temporary disruption of traffic on neighborhood street

  » **Significant**—Consequences involve property damage of moderate to high value, considerable disruption, or personal injury.

  - a medium-sized part striking a vehicle from a moderate or high height
  - a large tree part striking a structure resulting in high monetary damage
  - disruption of distribution primary or secondary voltage power lines, including individual services and street-lighting circuits
  - disruption of traffic on a secondary street

  » **Severe**—Consequences involve serious potential injury or death, damage to high-value property, or disruption of important activities.

  - injury to a person that may result in hospitalization
  - a medium-sized part striking an occupied vehicle
  - a large tree part striking an occupied house
  - serious disruption of high-voltage distribution and transmission power line disruption of arterial traffic or motorways

- ***Risk Rating****—The overall risk rating of the tree will be determined based on combining the likelihood of tree failure impacting a target and the consequence of failure in the matrix below.*

  Trees have the potential to fail in more than way and can affect multiple targets.

  Tree risk assessors will identify the tree failure mode having the greatest risk, and report that as the tree risk rating. Generally, trees with the highest qualitative risk ratings should receive corrective treatment first. The following risk ratings will be assigned:

  » **None**—Used for planting and stump sites only.

  » **Low**—The Low Risk category applies when consequences are "negligible" and likelihood is "unlikely"; or consequences are "minor" and likelihood is "somewhat likely". Some trees with this level of risk may benefit from mitigation or maintenance measures, but immediate action is not usually required.

  » **Moderate**—The Moderate Risk category applies when consequences are "minor" and likelihood is "very likely" or "likely"; or likelihood is "somewhat likely" and consequences are "significant" or "severe." In populations of trees, Moderate Risk trees represent a lower priority than High or Extreme Risk trees.

  » **High**—The High Risk category applies when consequences are "significant" and likelihood is "very likely" or "likely", or consequences are "severe" and likelihood is "likely". In population of trees, the priority of High Risk trees is second only to Extreme Risk trees.

  » **Extreme**—The Extreme Risk category applies in situations where tree failure is imminent and there is a high likelihood of impacting the target, and the consequences of the failure are "severe". In some cases, this may mean immediate restriction of access to the target zone area to avoid injury to people.

- **Notes.** Additional information regarding disease, insect, mechanical damage, etc. are included in this field.

Maintenance needs are based on *ANSI A300 (Part 1)* (ANSI 2008). Risk assessment and risk rating are based on *Best Management Practices: Tree Risk Assessment* (International Society of Arboriculture [ISA] 2011).

The data collected were provided to the City of Somerville in an electronic ESRI® shapefile, and Microsoft Excel™ spreadsheet.

Likelihood of Failure	Consequences			
	Negligible	Minor	Significant	Severe
Very likely	Low	Moderate	High	Extreme
Likely	Low	Moderate	High	High
Somewhat likely	Low	Low	Moderate	Moderate
Unlikely	Low	Low	Low	Low

Base Map Layers Utilized for Inventory

Imagery/Data Source	Date	Projection
Shapefiles Keith Johnson, City of Somerville GIS Coordinator, Capital Projects and Planning/Engineering Dept.	2018-2019	NAD 1983 StatePlane Massachusetts Mainland; Feet
6in Aerial Imagery City of Somerville GIS	2017	NAD 1983 StatePlane Massachusetts Mainland; Feet

Site Location Methods

EQUIPMENT AND BASE MAPS

Inventory arborists use FZ-G1 Panasonic Toughpad® unit(s) and internal GPS receiver(s).

Base map layers were loaded onto these unit(s) to help locate sites during the inventory. The table below lists the base map layers, utilized along with source and format information for each layer.

STREET RIGHT-OF-WAY (ROW) SITE LOCATION

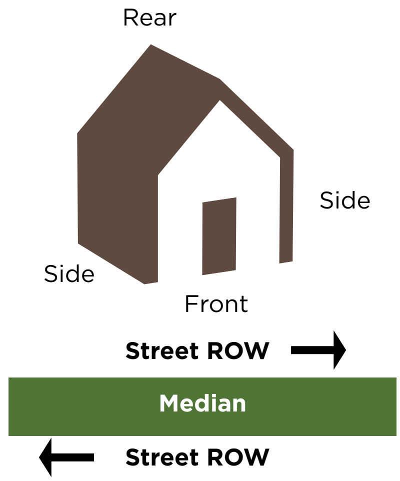
Individual street ROW sites (trees, stumps, or planting sites) were located using a methodology that identifies sites by *address number, street name,* or *side*. This methodology was developed by DRG to help ensure consistent assignment of location.

ADDRESS NUMBER AND STREET NAME

The *address number* was recorded based on visual observation by the arborist at the time of the inventory (the address number was posted on a building at the inventoried site). Where there was no posted address number on a building, or where the site was located by a vacant lot with no GIS parcel addressing data available, the arborist used his/her best judgment to assign an address number based on opposite or adjacent addresses. An "X" was then added to the number in the database to indicate that it was assigned (for example, "37X Choice Avenue").

Sites in medians or islands were assigned an address number using the address on the right side of the street in the direction of collection closest to the site. Each segment was numbered with an assigned address that was interpolated from addresses facing that median/island. If there were multiple median/islands between cross streets, each segment was assigned its own address.

The *street name* assigned to a site was determined by street ROW parcel information and posted street name signage.



Side values for street ROW sites.

SIDE VALUE

Each site was assigned a *side value*. Side values include: *front, side, median* (includes islands), or *rear* based on the site's location in relation to the lot's street frontage. The *front side* is the side that faces the address street. *Side* is the name of the street the arborist walks towards or away from while collecting data. *Median* indicates a median or island. The *rear* is the side of the lot opposite the front.

PARK AND/OR PUBLIC SPACE SITE LOCATION

Park and/or public space site locations were collected using the same methodology as street ROW site.

SITE LOCATION EXAMPLES

The tree trimming crew in the truck traveling westbound on E. Mac Arthur Street is trying to locate an inventoried tree with the following location information:

Address/Street Name: 226 E. Mac Arthur Street

Side: Side

On Street: Davis Street

The tree site circled in red signifies the crew's target site. Because the tree is located on the side of the lot, the *on* street is Davis Street, even though it is addressed as 226 East Mac Arthur Street.

Location information collected for inventoried trees at Corner Lots A and B.

Corner Lot A

Address/Street Name:	205 Hoover St.
Side:	Side
On Street:	Taft St.
Address/Street Name:	205 Hoover St.
Side:	Side
On Street:	Taft St.
Address/Street Name:	205 Hoover St.
Side:	Side
On Street:	Taft St.
Address/Street Name:	205 Hoover St.
Side:	Front
On Street:	Hoover St.

Corner Lot B

Address/Street Name:	226 E Mac Arthur St.
Side:	Side
On Street:	Davis St.
Address/Street Name:	226 E Mac Arthur St.
Side:	Front
On Street:	E Mac Arthur St.
Address/Street Name:	226 E Mac Arthur St.
Side:	Front
On Street:	E Mac Arthur St.

List of Parks/Public Areas Collected in Somerville

- ALBION PLGD
- ALEWIFE BROOK RESERVATION*
- ALLEN ST PLGD & COMM GARDEN
- ARGENZIANO SCHOOL PLGD
- ASSEMBLY SQUARE BLOCK 2A PLAZA**
- AVON COMMUNITY GARDEN**
- BAILEY PARK
- BIKEWAY COMMUNITY GARDEN*
- BLESSING OF THE BAY*
- BROWN SCHOOL PLGD
- CENTRAL HILL PARK
- CHUCKIE HARRIS PARK
- CITY HALL
- COMMUNITY PATH*
- CONCORD SQUARE
- CONWAY FIELD
- CONWAY PARK
- CORBETT-MCKENNA PARK
- CREMIN PLGD
- CUMMINGS SCHOOLYARD
- DAVIS SQUARE PLAZA (STATUE PARK)
- DEPARTMENT OF PUBLIC WORKS
- DICKERMAN PLGD
- DILBOY FIELDS & STADIUM*
- DRAW 7 PARK*
- DURELL POCKET PARK & COMM GARDEN
- EAST LIBRARY
- EAST SOMERVILLE SCHOOLYARD
- EDGERLY EDUCATION CENTER SCHOOLYARD
- EDWARD LEATHERS PARK
- FIRE STATION
- FLORENCE PLAYGOUND
- FOSS PARK*
- GILMAN SQUARE
- GLEN PARK & CAPUANO/JAMES MCCARTHY FIELD
- GRIMMONS PARK
- HARRIS PLGD
- HEALEY COMMUNITY SCHOOLYARD
- HENERY HANSEN PARK
- HODGKINS-CURTIN PARK
- HOYT-SULLIVAN PLGD
- KENNEDY SCHOOLYARD
- KENNEY PARK
- LEXINGTON PARK
- LINCOLN PARK
- MARSHALL STREET PLGD
- MAXPAC SQUARE AND DOG PARK**
- MILK ROW CEMETERY
- MORSE-KELLEY PLGD
- MYSTIC HOUSING DEVELOPMENT***
- NATHAN TUFTS/POWDERHOUSE PARK
- NORTH STREET VETERANS PLGD
- NUNZIATO FIELD
- OSGOOD PARK
- PALMACCI PLGD
- PAUL REVERE PARK
- PERKINS PLGD
- PERRY PARK
- POLICE & FIRE STATION
- POWDERHOUSE ROTARY
- PROSPECT HILL PARK
- QUINCY ST PARK
- SEVEN HILLS PARK
- SOMERVILLE COMM GROWING CENTER
- SOMERVILLE HIGH SCHOOL
- SOMERVILLE JUNCTION PARK
- SOMERVILLE LIBRARY
- SOUTH STREET FARM
- STONE PLACE PARK
- SYLVESTER BAXTER RIVERFRONT PARK*
- SYMPHONY PARK
- TRUM FIELD
- TRUM PLGD
- TUFTS PLAYING FIELD & COMM GARDEN***
- UNION SQUARE PLAZA
- VETERANS MEMORIAL CEMETARY
- VETERANS MEMORIAL RINK
- WALNUT STREET PARK
- WEST BRANCH LIBRARY
- WEST SOMERVILLE NEIGHBORHOOD SCHOOLYARD
- WINTER HILL SCHOOLYARD
- WOODSTOCK PLGD
- ZERO NEW WASHINGTON PARK

*Designates State-owned property

**Designates Privately-owned public space

***Designates Privately-owned property

References

American National Standards Institute (ANSI). 2008. *ANSI A300 (Part 1)–2008, American National Standard for Tree Care Operations—Tree, Shrub, and Other Woody Plant Management—Standard Practices (Pruning)*. Londonderry: Tree Care Industry Association, Inc.

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SUGGESTED TREE SPECIES

Proper landscaping and tree planting are critical components of the atmosphere, livability, and ecological quality of a community's urban forest. The tree species listed below have been evaluated for factors such as size, disease and pest resistance, seed or fruit set, and availability. The following list is offered to assist all relevant community personnel in selecting appropriate tree species. These trees have been selected because of their aesthetic and functional characteristics and their ability to thrive in the soil and climate conditions throughout Zone 6 on the USDA Plant Hardiness Zone Map.

Hardy Trees and Shrubs (Dirr 2010), *Landscape Plants of the Southeast* (Halfacre & Shawcroft 1999), and *Manual of Woody Landscape Plants (5th Edition)* (Dirr 1998) were consulted to compile this suggested species list. Cultivar selections are recommendations only and are based on DRG's experience. Tree availability will vary based on availability in the nursery trade.

DECIDUOUS TREES

Large Trees: Greater than 45 Feet in Height at Maturity

Scientific Name	Common Name	Cultivar
Acer rubrum[d,n]	red maple	Red Sunset®
Acer saccharum[n]	sugar maple	'Legacy'
Aesculus flava[n]*	yellow buckeye	
Betula alleghaniensis[n]*	yellow birch	
Betula lenta[n]*	sweet birch	
Betula nigra[a,n]	river birch	Heritage®
Carpinus betulus	European hornbeam	'Franz Fontaine'
Carya illinoensis[d,n]*	pecan	
Carya laciniosa[d,n]*	shellbark hickory	
Carya ovata[d,n]*	shagbark hickory	
*Castanea mollissima**	Chinese chestnut	
Celtis laevigata[a,s,n]	sugar hackberry	
Celtis occidentalis[d,n]	common hackberry	'Prairie Pride'
Cercidiphyllum japonicum	katsuratree	'Aureum'
Diospyros virginiana[d,s,n]*	common persimmon	
Fagus grandifolia[a,n]*	American beech	
*Fagus sylvatica**	European beech	(Numerous exist)
Ginkgo biloba[d,s]	ginkgo	(Choose male trees only)
Gleditsia triacanthos inermis[d,s,n]	thornless honeylocust	'Shademaster'
Gymnocladus dioicus[d,s,n]	Kentucky coffeetree	Prairie Titan®
Juglans nigra[d,s,n]*	black walnut	
Larix decidua[a,s]*	European larch	
Liquidambar styraciflua[s,n]	American sweetgum	'Rotundiloba'
Liriodendron tulipifera[n]*	tuliptree	'Fastigiatum'
Magnolia acuminata[n]*	cucumbertree magnolia	(Numerous exist)
Magnolia macrophylla[n]*	bigleaf magnolia	

DECIDUOUS TREES continued

Large Trees: Greater than 45 Feet in Height at Maturity (Continued)

Scientific Name	Common Name	Cultivar
Metasequoia glyptostroboides[a]	dawn redwood	'Emerald Feathers'
Nyssa sylvatica[d,s,n]	black tupelo	
Platanus occidentalis[n*]	American sycamore	
Platanus × acerifolia	London planetree	'Yarwood'
Quercus alba[s,n]	white oak	
Quercus bicolor[s,n]	swamp white oak	
Quercus coccinea[d,n]	scarlet oak	
Quercus imbricaria[n]	shingle oak	
Quercus lyrata[d,n]	overcup oak	
Quercus macrocarpa[d,s,n]	bur oak	
Quercus montana[d,n]	chestnut oak	
Quercus muehlenbergii[n]	chinkapin oak	
Quercus palustris[d,s,n]	pin oak	
Quercus phellos[d,s,n]	willow oak	
Quercus robur[s]	English oak	Heritage®
Quercus rubra[d,s,n]	northern red oak	'Splendens'
Quercus shumardii[d,n]	Shumard oak	
Styphnolobium japonicum[s]	Japanese pagodatree	'Regent'
Taxodium distichum[s,n]	common baldcypress	'Shawnee Brave'
Tilia americana[n]	American linden	'Redmond'
Tilia cordata[a]	littleleaf linden	'Greenspire'
Tilia × euchlora	Crimean linden	
Tilia tomentosa[a]	silver linden	'Sterling'
Ulmus americana[a,d,n]	American elm	'Jefferson'
Ulmus parvifolia[d]	Chinese elm	Allée®
Zelkova serrata	Japanese zelkova	'Green Vase'

DECIDUOUS TREES continued

Medium Trees: 31 to 45 Feet in Height at Maturity

Scientific Name	Common Name	Cultivar
Aesculus × carnea	red horsechestnut	
Alnus cordata	Italian alder	
Asimina triloba[n]*	pawpaw	
Cladrastis kentukea[n]	American yellowwood	'Rosea'
Corylus colurna[d]	Turkish filbert	
Eucommia ulmoides	hardy rubber tree	
Koelreuteria paniculata[d,s]	goldenraintree	
Ostrya virginiana[n]	American hophornbeam	
Parrotia persica	Persian parrotia	'Vanessa'
Pistacia chinensis	Chinese pistache	
Prunus maackii	amur chokecherry	'Amber Beauty'
Prunus sargentii	Sargent cherry	
*Pterocarya fraxinifolia**	Caucasian wingnut	
Quercus acutissima	sawtooth oak	
Quercus cerris	European turkey oak	
Sassafras albidum[d,n]*	sassafras	

DECIDUOUS TREES continued

Small Trees: 15 to 30 Feet in Height at Maturity

Scientific Name	Common Name	Cultivar
Acer buergerianum	trident maple	Streetwise®
Acer campestre[s]	hedge maple	Queen Elizabeth™
Acer cappadocicum	coliseum maple	'Aureum'
Acer ginnala	amur maple	Red Rhapsody™
Acer griseum	paperbark maple	
Acer nigrum[n]	black maple	
Acer pensylvanicum[n]*	striped maple	
Acer triflorum	three-flower maple	
Aesculus pavia[s,n]*	red buckeye	
Amelanchier arborea[n]	downy serviceberry	(Numerous exist)
Amelanchier laevis[n]	Allegheny serviceberry	
Carpinus caroliniana[n]*	American hornbeam	
Cercis canadensis[d,n]	eastern redbud	'Forest Pansy'
Cornus alternifolia[n]	pagoda dogwood	
Cornus kousa	Kousa dogwood	(Numerous exist)
Cornus mas	corneliancherry dogwood	'Spring Sun'
Corylus avellana	European filbert	'Contorta'
*Cotinus coggygria**	common smoketree	'Flame'
Cotinus obovata[n]*	American smoketree	
Crataegus phaenopyrum[d,n]*	Washington hawthorn	Princeton Sentry™
Crataegus viridis[d,n]	green hawthorn	'Winter King'
Franklinia alatamaha[n]*	Franklinia	
Halesia tetraptera[n]*	Carolina silverbell	'Arnold Pink'
Laburnum × watereri	goldenchain tree	
Maackia amurensis	amur maackia	
*Magnolia × soulangiana**	saucer magnolia	'Alexandrina'
*Magnolia stellata**	star magnolia	'Centennial'
*Magnolia tripetala**	umbrella magnolia	
Magnolia virginiana[s,n]*	sweetbay magnolia	Moonglow®

DECIDUOUS TREES continued

Small Trees: 15 to 30 Feet in Height at Maturity (continued)

Scientific Name	Common Name	Cultivar
Malus spp.	flowering crabapple	(Disease resistant only)
Oxydendrum arboreum[n]	sourwood	'Mt. Charm'
Prunus subhirtella	Higan cherry	'Pendula'
Prunus virginiana[n]	common chokecherry	'Schubert'
Staphylea trifolia[n]*	American bladdernut	
Stewartia ovata[n]	mountain stewartia	
*Styrax japonicus**	Japanese snowbell	'Emerald Pagoda'
Syringa reticulata[s]	Japanese tree lilac	'Ivory Silk'

[a] denotes species that are recommended for improving air quality (Bell and Wheeler 2006).
[d] denotes species that are drought tolerant (Clatterbuck 2012).
[s] denotes species that are tolerant to salt spray, saline soils, or both (Appleton et al. 2015).
[n] denotes species that are native to the eastern United States (USDA PLANTS database 2020).
* denotes species that are not recommended for use as street trees.

CONIFEROUS AND EVERGREEN TREES

Large Trees: Greater than 45 Feet in Height at Maturity

Scientific Name	Common Name	Cultivar
Abies balsamea[n]	balsam fir	
Abies concolor[n]	white fir	'Violacea'
Cedrus libani	cedar-of-Lebanon	
Chamaecyparis nootkatensis	Nootka falsecypress	'Pendula'
Cryptomeria japonica[s]	Japanese cryptomeria	'Sekkan-sugi'
× *Cupressocyparis leylandii*	Leyland cypress	
Ilex opaca[d,s,n]	American holly	
Picea omorika	Serbian spruce	
Picea orientalis	Oriental spruce	
Pinus densiflora	Japanese red pine	
Pinus strobus[d,n]	eastern white pine	
Pinus sylvestris	Scotch pine	
Pinus taeda[d,n]	loblolly pine	
Pinus virginiana[d,n]	Virginia pine	
Psedotsuga menziesii[n]	Douglas-fir	
Thuja plicata	western arborvitae	(Numerous exist)

Medium Trees: 31 to 45 Feet in Height at Maturity

Scientific Name	Common Name	Cultivar
Chamaecyparis thyoides[n]	atlantic whitecedar	(Numerous exist)
Juniperus virginiana[d,s,n]	eastern redcedar	
Pinus bungeana	lacebark pine	
Pinus flexilis	limber pine	
Pinus parviflora	Japanese white pine	
Thuja occidentalis[n]	eastern arborvitae	(Numerous exist, many are shrubs)

Small Trees: 15 to 30 Feet in Height at Maturity

Scientific Name	Common Name	Cultivar
Ilex × attenuata[d]	Foster's holly	
Pinus aristata	bristlecone pine	
Pinus mugo[d,s]	mugo pine	

[d] denotes species that are drought tolerant (Clatterbuck 2012).
[s] denotes species that are tolerant to salt spray, saline soils, or both (Appleton et al. 2015).
[n] denotes species that are native to the eastern United States (USDA PLANTS database 2021).

ZONE 7 TREES

With climate shifts due to climate change, there may be opportunities to plant a variety of species that were previously unsuited to Somerville's climate.

Trees Suitable for Zone 7

Scientific Name	Common Name	Cultivar	Mature Height
Acer nigrum[n]	black maple		>45 feet
*Cedrus deodara**[*]	deodar cedar		>45 feet
Ilex x[d]	Nellie R. Stevens holly	'Nelly R. Stevens'	15-30 feet
Juglans regia[*]	English walnut		>45 feet
Lagerstroemia fauriei	Japanese crapemyrtle		31-45 feet
Lagerstroemia indica	common crapemyrtle	(Numerous exist)	15-30 feet
Magnolia grandiflora[s,n*]	southern magnolia		>45 feet
Pinus echinate[d]	shortleaf pine		>45 feet
Pinus elliottii[n]	slash pine		>45 feet
Quercus hemisphaerica[n]	Darlington oak		>45 feet
Quercus pagoda[n]	cherrybark oak		>45 feet
Quercus michauxii[n]	swamp chestnut oak		>45 feet
Quercus buckleyi	Texas red oak		>45 feet
Quercus velutina[d,n]	black oak		>45 feet
Sorbus alnifolia	Korean mountainash	'Redbird'	31-45 feet
Stewartia koreana	Korean stewartia		15-30 feet

[d] denotes species that are drought tolerant (Clatterbuck 2012).
[s] denotes species that are tolerant to salt spray, saline soils, or both (Appleton et al. 2015).
[n] denotes species that are native to the eastern United States (USDA PLANTS database 2020).
[*] denotes species that are not recommended for use as street trees.

References

Appleton, Bonnie, et al. *Trees and Shrubs That Tolerate Saline Soils and Salt Spray Drift*. Virginia Polytechnic Institute and State University, 2015, pp. 6–9.

Bell, R., and J. Wheeler. 2006. "Talking Trees, An Urban Forestry Toolkit for Local Governments." *ICLEI Local Governments for Sustainability*.

Clatterbuck, Wayne K. 2012. *SP570 Drought-Tolerant Trees*. Tennessee Urban Forestry Council.

Dirr, Michael. 2010. *Dirr's Hardy Trees and Shrubs: an Illustrated Encyclopedia*. Timber Press.

Dirr, Michael A. 1998. *Manual of Woody Landscape Plants, 5th Edition*. Stipes.

Halfacre, R. Gordon., and Anne R. Shawcroft. *Landscape Plants of the Southeast*. Sparks Press, 1999.

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TREE PLANTING

Tree Planting Overview

Planting trees is a valuable goal as long as tree species are carefully selected and correctly planted. When trees are planted, they are planted selectively and with purpose. Without proactive planning and follow-up tree care, a newly planted tree may become a future problem instead of a benefit to the community.

When planting trees, it is important to be cognizant of the following:

- Consider the specific purpose of the tree planting.
- Assess the site and know its limitations (i.e., confined spaces, overhead wires, and/or soil type).
- Select the species or cultivar best suited for the site conditions.
- Examine trees before buying them, and buy for quality.
- Properly prepare the tree planting site prior to planting.
- Ensure that the tree is planted at the correct depth.
- Only apply soil amendments (fertilizer, compost) if necessary.
- After planting, use mulch or ground cover, but be sure not to cover the root flare of the tree.
- Water the tree regularly, at least until is it established.
- Long-term tree care includes watering during drought periods, adding mulch, and selective pruning.

For additional details see *Section 3.1 Tree Planting Plan*.

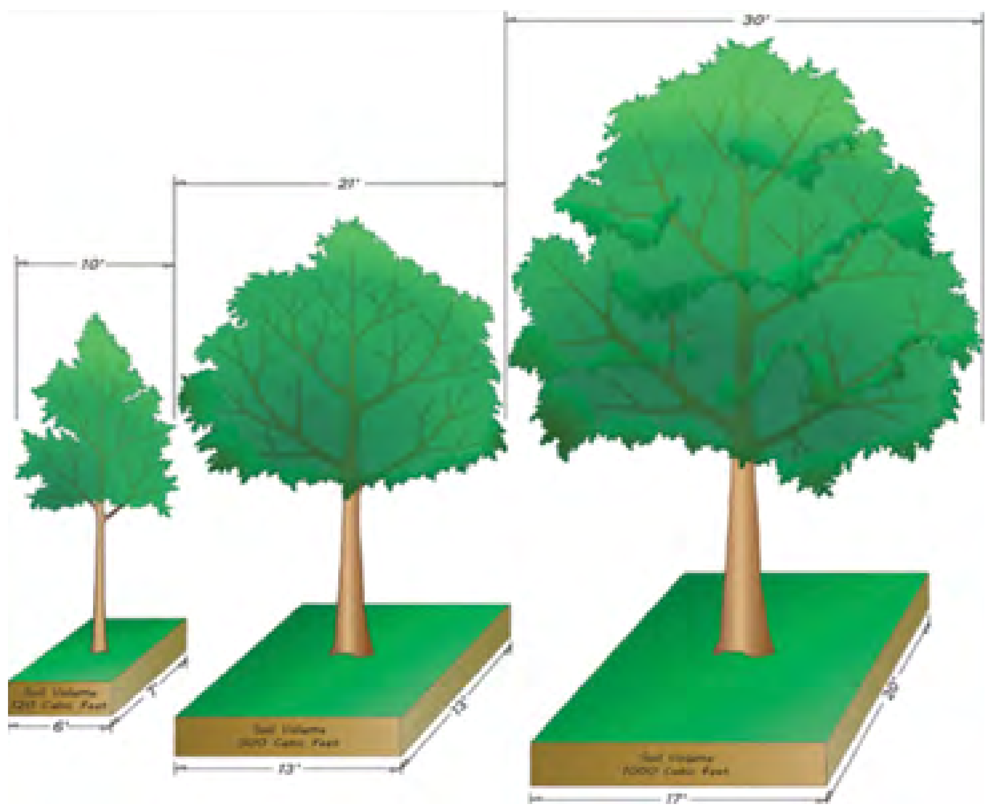
Tree Size and Soil Availability

The goal of tree planting is to have a vigorous, healthy tree that lives to the limits of its natural longevity. That can be difficult to achieve in an urban growing environment because irrigation is limited and the soils are typically poor quality. However, proper planning, species selection, tree planting techniques, and follow-up tree maintenance will improve the chance of tree planting success.

The ability for a tree to grow to its full potential is highly dependent on soil conditions. A tree's root system is typically quite shallow, with the majority of roots in the top two feet of soil, and the roots usually spread outwards up to three times the width of the tree canopy. Thus, the ultimate size a tree will grow is highly dependent on the volume of soil it has available. The quality of that soil is also very important.

City of Somerville Technical Specifications for Tree Planting

The following technical specifications are included the City of Somerville Tree Planting contracts. They detail the requirements that contractors must follow to ensure that tree planting is performed correctly.



Minimum recommended requirements for tree sites is based on tree size/dimensions.
This illustration is based on the work of Casey Trees (2008).

CITY OF SOMERVILLE
2021 TREE PLANTING AND RELATED SERVICES
TECHNICAL SPECIFICATIONS

PART 1 – GENERAL

1.1 SCOPE OF WORK

A. The scope of work includes all labor, materials, tools, equipment, facilities, transportation and services necessary for, and incidental to performing all operations in connection with furnishing, delivery, and installation of all the planting work as shown on the drawings and as specified herein. The scope of work in includes, but is not limited to, the following:

1. Submitting samples of materials and analyses for approval.
2. Securing necessary permits and approvals.
3. Site preparations, which may include any or all of the following: sawcutting asphalt, concrete, or brick and removing material, removing dead or dying trees (maximum caliper size of 9 inches), removing cobbles from around the edge of tree wells and disposing of the material, installing edging material to stabilize brick sidewalks, removing and disposing of tree grate.
4. Locating, purchasing, delivering and installing all specified trees.
5. Back filling with suitable material within tree planting area.
6. Furnishing and installing all necessary planting operations, including: staking, guying, watering, fertilizing, mulching, weeding, pruning, drip bag installation, etc.
7. Establishing finished grades.
8. Cleaning site at end of planting operations, and properly disposing of all excess and surplus material.
9. Providing a two year warranty and maintenance period for all trees.
10. Maintaining, protecting, composting, mulching, weeding, pruning damaged or broken limbs, and replacing dead trees during the warranty period.

B. Planting will take place throughout the City at various locations along streets and in other City-owned City-leased land. Planting on private property within 20 feet of Right-of-Way may be required as well.

C. The City anticipates the planting work will take place during the Spring and Fall planting seasons. Occasional plantings may take place outside of this time.

1. Spring Planting Season: April 1st – June 15th
2. Fall Planting Season: September 15th – November 30th

D. The City of Somerville reserves the right to work with its own work force or other Contractor(s) as necessary.

E. Approved plant locations shall be marked by City staff prior to planting. The City does not guarantee the locations of existing pipes or underground conduits. The Contractor will have planting locations checked by Dig-Safe for utility conflicts before any excavation or pavement removal is started. In the case of conflicts, the Contractor will inform the City Urban Forester immediately to arrange an alternative planting location. The Contractor shall use due caution when excavating in the vicinity of sprinkler systems, driveways, walks, steps, walls, heating cables, and/or heating pipes, and will be required to repair any damages caused at the Contractor's expense.

F. The tree planting will be performed by the requirements of the Contract Documents and will be directed by the City Urban Forester. The Urban Forester will instruct the Contractor if changes need to be made due to any omission, contractual or otherwise, being noticed during the planting operation.

G. All work shall be done in a safe and workman-like manner, in compliance with the rules and regulations of the Massachusetts Occupational Safety & Health Administration (OSHA) and all other City and State agencies and authorities having jurisdiction of the types of work included in this Contract.

H. A Massachusetts Certified Arborist (MCA) or International Society of Arboriculture Certified Arborist (ISA) will carry out the planting of City of Somerville Public Shade Trees. These persons will be at the work site for all planting operations. Names and certification numbers of MCA, ISA, or equivalent arborists will be submitted and approved by the City Urban Forester before any planting occurs.

I. Powers and Duties of the City Urban Forester

   1. For the purposes of the contract, the City of Somerville is acting through its City Urban Forester who is a Certified Arborist and who, in combination with the Tree Warden, by delegation and local ordinance, has control over and is responsible for the care and removal of all trees on City streets, playgrounds, schools, recreation lands and conservation land. The City's Tree Warden, in accordance with the Massachusetts General Laws, Chapter 87 entitled "Shade Trees", has authority over, control and supervision of all trees which now or which may hereafter exist upon any public street or highway in this City. The term City Urban Forester shall mean City Urban Forester or his/her designee.

   2. In the exercise of all or any of the powers herein granted, the City Urban Forester shall have the authority to delegate all or any part of his/her powers and duties with respect to the supervision and control of this contract to his/her subordinates and assistants in the employ of the City of Somerville as s/he may determine.

1.2 CONTRACT DOCUMENTS

A. Shall consist of written specifications and drawings and general conditions. The intent of these documents is to include all labor, materials, and services necessary for the proper execution of the work. The documents are to be considered as one. Whatever is called for by any part shall be as binding as if called for in all parts.

1.3 APPLICABLE STANDARDS

A. The standards and documents listed in the following paragraph form a part of the specification to the extent required by the references thereto. In the event that the requirements of the following referenced standards and specification conflict with this specification section, the requirements of this specification shall prevail. In the event that the requirements of any of the following referenced standards and specifications conflict with each other the more stringent requirement shall prevail or as determined by the City Urban Forester.

   1. American National Standards Institute (ANSI) Z60.1-2014 American Standard for Nursery Stock.

2. American National Standards Institute (ANSI): Standard A300. Standard Practices for Tree, Shrub and other Woody Plant Maintenance, most current edition and parts.
3. Pruning practices shall conform to recommendations in "Structural Pruning: A Guide for the Green Industry"; 2013; Urban Tree Foundation, Visalia, California.
4. American National Standards Institute (ANSI): Standard Z-133.1-2012. Safety Requirements for Arboricultural Operations.
5. Occupational Safety and Health Administration (OSHA) standards, state and local regulations.
6. Interpretation of plant names and descriptions shall reference the following documents. Where the names or plant descriptions disagree between the several documents, the most current document shall prevail.
    a. USDA - The Germplasm Resources Information Network (GRIN) http://www.ars-grin.gov/npgs/searchgrin.html
    b. Manual of Woody Landscape Plants; Michael Dirr; 2009; Stipes Publishing, Champaign, Illinois; 6th Edition.
7. Glossary of Arboricultural Terms; 2015; International Society of Arboriculture, Champaign IL.

1.4 REGULATIONS

A. The Contractor shall comply with all laws and ordinances bearing on the operation or conduct of the work as specified. If the Contractor observes that a conflict exists between laws and ordinances and the work outlined in the contract documents, the Contractor shall promptly notify the City's Urban Forester in writing including a description of any necessary changes and changes to the contract price resulting from changes in the work.

B. Wherever references are made to standards or codes in accordance with which work is to be performed or tested, the edition or revision of the standards and codes current on the effective date of this contract shall apply, unless otherwise expressly set forth.

C. In case of conflict among any referenced standards or codes or between any referenced standards and codes and the specifications, the more restrictive standard shall apply or the City Urban Forester shall determine which shall govern.

1.5 PROTECTION OF WORK, PROPERTY AND PERSON

A. The Contractor shall adequately protect the work, adjacent property(ies), and the public, and shall be responsible for any damages or injury due to his/her actions.

1.6 CHANGES IN THE WORK

A. The City Urban Forester may order changes in the work, and the contract sum should be adjusted accordingly. All such orders and adjustments plus claims by the Contractor for extra compensation must be made and approved in writing before executing the work involved.

B. All changes in the work, notifications, and Contractor's request for information (RFI) shall conform to the contract general condition requirements.

1.7 CORRECTION OF WORK

A. The Contractor, at their own cost, shall re-execute any work that fails to conform to the requirements of the contract and shall remedy defects due to faulty materials or workmanship upon written notice from the City Urban Forester, at the soonest as possible time that can be coordinated with other work and seasonal weather demands**.**

1.8 DEFINITIONS

A. Whenever used in any of the Contract Documents, the terms shall be defined as in the "Glossary of Arboricultural Terms", or as herein defined.

1. Bare Root – a tree or shrub with minimal or no soil surrounding the roots of the plant.
2. Balled and Burlapped (B&B): A tree or shrub dug from the ground with intact soil surrounding its roots. Soil and roots (collectively known as a root ball) are covered by a natural or synthetic burlap material. Burlap-covered root ball may be contained in a wire mesh cage.
3. Caliper: The measure of a plant's trunk diameter. Caliper measurement of the trunk shall be taken six inches above the ground up to and including four-inch caliper size. If the caliper at six inches above the ground exceeds four inches, the caliper should be measured at 12 inches above the ground. Caliper will be measured to the *nearest ½ inch*.
4. Certified Arborist: An individual who has passed and currently maintains an arborist certification with the International Society of Arboriculture, the Massachusetts Arborist Association, or equivalent. Arborist certification shall require continuing education units (CEU's) in order to maintain certification.
5. Contract Supervisor: The individual or designated representative responsible for insuring the requirements of this contract are adhered to.
6. Defective Plant: Any plant that fails to meet the plant quality requirement of this specification.
7. End of Warranty Final Acceptance: The date when the City accepts that the plants and work in this specification meet all the requirements of the warranty.
8. Field Grown Trees: Trees growing in field soil for at least 12 months prior to harvest.
9. Healthy: Plants that are growing in a condition that expresses leaf size, crown density, and color typical of the species and cultivar's horticultural description; and with typical annual growth rates for the species adjusted for the planting site soil, drainage and weather conditions.
10. Kinked Root: A root within the root package that bends more than 90 degrees.
11. Maintenance: Actions that preserve the health of plants after installation and as defined in this specification.
12. Maintenance Period: The time period, as defined in this specification, which the Contractor is to provide maintenance.
13. Normal: the prevailing protocol of industry standard(s).
14. Reasonable and Reasonably: When used in this specification relative to plant quality, it is intended to mean that the conditions cited will not affect the establishment or long term stability, health or growth of the plant. This specification recognizes that it is not possible to produce plants free of all defects, but that some accepted industry protocols and standards result in plants unacceptable to this project.
    a. When *reasonable* or *reasonably* is used in relation to other issues such as weeds, diseases, or insects, it shall mean at levels low enough that no treatment would be

required when applying recognized Integrated Plant Management practices.

b. This specification recognizes that some decisions cannot be totally based on measured findings and that professional judgment is required. In cases of differing opinion, the City Urban Forester shall determine when conditions are judged as reasonable.

15. Root Ball: The mass of roots including any soil or substrate that is shipped with the tree within the root ball package.
16. Root Ball Package: The material that surrounds the root ball during shipping. The root package may include the material in which the plant was grown, or new packaging placed around the root ball for shipping.
17. Root Collar (a.k.a. root crown, root flare, trunk flare, flare): The region at the base of the trunk where the majority of the structural roots join the plant stem, usually at or near ground level.
18. Shrub: Woody plants with mature height approximately less than 15 feet.
19. Stem: The trunk of the tree.
20. Stem Girdling Root: Any root more than ¼ inch diameter currently touching the trunk, or with the potential to touch the trunk, above the root collar approximately tangent to the trunk circumference or circling the trunk. Roots shall be considered as stem girdling that have, or are likely to have in the future, root to trunk bark contact.
21. Structural Root: One of the largest roots emerging from the root collar.
22. Tree: Single and multi-stemmed plants with mature height greater than ~15 feet.

1.9 SAMPLES AND SUBMITTALS

A. Complete lists of the available shade and ornamental tree species shall be submitted as part of the Contractor’s bid. The species lists shall include common name and scientific name, including the cultivar or variety, when applicable, caliper size range, and number of trees available. The list of species that the City of Somerville currently plants is located near the end of the Technical Specification (see *Recommended Species*). It is expected that the Contractor will be able to acquire most of the species in the Recommended Species list.

B. Upon award of the contract and at least thirty (30) days prior to intended use, the Contractor shall provide the following samples and submittals to the City Urban Forester for approval. Label samples to indicate product, characteristics, and locations in the work. Samples will be reviewed for appearance only. Compliance with all other requirements is the exclusive responsibility of the Contractor. Delivered materials shall closely match the approved samples. DO NOT order materials until City Urban Forester’s approval of submittal has been obtained. Should the source of supply be changed within the course of the contract, the Contractor shall submit new samples or submittals for approval per the original submission.

1. Plant sources: Submit sources of all plants to the City Urban for approval. Include plant growers’ certificates for all plants indicating that each meets the requirements of the specification, including the requirements of tree quality, to the City Urban Forester for approval. Provide submittal 30 days before the installation of plants.
2. Certify, invoice, and order plants for each shipment grown, free of disease and insect pests. Submit certificates to City Urban Forester.
3. Planting soil: At least 30 days prior to ordering materials, the Contractor shall submit to the City Urban Forester representative samples, certifications, manufacturer's literature and certified test

results for proposed planting soil.

a. Test results should include standard nutrient analysis, soil pH, soil textural analysis, organic matter content, and soluble salt content. These tests shall be performed by an accredited and independent laboratory and testing company.

4. Fertilizer: Submit one (1) sample packet of fertilizer, and manufacturer product data and literature product showing fertilizer composition and analysis; also submit invoices of total purchased material for this contract.
5. Mycorrhizal Fungal Transplant Inoculant with hydrogel for bare root trees: Submit one (1) sample packet showing composition and analysis of inoculant; also submit invoices of total purchased material for this contract.
6. Compost: Submit a copy of the lab analysis, performed by a STA Program certified lab, verifying that the compost meets the product parameters listed in Section 2.5 COMPOST (B). The lab analysis should not be more than 90 days old.
7. Planting Mulch: Submit a one- (1) cubic foot sample.
8. Drip irrigation bag product: Submit manufacturer product data and literature, and a sample.
9. Stakes and ties: Submit manufacturer product data and literature, and a sample.
10. Edging: Submit manufacturer product data and literature, and a sample.

C. Names of Massachusetts Certified Arborist (MCA), or International Society of Arboriculture (ISA) certified arborist(s) that will be on site during all planting activities will be submitted and approved by the City Urban Forester before any planting occurs.

D. Installation plan submitted a minimum of 14 days prior to the scheduled installation. Plan should describe the methods, activities, materials and schedule to achieve installation of plants. The review will be only for the information of the City for an overall understanding of the project sequence and site utilization. The contractor shall remain responsible for the adequacy and safety of the means, methods, and sequencing of construction. The plan shall include but not be limited to the following items:

1. Detailed sequence of work
2. General description of construction methods
3. Number and location of crews and equipment and manpower to be deployed
4. Traffic, bicycle and pedestrian management
5. Proposed location of stockpiles
6. Maintenance and continued operation of existing infrastructure.

E. Warranty period site visit records: After each site visit during the warranty period by the Contractor, as required by this specification, submit a written record of the visit to the City Urban Forester for approval. Site visit record shall include details about which planting sites were visited, what maintenance was performed at each site, as well as any problems, potential problems, and any recommended corrective action.

1.10 OBSERVATION OF THE WORK

A. The City Urban Forester may observe the work at any time. S/he may remove samples of materials for conformity to specifications. Rejected materials shall be immediately removed from the site and replaced at the Contractor's expense. The cost of testing materials not meeting specifications shall be paid by the Contractor.

B. The City Urban Forester shall be informed of the progress of the work so the work may be observed at the following key times in the planting and maintenance processes. The City Urban Forester shall be afforded sufficient time to schedule visit to the site. Failure of the City Urban Forester to make field observations shall not relieve the Contractor from meeting all the requirements of this specification.

   1. Plant quality: Review of plant quality at the time of delivery and prior to installation. Review tree quality prior to unloading where possible, but in all cases prior to planting.
   2. Planting activities: Monitor all planting activities, including, but not limited to, tree well excavation, tree placement, backfilling, watering, and mulching.
   3. Completion of the planting: Review the completed planting.

1.11 PRE-PLANTING CONFERENCE

A. Schedule a pre-construction meeting with the City Urban Forester at least five (5) business days before beginning work to review any questions the Contractor may have regarding the work, administrative procedures during construction, and project work schedule.

1.12 QUALITY ASSURANCE

A. General Personnel Requirements:

   1. Horticulturally skilled workers, trained and experienced in accepted nursery and arboriculture practices shall perform the planting. The work shall be done in a workmanlike manner under the supervision of a qualified planting supervisor demonstrating a background in landscape operations. It is required that the planting supervisor be a Massachusetts Certified Arborist, ISA Certified Arborist, or equivalent pending the City Urban Forester’s approval and as defined in Section 1.8 DEFINITIONS (A)(4).
   2. Each worker shall be trained in worker safety, and in compliance with current OSHA and ANSI standards.
   3. In the event that the Contractor and/or his/her employees are found to be in violation of applicable safety requirements, the Contractor will be so notified by the City Urban Forester, and said person(s) may order that work be stopped until any and all such violations are corrected.
   4. The City expects that all employees of the Contractor will interact with the public in a polite and professional manner. If the Contractor or his/her employees are not able to answer a question or satisfy a resident request, then the Contractor shall promptly refer the resident to the City Urban Forester as well as contact the City Urban Forester right away to report the nature of the resident’s inquiry.

B. Equipment Requirements

   1. The equipment used for tree planting and watering shall be of sufficient type, capacity and quantity to safely and efficiently perform the tree planting work as specified.
   2. The Contractor shall not allow any operator to leave any vehicles/equipment unattended with the motor running.

C. Requirements Regarding Private Property

1. The normal access to a job site shall be along public roadways. Contractor shall not place equipment and/or personnel on private property.
2. The Contractor shall be required to deal directly with private citizens with respect to repairing and/or replacing damaged bushes, shrubs, and other damage to private property that may be caused by the Contractor in connection with work performed pursuant to this contract. A report in writing concerning such damage and action taken to correct the damages shall be given to the City Urban Forester.
3. The Contractor shall respond to the City Urban Forester within 24 hours in regards to all complaints of damage to private property alleged to have been caused by work performed by the Contractor. In case of such damage, the Contractor shall be required to make arrangements with the homeowner or business to remedy the damage. The Contractor shall make or effectuate any such repairs with in thirty (30) days of the date of the damage, or within such additional times as agreed in writing between the Contractor and homeowner or business owner.

D. Work scheduling and hours

1. The City intends on having scheduled tree planting work twice a year, during the Spring planting season and the Fall planting season. However, there may be other times during the year that the City will request that trees be planted. The City will make a list of planting location(s) in advance of the work for the Contractor.
2. Prior to the commencement of work the Contractor shall meet with the City Urban Forester and provide a written schedule for the completion of work. The City Urban Forester requires that this schedule be closely adhered to. Any changes to the schedule must be submitted to the City Urban Forester in writing for approval.
3. The Contractor shall begin work upon receipt of written and/or verbal orders to begin such work, and the work once begun shall be continuously carried forward with a force of persons adequate in the opinion of the City Urban Forester to complete the work in a continuous, uninterrupted, reasonable and expeditious manner, except in the case of inclement and unseasonable weather conditions. In the event the City Urban Forester determines that the Contractor has not begun work on orders to do so, or that the work once begun has been abandoned without authority, then the City Urban Forester shall give the Contractor seventy-two (72) hours' notice (Sunday excepted) to begin work, or resume work in case of abandonment. Failure of the Contractor to act within this specified time shall be deemed a breach of this contract and the Contractor shall be held liable for any damage or expense arising from such breach of contract.
4. The work crew(s) will report daily to the City Urban Forester when they start and when they finish work for the day. Completed work locations are to be faxed or emailed on a daily basis to the City Urban Forester.

E. General Standards

1. The Contractor's work shall be done in a workmanlike manner and performance thereof and all materials and facilities furnished by him/her shall be to the satisfaction of the City Urban Forester.
2. Approved plant locations shall be marked by the City. Contractor to have planting locations checked by Dig-Safe for utility conflicts before any excavation or pavement removal is started.
3. Any unexpected Dig-Safe conflicts or obstructions at the site that interfere with the tree planting operation will be communicated to the City Urban Forester to determine a solution before planting occurs. The Contractor will not be compensated for any planting adjustments not approved by the City Urban Forester.

4. All work areas shall be kept in such a manner so as to cause as little inconvenience as possible to the general public and adjacent property owners. When it is necessary to close pedestrian walks, vehicular traffic lanes or private access roads and drives, the Contractor shall provide personnel, barricades, warning signs, cones, flags or other means required by governing rules and ordinances, along with notifying the affected property owner or resident. Driveways are not to be blocked with debris at any time.
5. Contractor shall make no excavation in any public way or utility easement unless at least seventy-two (72) hours, exclusive of Saturdays, Sundays and legal holidays, before the proposed excavation is to be made, s/he has given notice in writing by registered mail if deemed necessary by the Contract Supervisor, of the proposed excavation to such public utility companies as supply gas, electricity and telephone service in the City, to such private companies as supply cable television service in the City and also to the City of Somerville Water Department. Such notice shall set forth the name of the street and a reasonably accurate description of the location in which the excavation is to be made. The Contractor shall comply with DIG SAFE LAW (G.I.C. 82, Sec 40).
6. PERMITTING: It shall be the responsibility of the Contractor to apply for and receive the appropriate permits from Department of Public Works and the Department of Parking and Traffic before the start of work.
    a. The Contractor shall obtain a permit from the Department of Infrastructure and Asset Management (Engineering Division) prior to any sidewalk or roadway obstruction. A copy of this permit must be available at the work site at all times. The Contractor is required to obtain street excavation and street obstruction permits to complete the work under this contract. Fees for permits to excavate or obstruct the public way shall be waived; all permits must be obtained prior to beginning work on the City streets and sidewalks. Permits will be required for each of the project components.
        i. Traffic plans and work zones shall be in accordance with the Manual of Uniform Traffic Control Devices (MUTCD) of the U.S. Department of Transportation.
    b. To restrict parking at the tree planting locations, the Contractor shall obtain "NO PARKING" signs from Somerville Traffic and Parking located at 133 Holland Street, and post them a minimum of forty-eight (48) hours before any sidewalk cutting or tree installation work may begin. All signs must be clearly posted with the dates that work will be done and the reason for the temporary parking restriction (*i.e.*, "tree planting"). Parking may not be restricted for more than three business days, and not outside of the hours of 8:00 a.m.− 7:00 p.m. The signs shall be placed in each location designated for tree service on any and all roadways prior to servicing the area. Signs shall be taped to trees, utility poles or city owned street signage. Both tape and sign shall be removed and disposed of by the Contractor immediately after the planting has been completed. Nails, tacks, wires or staples MAY NOT be used to attach signs to trees.
        i. Road closures, if necessary, must be approved by the City of Somerville Traffic and Parking Department (telephone 617-666-3311 ext. 7900) not less than 48 hours prior to the Commencement of work.
7. Scheduling Police Details shall be the responsibility of the Contractor. A Police Detail is to be present during all construction activity. Police details are to be paid by the Contractor, who will then be reimbursed by the City upon request and *with proper documentation of the paid police detail expenses*. *The Contractor will not be paid any administrative or interest costs associated with police details*. An allowance for police details is included in the bid price. Contractor shall pay police traffic detail bills within 14 days of receipt to avoid a 10% late payment surcharge. The City will not pay any late charges.

8. Contractor is required to maintain all work areas in a safe fashion, especially during times when a police detail is not required. The Contractor will set up all necessary caution signs, high visibility flags, traffic cones, etc., at all times while working in the City.
9. The Contractor shall provide, erect and maintain all barricade warning signs, guards or other protection, as necessary and required for the safe execution of this Contract, and shall remove same upon completion of the work. No open tree pits shall be left unattended without safety and warning devices installed.
10. Contractor will not leave any excavated areas left open after securing his/her work site at the end of each day. The Contractor is responsible for barricading and cautioning off such open excavated areas before leaving the work site. The City Urban Forester may require the Contractor to cover over or backfill such excavated areas in reference to the safety of the general public.
11. Contractor shall carefully protect against damage to all existing trees and plants. The Contractor shall be liable for any and all damage to such trees, plants, real property and vehicles, and shall replace, repair, restore or provide for returning the same to their original condition, to the satisfaction of the City Urban Forester.
12. Contractor shall clean up the entire project site before the work will be accepted. All wood, brush, debris, rubbish, asphalt, stones from any excavation material, etc., shall be disposed of by the Contractor, unless specifically ordered by the City Urban Forester to do otherwise. All areas disturbed by the Contractor shall be left in a condition comparable to that originally found and satisfactory to the City Urban Forester.
13. Contractor shall exercise the greatest care to ensure that no material being hauled by the Contractor or Sub-Contractor either to or from the site is spilled onto any way, public or private, within the City limits. In the event that such spillage does occur, it shall be the Contractor's responsibility to remove the spilled material and clean the area promptly but in no event any later than the end of the workday. If in the judgment of the City Urban Forester, the Contractor has not satisfactorily cleaned the area of any spill, the City Urban Forester may then order the area to be cleaned by the City at the Contractor's expense.
14. Contractor shall furnish all the labor, materials, tools and equipment necessary to do all the work required for the completion of each item as specified.

F. Special Provisions

1. All work areas near and around the tree planting areas resurfaced by the Contractor shall be guaranteed against settlement, upheaval or failure of any kind for a period of two (2) years after the City accepts the work, and Contractor shall replace such resurfacing at their own expense. The City Urban Forester and/or the City's Engineering Department, shall be the sole judge as to what constituents a failure and which portion of the resurfacing is to be replaced, and his/her decision will be final.
2. Before starting the work and from time to time during the project's progress, as the City Urban Forester or the City's Engineering Department may request, the Contractor shall submit to him/her or them a written description of the methods s/he plans to use in doing the work and the various steps s/he intends to take.
3. Contractor shall cooperate with any other Contractors, utility companies and/or City of Somerville staff that may be working at or near this project's work site covered by this contract. The City Urban Forester and/or the City's Engineering Department, will decide as to the respective rights of the parties involved and their decisions shall be final.

G. Semi-Final Acceptance - Acceptance of the work prior to the start of the warranty period:

1. Once the Contractor completes the installation of all trees according to the specifications herein, and has completed the 30-day post-installation watering (2x per week), the City Urban Forester will observe all work for Semi-Final Acceptance upon written request of the Contractor. The request shall be received at least ten (10) calendar days before the anticipated date of the observation.
2. Semi-Final Acceptance by the City Urban Forester shall be for general conformance to specified size, character and quality and does not relieve the Contractor of responsibility for full conformance to the contract documents, including correct species.
3. Any plants that are deemed defective as defined under the provisions below shall not be accepted.
4. The City Urban Forester will provide the Contractor with written acknowledgment of the date of Semi-Final Acceptance and the beginning of the warranty and plant maintenance period.

H. Contractor's Quality Assurance Responsibilities: The Contractor is solely responsible for quality control of the work.

1.13 PLANT WARRANTY

A. Planting Period:

1. All plants shall be warrantied to meet all the requirements for plant quality in this specification. Defective plants shall be defined as plants not meeting these requirements. The Contractor agrees to replace defective work and defective plants. The City Urban Forester shall make the final determination if plants meet these specifications or that plants are defective.
2. Plants determined to be defective shall be removed immediately upon notification by the City Urban Forester and replaced without cost to the City, as soon as weather conditions permit and within the specified planting period.

B. Two-Year Plant Warranty:

1. Plant warranty shall begin on the date of Semi-Final Acceptance and continue for two (2) years.
2. When the work is accepted in parts, the warranty periods shall extend from each of the partial Semi-Final Acceptances to the terminal date of the last warranty period. Thus, all warranty periods for each class of plant warranty shall terminate at one time.
3. Any work required by this specification or the City Urban Forester during the progress of the work for the purpose of correcting plant defects, including the removal of roots or branches, or planting plants that have been bare rooted during installation to observe for or correct root defects, shall not be considered as grounds to void any conditions of the warranty. In the event that the Contractor decides that such remediation work may compromise the future health of the plant, the plant or plants in question shall be rejected and replaced with plants that do not contain defects that require remediation or correction.
4. Replacements shall conform to the species and size of the original specimen. Replacements shall be subject to all requirements stated in this specification.
5. Replacements shall be maintained and guaranteed for two years from the time of replacement, per the terms of the warranty period.
6. During and by the end of the warranty period, remove all tree stakes, ties, and guying materials unless agreed to in writing by the City Urban Forester that they should remain in place. All trees requiring additional anchorage in windy locations may need to remain staked, if required by the City Urban Forester.

C. End of Warranty Final Acceptance - Acceptance of plants at the end of the warranty period.

1. At the end of the warranty period, the City Urban Forester shall observe all warrantied work, upon written request of the Contractor. The request shall be received at least fourteen calendar days before the anticipated date for final observation.
2. End of Warranty Final Acceptance will be given only when all the requirements of the work under this specification have been met.

1.14 SELECTION AND OBSERVATION OF PLANTS

A. The City Urban Forester may review all plants to verify size, health, quality, character, etc. Review or approval of any plant during the process of selection, delivery, installation and establishment period shall not prevent that plant from later rejection in the event that the plant quality changes or previously existing defects become apparent that were not observed.

1. All plants that are rejected shall be immediately removed from the site and acceptable replacement plants provided at no cost to the City.

B. The City Urban Forester will select and tag all specified tree planting material at the nursery location(s). Only trees that are selected and tagged by the City Urban Forester will be planted in the City. The selecting of plants by the City Urban Forester at the nursery does not preclude the right to reject material while on site that does not conform to this specification.

1. The City Urban Forester may make invasive observation of the plant's root system in the area of the root collar and the top of the root ball in general in order to determine that the plant meets the quality requirements for depth of the root collar and presence of roots above the root collar. Such observations will not harm the plant.
2. The City Urban Forester reserves the right to reject plants that do not meet specifications as set forth in this specification. If a particular defect or substandard element can be corrected at the nursery, as determined by the City Urban Forester, the agreed upon remedy may be applied by the nursery or the Contractor provided that the correction allows the plant to meet the requirements set forth in this specification. Any work to correct plant defects shall be at the Contractor's expense.

3. Corrections are to be undertaken at the nursery prior to shipping. The Contractor shall bear all cost related to plant corrections.

1.15 SITE CONDITIONS

A. It is the responsibility of the Contractor to be aware of all surface and sub-surface conditions, and to notify the City Urban Forester, in writing, of any circumstances that would negatively impact the health of plantings. Do not proceed with work until unsatisfactory conditions have been corrected.

1. Should subsurface drainage or soil conditions be encountered which would be detrimental to growth or survival of plant material, the Contractor shall notify the City Urban Forester in writing, stating the conditions, and submit a proposal covering cost of corrections. If the Contractor fails to notify the City Urban Forester of such conditions, s/he shall remain responsible for plant material under the warranty clause of the specifications.

B. Actual planting shall be performed during those periods when weather and soil conditions are suitable in accordance with locally accepted horticultural practices.

1. Do not install plants into saturated or frozen soils. Do not install plants during inclement weather,

such as rain or snow or during extremely hot, cold or windy conditions.

1.16 PLANTING AROUND UTILITIES

A. Contractor must have planting locations checked by Dig-Safe to determine the location of underground utilities before any excavation or pavement removal is started. Perform work in a manner that will avoid possible damage. Inform the City Urban Forester of any conflicts prior to tree installation. The City Urban Forester will determine alternate planting locations, as needed.

1.17 ALTERNATES

A. Alternates may be included in the bid document. Alternates, if adopted by the City, shall either increase or decrease the Contractor's base bid contract price and lump sum bid. The City reserves the right to determine the lowest eligible bidder on the basis of the base bid or the adoption of the Alternates, selected in order, and in combination with the base bid. (For example: Base Bid, Base Bid + Alternate 1).

1. Alternates consist of watering up to 300 young trees throughout city that have been planted by means outside of the current contract. Each tree will be supplied with a 20 gallon irrigation bag by the City. Upon request of the City Urban Forester, the Contractor shall fill the irrigation bag for each tree with 20 gallons of water. Each tree will be required to be watered a maximum of once per week throughout the growing season (May 15th – November 15th), as requested by the City Urban Forester and depending on weather conditions. The location of each tree to be watered for a given growing season and the number of watering incidents for each tree in that growing season will be provided by the City's Urban Forester.
2. Contractor shall provide the City Urban Forester with a schedule of watering for the alternate trees. The watering schedule shall include details on the order in which the trees will be watered, the frequency of watering (based on the information provided by the City Urban Forester), and the volume of water that will be provided to each tree during each visit.
3. If any irrigation bag is missing, ripped, or otherwise not functioning according to the manufacturer's specifications, the Contractor will immediately notify the City Urban Forester. The bag will be replaced by the City and watering will continue for the remainder of the growing season.
4. The specifications for watering described in Sections 3.17 WATERING (INSTALLATION THROUGH FINAL ACCEPTANCE) (F) (G) (I) and 3.18 WATERING (2-YEAR WARRANTY PERIOD) (D) apply to the watering of these alternate trees.

PART 2 – PRODUCTS

2.1 TREES: GENERAL

A. Standards and measurements: Provide plants of quantity, size, genus, species, and variety or cultivars as shown and scheduled in contract documents. City Urban Forester will provide a list of chosen species at least 30 day prior to installation.

1. The Contractor shall supply the plants necessary to complete the work as intended.
2. All plants shall be nursery grown balled and burlapped trees or bare root trees (when specified by the City Urban Forester), grown under climatic conditions similar to those in Somerville, Massachusetts.

3. The root ball dimensions to trunk caliper ratio shall conform to American National Standards Institute (ANSI) Z60.1-2014 American Standard for Nursery Stock, unless modified by provisions in this specification. When there is a conflict between this specification and ANSI Z60.1, this specification section shall be considered correct.
4. When a range of sizes is given, no plant shall be less than the minimum size, and the average size of all plants furnished will be equal to the average of the two dimensions. The measurements specified are the minimum and maximum size acceptable and are the measurements after pruning, where pruning is required.
5. Plants larger than specified may be used if acceptable to the City Urban Forester. Use of such plants shall not increase the contract price. If larger plants are accepted the root ball size shall be in accordance with ANSI Z-60.1. Larger plants may not be acceptable if the resulting root ball cannot be fit into the required planting space.
6. Substitutions: Substitutions will **NOT** be permitted without the consent of the City Urban Forester. If proof is submitted that a plant(s) is not obtainable or does not meet requirements of the Specification, use of nearest equivalent size or variety will be considered. Plants larger than specified may be used at no increase in cost. Proposed substitutions must receive the written approval of the City Urban Forester. When sources for plants are located by the City Urban Forester, there will be no substitutions and those sources will be used at no increase in cost. The City does not guarantee it will accept substitutions. The City will require that the Contractor try every means possible to obtain the specified trees.

B. Plant Identification: The nomenclature used in the plant list conforms to the USDA Germplast Resource Information Network (http://www.ars-grin.gov/npgs/searchgrin.html) or as in the book "The Manual of Woody Landscape Plants" by Michael Dirr. All trees shall be true to name as ordered, and shall be labeled individually by genus, species, variety and cultivar.
   1. Plant labels shall be provided by the Contractor for each tree and shall be durable, legible labels stating the correct tree name and size, in weather resistant ink or embossed process lettering, and can be removed at the end of the Contract.

C. Plant Quality:
   1. **General**: Provide healthy stock, grown in a nursery and reasonably free of die-back, disease, insects, eggs, bores, larvae, and all forms of infestations. Tree plantings shall be typical of their species and variety. At the time of installation in the City, all plants shall have a normal balance between height and spread, and root system, stem, and branch form that will not restrict normal growth, stability and health for the expected life of the plant. The City prefers trees that have not been treated with neonicotinoid insecticides; whenever possible, Contractor shall source trees from nurseries that do not use neonicotinoids.
   2. **Plant quality above the soil line:** Plants shall be healthy with the color, shape, size and distribution of trunk, stems, branches, buds and leaves typical of the plant type specified. Plant quality above the soil line shall comply with the project Crown Acceptance details and the following:
      a. Crown: the form and density of the crown shall be typical for a young specimen of the species or cultivar, pruned to a central and dominant leader.
         i. Trees shall have a persistent main leader. If the leader was headed, a new leader (with a live terminal bud) at least one-half the diameter of the pruning cut shall be present.
         ii. Crown specifications do not apply to plants that have been specifically trained in the nursery as topiary, espalier, multi-stem, clump, or unique selections such as

contorted or weeping cultivars.

b. Leaves: the size, color, and appearance of leaves shall be typical for the time of year and stage of growth of the species or cultivar. Trees shall not show signs of prolonged moisture stress or over watering as indicated by wilted, shriveled, or dead leaves.

c. Branches: shoot growth (length and diameter) throughout the crown should be appropriate for the age and size of the species or cultivar. Trees shall not have dead, diseased, broken, distorted, or otherwise injured branches.

   i. Main branches shall be symmetrically distributed along the central leader not clustered together. They shall form a balanced crown appropriate for the cultivar/species.

   ii. Branch diameter shall be no larger than two-thirds (one-half is preferred) the diameter of the central leader measured 1 inch above the branch union.

   iii. The attachment of the largest branches (scaffold branches) shall be free of included bark.

d. Trunk: the tree trunk shall be relatively straight, vertical, and free of wounds that penetrate to the wood (properly made pruning cuts, closed or not, are acceptable and are not considered wounds), sunburned areas, conks (fungal fruiting bodies), wood cracks, sap leakage, signs of boring insects, galls, cankers, girdling ties, lesions (mechanical injury), or disfiguring knots.

   i. Trunk caliper and taper shall be sufficient so that the lower five feet of the trunk remains vertical without a stake. Auxiliary stakes may be used to maintain a straight leader in the upper half of the tree.

   ii. All graft unions, where applicable, shall be completely closed without visible sign of graft rejection. All grafts shall be visible above the soil line.

e. Temporary branches, unless otherwise specified, can be present along the lower trunk below the lowest main (scaffold) branch, particularly for trees less than 1 inch in caliper. These branches should be no greater than 3/8-inch diameter.

3. **Plant quality at or below the soil line:** Plant roots shall be normal to the plant type specified. Root observations shall take place without impacting tree health. Root quality at or below the soil line shall comply with the project Root Acceptance details and the following:

   a. The roots shall be reasonably free of scrapes, broken or split wood.

   b. The root system shall be reasonably free of injury from biotic (e.g., insects and pathogens) and abiotic (e.g., herbicide toxicity and salt injury) agents. Wounds resulting from root pruning used to produce a high quality root system are not considered injuries.

   c. A minimum of three structural roots reasonably distributed around the trunk (not clustered on one side) shall be found in each plant. Root distribution shall be uniform throughout the root ball, and growth shall be appropriate for the species.

      i. Plants with structural roots on only one side of the trunk (‘J roots’) shall be rejected.

   d. The root collar shall be within the upper 2 inches of the substrate/soil. Two structural roots shall reach the side of the root ball near the top surface of the root ball. The grower may request a modification to this requirement for species with roots that rapidly descend, provided that the grower removes all stem girdling roots above the structural roots across the top of the root ball.

e. The root system shall be free of stem girdling roots over the root collar or kinked roots from nursery production practices.

    i. Plant Grower Certification: The final plant grower shall be responsible to have determined that the plants have been root pruned at each step in the plant production process to remove stem girdling roots and kinked roots, or that the previous production system used practices that produce a root system throughout the root ball that meets these specifications. Regardless of the work of previous growers, the plant's root system shall be modified at the final production stage, if needed, to produce the required plant root quality. The final grower shall certify in writing that all plants are reasonably free of stem girdling and kinked roots as defined in this specification, and that the tree has been grown and harvested to produce a plant that meets these specifications.

f. At time of plant selection observations and delivery, the root ball shall be moist throughout. Roots shall not show signs of excess soil moisture conditions as indicated by stunted, discolored, distorted, or dead roots.

g. All plant root balls shall conform to the size requirements specified for the proposed tree species and size at planting identified in the Plant List, and to the code of standards set forth in the current edition of American Standard for Nursery Stock.

    i. All tree root systems shall be retained as solid units. The diameter and depth of the balls of soil must be sufficient to encompass the fibrous and feeding root system necessary for the healthy development of each tree planting.

    ii. The tree plantings and root balls shall remain intact as a unit during all operations. No tree planting shall be accepted when the ball of each surrounding its roots has been badly cracked or broken, either before or during the process of planting.

D. Submittals: for each plant type, submit the required plant quality certifications from the grower where plants are to be purchased to the City Urban Forester for approval. The certification must state that each plant meets all the above plant quality requirements.

1. The grower's certification of plant quality does not prohibit the City Urban Forester from observing any plant or rejecting the plant if it is found to not meet the specification requirements.

E. Inspections: Plants shall be inspected, selected, and tagged at the place of growth by the City Urban Forester with the Contractor. Inspection and approval at the source(s) shall not waive the right of rejection for failure to meet other requirements during progress of work.

2.2 PLANT ROOT BALL PACKAGE OPTIONS

The following root ball packages are permitted. Any type of root ball packages that is not specifically defined in this specification shall not be permitted.

A. **Balled and Burlapped Plants**

1. All Balled and Burlapped (B&B) plants shall be field grown, and the root ball packaged in burlap and twine and/or burlap and wire basket package.

2. The root ball dimensions to trunk caliper ratio shall conform to American National Standards Institute (ANSI) Z60.1-2014 American Standard for Nursery Stock. All tree plantings shall retain root systems as solid units. The diameter and depth of the balls of soil must be sufficient to encompass the fibrous and feeding root system necessary for the healthy development of each

tree planting.

3. The tree plantings and root balls shall remain intact as a unit during all operations. Tree plantings shall **NOT** be accepted when the ball of earth surrounding its roots has been badly cracked or broken, either before or during the process of planting.

4. Plants shall be harvested with the following modifications to standard nursery practices.

    a. Prior to digging any tree that fails to meet the requirement for maximum soil and roots above the root collar, carefully removed the soil from the top of the root ball of each plant, using hand tools, water or an air spade, to locate the root collar and attain requirements for soil depth over the structural roots (maximum of 2" soil depth above the point where the top-most root(s) emerges from the trunk). Remove all stem girdling roots above the root collar. Care must be exercised not to damage the surface of the root collar and the top of the structural roots.

    b. All root pruning and hardening off procedures shall be accomplished utilizing accepted horticultural practices. Trees that are stored out of the ground shall be placed in a holding area protected from extremes of wind and sun with the root ball protected by covering with mulch or straw and irrigated sufficiently to keep moisture in the root ball above wilt point and below saturation.

    c. If wire baskets are used to support the root ball, a "low profile" basket shall be used. A low profile basket is defined as having the top of the highest loops on the basket no less than 4 inches and no greater than 8 inches below the shoulder of the root ball package.

        i. At nurseries where sandy soils prevent the use of "low profile baskets", baskets that support the entire root ball, including the top, are allowable.

    d. Twine and burlap used for wrapping the root ball package shall be natural, biodegradable material. If the burlap decomposes after digging the tree then the root ball shall be re-wrapped prior to shipping if roots have not yet grown to keep root ball intact during shipping.

B. **Bare Root Plants**

1. Harvest bare root plants while the plant is dormant and a minimum of 4 weeks prior to leaf out (bud break).

2. The root spread dimensions of the harvested plants shall conform to ANSI Z60.1 for nursery grown bare root plants for each size and type of plant. Just prior to shipping to the job site, dip the root system into a slurry of hydrogel (cross linked polyacrylamide) and water mixed at a rate of 15 oz. of hydrogel in 25 gallons of water. Do not shake off the excess hydrogel. Place the root system in a pleated black plastic bag and tie the bag snugly around the trunk. Bundle and tie the upper branches together.

3. Keep the trees in a cool dark space for storage and delivery. If daytime outside temperatures exceeds 70 degrees F, utilize a refrigerated storage area with temperature between 35 and 50 degrees.

4. Where possible, plan time of planting to be before bud break. For trees to be planted after bud break, place the trees before bud break in an irrigated bed of pea gravel.

    a. The pea gravel bed shall be 18 inches deep over a sheet of plastic.

    b. Space trees to allow the unbundled branches to grow without shading each other.

    c. Once stored in pea gravel, allow the trees sufficient time for the new root system to flush and spring growth of leaves to fully develop before planting.

d. Pea gravel stored trees may be kept for up to one growing season.

e. Pea gravel stored trees shall be dipped, packaged and shipped similar to the requirements for freshly dug bare root trees above.

2.3 PLANTING SOILS

A. Contractor shall provide all topsoil required to complete the planting operation. Planting soil shall be a natural, fertile, friable loam typical of cultivated topsoil of the locality, containing at least 10% and not more than 20% decayed organic matter (humus). Topsoil shall be free of sub-soil, stones greater than 1-¼ inches in diameter in the longest dimension, earth clods, sticks, stumps, clay lumps, roots, or other objectionable, extraneous matter or debris. Topsoil shall not be by test either excessively acid or alkaline nor contain toxic substances. Soil soluble salt content shall be less than 2 dS/m, and pH shall be between 5.5 and 6.5. Topsoil shall not be delivered or used for planting while in a frozen or muddy condition.

B. Soil for planting trees shall be one of the following sandy loams; “course sandy loam”, “sandy loam”, and “fine sandy loam”: determined by soil texture analysis and based on the "USDA Classification System" and as defined in this section. It shall be of uniform composition, without admixture of subsoil. Planting soil for trees shall have the following grain size distribution for material passing the #10 sieve:

Millimeter	**Percent passing by weight**	
	Maximum	Minimum
2	-------	100
1	100	80
0.5	87	67
0.25	78	48
0.10	68	30
0.05	55	22
0.002	7	2

1. Maximum size shall be one and one quarter inches largest dimension. The maximum retained on the #10 sieve shall be 25% by weight of the total sample.
2. The ratio of the particle size for 80% passing (d80) to the particle size for 30% passing (d30) shall be 6.0 or less. (d80/d30 < 6.0)

C. Submittals: Representative sample, certification, manufacturer's literature and certified test results for proposed planting soil to be submitted to and approved by the City Urban Forester.

2.4 FERTILIZER

A. Fertilizer shall be a complete, slow-release, root contact packet, 16-8-16, or equal, that is engineered to stimulate root growth and is a standard product complying with State and Federal Fertilizer Laws. Slow release fertilizer is defined as having more than 50% of the nitrogen in the water insoluble nitrogen form.

B. Submittals: Name of supplier and sample to be approved by the City Urban Forester.

2.5 COMPOST

A. Compost mulch shall be a well decomposed, weed free organic matter source. It shall be derived from: agricultural, food, or industrial residuals; biosolids (treated sewage sludge); yard trimmings; or source-separated waste. The product shall contain no substances toxic to plants and be reasonably free (< 1% by dry weight) of man-made foreign matter. The compost will possess no objectionable odors and shall not resemble the raw material from which it was derived. For acid loving plants, only use a compost that has not received the addition of liming agents or ash by-products. The product shall be certified through the U.S. Composting Council's (USCC) Seal of Testing Assurance (STA) Program.

B. Product Parameters*:

Parameters[1,5]	**Reported as (units of measure)**	**General Range**
pH[2]	pH units	5.5 – 9.0
Soluble Salt Concentration[2] (electrical conductivity)	dS/m (mmhos/cm)	Maximum 10
Moisture Content	%, wet weight basis	25 – 60
Organic Matter Content	%, dry weight basis	> 30
Particle Size	% passing a selected mesh size, dry weight basis	99% pass through 3" screen, >25% passing 3/8" screen
Physical Contaminants (inerts)	%, dry weight basis	< 0.1
Chemical Contaminants[3]	mg/kg (ppm)	Meet or exceed US EPA Class A standard, 40 CFR § 503.13, Tables 1 and 3 levels
Biological Contaminants[4] Select Pathogens Fecal Coliform Bacteria, or Salmonella	MPN per gram per dry weight MPN per 4 grams per dry weight	Meet or exceed US EPA Class A standard, 40 CFR § 503.32(a) levels

[1] Recommended test methodologies are provided in Test Methods for the Examination of Composting and Compost (TMECC, the US Composting Council)

[2] It should be noted that the pH and soluble salt content of the amended soil mix is more relevant to the establishment and growth of a particular plant, than is the pH or soluble salt content of a specific compost (soil conditioner) used to amend the soil. Each specific plant species requires a specific pH range. Each plant also has a salinity tolerance rating, and maximum tolerable quantities are known. Most ornamental plants and turf species can tolerate a soil/media soluble salt level of 2.5 ds/m and 4 ds/m, respectively. Seeds, young seedlings and salt sensitive species often prefer soluble salt levels at half the afore mentioned levels. When specifying the establishment of any plant or turf species, it is important to understand their pH and soluble salt requirements, and how they relate to existing soil conditions.

[3] US EPA Class A standard, 40 CFR § 503.13, Tables 1 and 3 levels = Arsenic 41ppm, Cadmium 39ppm, Copper 1,500ppm, Lead 300ppm, Mercury 17ppm, Molybdenum 75ppm, Nickel 420ppm, Selenium 100ppm, Zinc 2,800ppm.

[4] US EPA Class A standard, 40 CFR § 503.32(a) levels = Salmonella <3 MPN/4 grams of total solids or Fecal Coliform <1000 MPN/gram of total solids.

[5] City Urban Forester may modify the allowable compost specification ranges based on specific field conditions and plant requirements.

C. Submittals: Submit a copy of the lab analysis, performed by a STA Program certified lab, verifying that the compost meets the product parameters listed in Section 2.5 COMPOST (B). The lab analysis should not be more than 90 days old.

2.6 MULCH

A. Mulch shall be applied for moisture retention in soil, abatement of dust and weeds, and for nutrient enrichment of the soil.

B. Mulch shall be high quality, premium coarse-grade bark mulch, 15 mm minimum length, consisting of clean organic plant material.

C. Bark mulch shall conform to the following:

1. Must be a uniform, natural wood color, without dyes, which shall not exhibit a noticeable degree of color change characteristic when wet.
2. Must not have an unpleasant odor.
3. Must be free of dirt, insects, disease, and extraneous debris that would be harmful to the trees being planted.
4. pH: between 4.0 and 8.0.
5. Particle size: 100% passing through a 50mm (2 inch) screen.
6. Soluble salt content: less than 4.0 mmhos/cm.

D. Submittals: Prior to the Contractor ordering the organic coarse-grade bark mulch material, the Contractor shall submit to the City Urban Forester, at the Contractor's expense, one cubic foot sample of the bark mulch material and the supplier's product specification data sheet. The Contractor shall not order any delivery of the bark mulch material until the Contractor's sample has been inspected and approved by the City Urban Forester.

1. If the City Urban Forester disapproves of the sample submitted by the Contractor, then the Contractor shall continue at no expense to the City, to obtain other sources of bark mulch material as specified until the Contractor's sample of such material, meets with the City Urban Forester's approval.

2.7 WATER AND WATERING BAGS

A. Water furnished by the Contractor will be free of ingredients harmful to humans and plant life. The Contractor will supply hoses and other watering equipment required for the work.

B. The Contractor shall be responsible to furnish its own supply of water to the site. At no time will the Contractor seek to use water from private property owners.

C. Contractor may get water from City of Somerville fire hydrants ONLY with the approval of the City's Water Department. The Contract will be responsible for following all the procedures and requirements set by the Water Department. The Water Department will provide the Contractor with a meter and/or backflow device and will charge the Contractor a few for the water and meter and/or backflow device. It is the responsibility of the Contractor to obtain this information. The Somerville Water Department is located at 1 Franey Rd., and can be reached at 617-625-6600 extension 5850, or water@somervillema.gov.

D. Watering for trees shall be provided through use of a drip irrigation bag which shall be approved by the City Urban Forester. Irrigation bag must:

1. Be constructed of plastic or other flexible watertight material.
2. Have a holding capacity of a minimum of 20 gallons.
3. Have an opening in the top for filling.

4. Have a slow drip hole(s) water release system in the bottom, specifically designed to water establishing trees. Rate of complete water release must be no quicker than 5 hours for a complete fill.

E. Submittals: Name of drip irrigation bag product supplier, including manufacturer product data and literature, and sample to be approved by the City Urban Forester.

2.8 TREE STAKING AND GUYING MATERIAL

A. Tree stakes shall be 10 foot long lodge pole wooden stakes free of knots, 3” in diameter, or 2” x 3”, and pointed at one end.

B. Tree ties shall be flat woven straps, made of polyester or polypropylene, 3/4 inch wide, and 900 lb. break strength. Color to be green or black.

C. Submittals: Samples of stakes and tree ties and manufacturer product data and literature shall be submitted to the City Urban Forester for approval.

2.9 EDGING

A. For new or expanded tree wells in brick sidewalks or wells with brick borders, the Contractor shall install edging around the perimeter of the tree well to keep the bricks from displacing.

B. Aluminum edging shall be shop fabricated from aluminum alloy 6063-T6, 3/16 inch thick x 1-5/8 inch or 2-1/4 inch deep, with standard black baked-on acrylic paint finish. Edging shall be furnished in 16-foot lengths.

1. Adjacent sections shall be adjoined using a 4 inch sliding, locking connector of aluminum alloy 6063-T6.

2. Stakes shall be spiral steel spikes with insulating plastic washers 10 inches x 3/8 inch.

C. Name of edging product, supplier and sample to be approved by the City Arborist.

PART 3 – EXECUTION

3.1 SAW CUTTING AND PAVEMENT REMOVAL

A. Certain locations will require the removal of pavement to allow for the excavation or expansion of the planting holes. Pavement types may include cement, bituminous concrete, brick or stone, and other similar substances.

B. All areas where pavement will be removed will be marked in the field by white marking paint. Dimensions of each cut will be provided by the City Urban Forester. All edges are to be cut with straight, clean cuts using a saw. Water shall be used during the saw cutting to reduce dust.

C. The Contractor shall be responsible for the legal disposal of all excavated pavement off site, at the Contractor’s expense.

D. All dust, debris and deposits (including any residue from wet-saw cutting) left behind from the cutting and excavating operation shall be cleaned up immediately and removed from the site following the installation of the tree. Dust, debris, and deposits shall NEVER be left in the newly created tree well.

3.2 REMOVAL OF DEAD OR DYING TREES

A. Certain locations will require the removal of dead or dying trees prior to the installation of a new tree. Locations of each tree removal will be provided by the City Urban Forester. Trees designated for removal will be a maximum of 9 inches in caliper.

B. Contractor will be responsible for the removal and legal disposal of any dead or dying trees that are removed.

C. Saws or other equipment may be necessary for the removal of these dead or dying trees, at the discretion of the contractor.

3.3 REMOVAL OF UNDERGROUND STUMPS

A. Occasionally the Contractor may find a residual stump below the cement or asphalt where the City has located a new tree to be placed. At the direction of the City Urban Forester, the Contractor will remove the stump or grind it down sufficiently to allow for the site to be planted with a new tree. Any sidewalk that is damaged during the removal or grinding of the stump will be repaired at the expense of the Contractor.

3.4 REMOVAL OF COBBLES FROM EXISTING TREE WELLS

A. Certain existing tree wells have a border of stone cobbles (ex. on Somerville Avenue). At the direction of the City Urban Forester, the Contractor will remove these cobbles from the tree wells. The stone cobbles will either be reset after the new tree is installed or legally disposed of, as determined by the City Urban Forester.

3.5 TREE GRATE AND GUARD REMOVAL

A. From time to time prior to the planting of trees and/or at locations with existing trees the City may require that metal tree grates and tree guards be removed. Removal shall be done in such a manner that does not damage an existing tree to remain with whatever tools and equipment the Contractor deems necessary and is approved by the contract supervisor.

B. The legal disposal of the grate and/or guard shall be the sole responsibility of the Contractor. The City reserves the right to keep the grate and/or guard as it deems necessary.

C. After removing the grate and/or guard each tree well is to be weeded and cleaned of all debris. Bark mulch is to be replaced in the tree well to a level that meets the surrounding grade/ sidewalk surface.

3.6 EDGING

A. Edging shall be installed at perimeter of new and expanded tree pits that abut brick paving. Install edging with the base resting on the ground and facing toward the brick paving and sidewalk. Set edging to the required alignment, straight and true and to the required elevation to ensure full paver restraint. Thread spike through insulating washer. Drive spikes into base until spike head firmly wedges washer against flange of aluminum edging.

1. Edging shall be securely staked in required position. Stakes shall be driven every 12 inches in straight runs and into every support section in curved sections.

2. Adjacent lengths shall be attached using manufacturer's standard connections according to manufacturer's published instructions.

3. Edging shall be set plumb and vertical at required line and grade. Straight sections shall not be wavy; curved sections shall be smooth and shall have no kinks or sharp bends.

3.7 TREE PLANTING SEASON

A. Planting shall only be performed when weather and soil conditions are suitable. No planting shall take place during adverse weather conditions as determined by the City Urban Forester. Adverse weather conditions include extremely hot, dry, windy or freezing weather.

B. Install plants during the planting time as described below unless otherwise requested by or approved in writing by the City Urban Forester. On occasion, plantings may take place outside of these times. In the event that the Contractor requests planting outside the dates of the planting season, approval of the request does not change the requirements of the warranty.

1. Spring Planting Season: April 1st – June 15th
2. Fall Planting Season: September 15th – November 30th

3.8 TREE PLANT SELECTION

A. The City Urban Forester will select and tag all specified tree planting material at the nursery location(s).

3.9 PLANT MATERIAL HANDLING, DELIVERY, AND STORAGE

A. Protect materials from deterioration during delivery and storage. Adequately protect plants from drying out, exposure of roots to sun, wind or extremes of heat and cold temperatures. If planting is delayed more than 24 hours after delivery, set plants in a location protected from sun and wind. Provide adequate water to the root ball package during the shipping and storage period.

1. The Contractor will inspect and approve all trees at the nursery(ies) prior to pick up. However, this does not alter the right of the City Urban Forester to inspect and reject unsuitable trees delivered to the planting site.
2. During transport, cover trees with a breathable protective mesh covering (no plastic) to prevent wind damage.
3. When plants cannot be transported and planted immediately upon being dug they shall be stored and protected from desiccation and extremes in temperature by being heeled-in, watered, and covered.
4. Special care shall be taken to insure that the roots of bare root and balled and burlapped trees are not damaged and not allowed to dry out during the course of a work day. Using a soil moisture meter, periodically check the soil moisture in the root balls of all balled and burlapped plants to assure that the plants are being adequately watered. Volumetric soil moisture shall be maintained above wilting point and below field capacity for the root ball substrate or soil.

B. Plants shall be handled, transported, and stored so as to prevent damage of any sort, including but not limited to breaking of branches, scraping or bruising the trunk or root collar, breaking root balls or roots.

1. Bare root and balled and burlapped trees are to be placed on a trailer, truck, or other equipment gently and in a manner that does not damage any portion of the tree. Once placed, they are to be covered in a manner that sunlight does not shine on the roots of the plants and the branches are

protected from wind damage.

2. Move balled and burlapped trees using only the root ball; never pick up or move the tree using the trunk as a handle.
3. All unplanted tree plantings shall be protected at all times from sunlight and drying winds.
4. At no time shall the roots of the trees be exposed to direct sunlight, wind, or drying out. Balled and burlapped and bare root plants are to be covered during all forms of transport, and are not to be uncovered until immediately prior to installation. While sitting and waiting to be installed, plants and associated roots must be covered and protected from light and drying out.

C. Tree plantings shall be delivered to the tree planting site in a well-watered and vigorous condition.

D. If necessary, provide a suitable remote staging area for plants and other supplies. The City Urban Forester shall approve the duration, method and location of storage of plants.

1. Do not deliver more plants to the site than there is space with adequate storage conditions.
2. If desired, the Contractor must request a staging area 30 days before the start of any work. Request will be submitted to the City Urban Forester. If the request is made less than 30 days before the start of any work, the Contractor shall be responsible for furnishing and/or leasing any temporary storage or construction staging area required.
3. All trees shall be stored in an upright position, and grouped according to Genus, Species, and 'cultivar' or 'variety'. Stored trees shall be mulched such that 2/3 of each root ball is covered, and heavily watered twice a day to prevent wilt and undue stress to the trees.
4. Trees are to be removed from the temporary holding area on a daily basis. Only the plants that can be planted in the course of a normal work day should be removed from the holding area.
5. Care shall be taken to not damage the trees or roots during the transport from the temporary holding area to the planting site. It is the Contractor's responsibility to determine the best method to ensure that the roots are not damaged and do not dry out during the course of the planting process. Damaged roots/ plants will be the responsibility of the Contractor.
6. The City Urban Forester may inspect the temporary storage area upon notifications to the Contractor.
7. The Contractor shall provide the City Urban Forester with a schedule of tree pick-up from the temporary storage location, including the day and time of pick up for each tree.

E. If it is determined that poor handling and neglect by the Contractor has caused a plant to die or fail to establish, the Contractor shall be responsible for the cost of replacing the plant. Costs shall include the cost of purchase, cost to remove dead plant, and cost to install new plant. Poor handling and/or neglect may result in contract termination.

3.10 SOIL MOISTURE

A. Volumetric soil moisture level, in both the planting soil and the root balls of all plants, prior to, during and after planting shall be above permanent wilting point and below field capacity for each type of soil texture within the following ranges.

Soil type	Permanent wilting point	Field capacity
Sand, loamy sand, sandy loam	5-8%	12-18%
Loam, sandy clay, sandy clay	14-25%	27-36%

loam		
Clay loam, silt loam	11-22%	31-36%
Silty clay, silty clay loam	22-27%	38-41%

B. The Contractor shall confirm the soil moisture levels with a moisture meter. If the moisture is too high, suspend planting operations until the soil moisture drains to below field capacity.

1. Volumetric soil moisture shall be measured with a digital moisture meter. The meter shall be the Digital Soil Moisture Meter, DSMM500 by General Specialty Tools and Instruments, or approved equivalent.

3.11 GENERAL TREE PLANTING

A. Prior to tree planting, the City Urban Forester will supply in writing to the Contractor specified tree planting locations showing the tree species selected and approved.

B. Contractor installation plan shall be submitted a minimum of 14 days prior to the scheduled installation. Plan should describe the methods, activities, materials and schedule to achieve installation of plants.

C. Tree planting areas may need pavement removal and/or tree or stump removal, as required by the City Urban Forester. All materials excavated from the tree planting areas and considered detrimental to the growth of the trees, such as an existing tree or stump, old wire baskets, burlap and aeration tubes, sidewalk paving, rocks, sub-soil and debris, shall not be reused for fill or in the planting operation, and must be removed from the site and disposed of properly.

D. Any unexpected obstructions at the site that interfere with the tree planting operation will be communicated to the City Urban Forester to determine a solution before planting occurs.

E. Soil of very poor quality or heavy clay encountered by the Contractor must be reported to the City Urban Forester for removal and amended as required.

F. Observe each plant after delivery and prior to installation for damage or other characteristics that may cause rejection of the plant. Notify the City Urban Forester of any condition observed.

3.12 PLANTING HOLE PREPARATION

A. For tree planting pits that are surrounded by brick or stone cobbles, carefully remove brick or stone such that it can be reused after the tree has been planted.

B. Remove all soil, where present, from above the root flare to expose the top-most root where it emerges from the trunk, and measure the distance between the top-most root and the bottom of the root ball or root mass.

C. Hole shall be dug about 10% shallower than this depth.

D. Planting pits shall be excavated to the full width and length of the surface opening. In lawn areas, the planting area must be dug to the depth of the root-ball and 3 times the width.

E. When planting holes are dug using mechanical means, i.e. backhoe, excavator, auger, etc., and the side walls of the pits become plastered or glazed, the plastered or glazed surface shall be properly scarified.

F. Upon approval of planting locations and pavement removal (where applicable), excavate existing soils and remove all trees and stumps 9 inches or less in caliper, and any other deleterious materials as specified herein. The Contractor must haul and legally dispose of excavated material off-site.

G. The tree well will be cut based on the markings on the sidewalk. The dimensions of each tree well will be noted on the planting list given to the Contractor prior to the start of planting. The tree well must be excavated to its full extent. Acceptable material may be put back into tree well and amended as needed with approved planting soil. Remove any stones greater than 1-¼ inches in diameter in the longest dimension, earth clods, sticks, stumps, clay lumps, roots, or other objectionable, extraneous matter or debris from the excavated soil before using it for backfill. If excavated material cannot be reused refer to Section 3.13 SOIL AND WASTE MANAGEMENT for instruction.

H. Surplus excavation and unsuitable material from the planting holes shall be removed from the site and disposed of per Section 3.13 SOIL AND WASTE MANAGEMENT of this specification.

I. Planting pits will require a minimum of 3 feet (36 inches) of walking space for sidewalk pedestrian traffic.

J. Planting wells and areas shall be approved by the City Urban Forester, or designee, before back filling.

K. Tree wells shall be at least 18 square feet, 6’ x 3’ or as directed by the City Urban Forester.

3.13 SOIL AND WASTE MANAGEMENT

A. For guidelines and policies related to handling and disposal of contaminated soil please refer to the Department of Environmental Protection (DEP) website at http://www.mass.gov/eea/agencies/massdep/.

B. It is the objective of soil/fill management practices specified here to handle all soil/fill excavated during the course of this contract in a cost-effective manner and in accordance with applicable State and Federal regulations. The Contractor shall reuse excavated materials, as approved by the City Urban Forester, prior to using imported fill in order to reduce the volume of material to be disposed off-site provided the material is geotechnically suitable as backfill and does not result in spreading contamination to other areas or other soil/fill strata. Excavated soil/fill, which is displaced by planting of trees, may be used as backfill elsewhere on the project provided the soil/fill is geotechnically suitable and does not result in spreading contamination or degrade the environmental quality at the location of reuse. Imported backfill shall be used only as accepted by the City Urban Forester.

C. Any soils which exhibit petroleum or chemical odor or visual indications of oil or hazardous materials shall be handled as potentially contaminated soils. Soil which does not have any evidence of contamination can be reused within the *area of excavation*. Soil/fill which is staged and characterized can be reused within the area of excavation or elsewhere on site provided the material has equal or less contamination than the point where it is to be reused.

D. Contaminated soil/fill (including petroleum-contaminated soil/fill) which cannot be reused on site shall be removed and disposed of by the Contractor, or shall be delivered within the City to a stockpile location to be determined by the City of Somerville.

E. Notification procedures:

   1. In the event of an emergency, the Contractor shall contact the following entities at the earliest possible opportunity:

      a. City of Somerville designated representatives

      b. City of Somerville Department of Public Works

c. City of Somerville Fire Department

d. City Urban Forester

e. MassDEP

2. The Contractor shall prepare in advance of work activities a notification list, complete with phone numbers, addresses, and contact names for all parties to be notified (including, but not limited to, the parties listed above) in the event of an emergency.

3.14 TREE INSTALLATION

A. The root system of each plant shall be observed by the Contractor at the time of planting to confirm that the roots meet the requirements for plant root quality in *Part 2.1.C (Part 2 – Products: Trees General: Plant quality)*. The Contractor shall undertake at the time of planting all modifications to the root system required by the City Urban Forester to meet these quality standards.

1. Modifications at the time of planting to meet the specifications for the depth of the root collar and removal of stem girdling roots and circling roots may make the plant unstable or stress the plant to the point that the City Urban Forester may choose to reject the plant rather than permitting the modification.

2. Any modifications required by the City Urban Forester to make the root system conform to the plant quality standards outlined in *Part 2.1.C (Part 2 – Products: Trees General: Plant quality)*, or other requirements related to the permitted root ball package, shall not be considered as grounds to modify or void the plant warranty.

3. The resulting root ball may need additional staking and water after planting. The City Urban Forester may reject the plant if the root modification process makes the tree unstable or if the tree is not healthy at the end of the warranty period. Such plants shall still be covered under the warranty.

4. The Contractor remains responsible to confirm that the grower has made all required root modifications noted during any nursery observations

B. Trees shall be plumb and upright, faced to give best appearance, and planted at the center of the planting areas. The tree graft, if applicable, shall be visible above the grade. If the Contractor is unable to install tree at proper grade and/or in center of tree well or designated planting location, the Contractor shall not install tree and immediately contact the City Urban Forester.

C. Trunk flare must be visible and free of adventitious roots.

1. Place the tree in the planting hole so that the top of the root ball where the trunk flare is visible is 1” above the established sidewalk level. Do not place soil on top of the root ball. If root flare is covered or set significantly higher (or lower) than 1” above sidewalk grade than the Contractor will not be paid for that tree until it is properly adjusted.

D. Any non-degradable materials used in wrapping the root ball must be entirely and carefully removed so as not to disturb the roots.

1. Carefully cut and remove all rope, string, and twine from the root ball, making sure not to damage the trunk or roots in the process.

2. Cut and remove the entire wire basket from root ball, while keeping the root ball intact. If the root ball is loose, it is acceptable to cut the top 2/3 off of the basket, and cut the sides of the remaining wire such that the roots will not be impaired in the future. In the case of a loose root ball, do not pull the wires out from under the root ball.

3. Remove top 2/3 of burlap from the root ball. DO NOT PULL BURLAP OUT FROM UNDER THE ROOT BALL. Push or fold the remaining sides of the burlap into the bottom of the well after the tree is properly set.
4. All materials cut away from the root ball must be removed from the site.

3.15 FERTILIZING

A. Insert approved slow-release tree fertilizer packets before back-filling. The number of packets to insert shall be based on the percent nitrogen in the packet and the size of the tree planting area, with the approval of the City Urban Forester.

3.16 BACK-FILLING

A. Carefully backfill the space around the root ball by hand using the existing soil that was excavated for the planting space and approved topsoil in layers, and water each layer thoroughly to fill all voids and allow to settle. Finish back-filling to a depth such that finished grade level at settlement will be at established sidewalk level.
   1. Fill hole about 1/3 full and gently slice a shovel down into the backfill 15 to 25 times all around the tree. Be careful not to damage the trunk or roots in the process. DO NOT step firmly in the backfill soil because this could compact it and restrict root growth. DO NOT over compact the backfill or use mechanical or pneumatic tamping equipment. Over compaction shall be defined as greater than 85% of maximum dry density as measured by a standard proctor compaction test, or greater than 250 psi as measured by a cone penetrometer when the volumetric soil moisture is lower than field capacity.
   2. Water the first third of soil to settle and eliminate air pockets. Backfill the remainder of the tree well in layers not to exceed six 6 inches. Water soil to settle. Do not flood the planting space. If the soil is above field capacity, allow the soil to drain to below field capacity before finishing the planting. Air pockets shall be eliminated and backfill continued until the planting soil is brought to grade level.

B. When the hole is filled with soil the root ball should remain approximately 2 inches above the backfill soil. The top of the root ball is not to be covered by the backfill soil.

C. Surround each tree with a shoulder of topsoil around the outside of the root ball to form a temporary saucer, 3 to 4 inches deep. Tamp the berm to reduce leaking and erosion of the saucer.

3.17 WATERING (INSTALLATION THROUGH FINAL ACCEPTANCE)

A. The Contractor shall be fully responsible to ensure that adequate water is provided to all plants from the point of installation until the date of final acceptance.

B. At the time of planting judiciously flood plants with water. After installing the tree, bringing soil to grade and forming the planting saucer, thoroughly soak the tree well by repeatedly filling the well with water to the full depth of the saucer, allowing the water to completely percolate into the soil between fillings.

C. Watering shall be provided from May 15 through November 15 at the discretion of the City Urban Forester.
   1. The Contractor will also include in his base bid costs for watering trees <u>twice per week</u> exclusive of Saturdays, Sundays and holidays for a period of <u>30 days</u> from the date of planting.

2. Beginning 30 days after planting, the Contractor will water trees once per week.

D. Watering shall be provided through use of a drip irrigation bag which shall be furnished by the Contractor and installed immediately on each tree following planting per the manufacturer's instructions.

1. Immediately following the planting of the tree, a drip irrigation bag is to be installed per the manufacturer's instructions.
2. Drip irrigation bag is to be secured with a zip tie or similar locking device to avoid unwarranted removal.
3. At the end of the watering period the Contractor shall remove all irrigation bags and deliver them neatly stacked to the Department of Public Works for winter storage.

E. Contractor shall provide the City Urban Forester with a schedule of watering during the warranty period. The watering schedule shall include details on the order in which the trees will be watered, the frequency of watering, and the volume of water that will be provided to each tree during each visit.

F. For each day that watering occurs, the watering crew is to report to the City Urban Forester, by phone or in person, as to the locations they will be watering that day.

G. Assure that hoses and watering equipment and other maintenance equipment does not block paths or be placed in a manner that may create tripping hazards. Use standard safety warning barriers and other procedures as necessary to ensure the site is safe at all times for any passersby.

H. All installed trees that are injured or damaged due to the lack of water, or the use of too much water, shall be the Contractor's responsibility to correct.

I. The Contractor is to provide a watering truck and water as outlined in the Equipment section (Section 1.12 QUALITY ASSURANCE (B)) and Products section (Section 2.7 WATER AND WATERING BAGS) of this specification.

3.18 WATERING (2-YEAR WARRANTY PERIOD)

A. Watering during the 2-year warranty period shall be performed as specified in Section 3.17 WATERING (INSTALLATION THROUGH FINAL ACCEPTANCE) and shall occur a minimum of once per week (approximately 4x per month) or as acceptable to the City Urban Forester.

B. Watering and maintenance during the warranty period will be recorded and tracked as described in the Section 3.25 WARRANTY of this specification.

C. If a tree is dead or damaged and not watered, the Contractor shall notify the City Urban Forester immediately.

D. The watering bags shall remain the property of the City at the completion of the work.

3.19 COMPOSTING

A. Applying compost to the soil surface after planting to help inhibit weed growth, conserve soil moisture, and reduce soil erosion.

B. Compost shall be uniformly applied over the entire area at an average depth of 1- 2 inches immediately after weed removal and planting. Compost is to be applied on top of soil, and underneath wood bark mulch.

C. Avoid placing compost against the trunk or stem of any plant material.

D. Water thoroughly before and after placing compost to saturate the root zone and entire compost layer.

E. All stones, roots, or other debris shall be removed from the surface of the composted area.

3.20 MULCHING

A. Place coarse grade wood mulch on top of compost immediately after planting. No planting areas shall be left for any longer than thirty minutes without mulch. No mulch material shall be applied prior to the initial watering of plant.

B. Apply a three inch layer of mulch (after settlement) around plants. Mulched area shall be six feet in diameter around the trunk of the plant, unless otherwise specified by the City Urban Forester. For tree wells that are less than six feet long in any direction, mulch shall be applied to the entire tree well.

C. Mulch shall NOT come in contact with the trunk of the plant or the root flare. No mulch should be placed within 2 to 3 inches from the trunk.

D. Periodically throughout the warranty period, at the direction of the City Urban Forester, re-apply mulch to the planting areas in the manner described in this section.

E. From time to time the City may require additional mulch to be placed at various tree locations and existing planting beds citywide. Mulch is to be applied as outlined in this section.

F. When the City opts to mulch existing trees and planting beds the Contractor is to first remove all existing unwanted vegetation (i.e. weeds) and debris.

3.21 STAKING

A. Stake, guy and anchor immediately after planting of each tree. Two stakes shall be used for each tree from 1” caliper up to and including 3-1/2” caliper.

B. Stakes for supporting trees shall be of uniform size, either 2” x 3” x 10’ or 3” diameter x 10’, and which are capable of standing in the ground at least two years.

C. Equally space stakes and set parallel to structures, contours, paving or curbs. Set trees plumb and hold in position until the soil has been solidly backfilled around the root ball and/or roots. Stakes shall be driven to sufficient depth to hold the tree rigid, and shall be fastened to tree with approved strapping, and with appropriate knot.

D. Tree guying shall utilize the tree staking and guying materials specified. Guying to be tied in such a manner as to create a minimum 12-inch loop to prevent girdling. Refer to manufacturer’s recommendations and the planting detail for installation.

E. Stakes shall be driven into the ground, and resulting stakes will be of a uniform height. Place stakes to avoid root damage and at reasonable and proper distance from trunk to prevent movement of tree and root system; tension on stakes and guy wires to be equal and at a slight angle away from tree.

F. Plants shall stand plumb after staking or guying.

G. Any stake or strap that becomes displaced or broken shall be reset or replaced promptly.

H. Stakes and guys shall be removed from all trees by the Contractor after one full growing season, or at other times as required by the City Urban Forester. If the stability of any tree will be compromised by removing the stakes after one full growing season, notify the City Urban Forester immediately. If any tree becomes unstable after removing the stakes, the stakes will be replaced for an additional year, following the protocol outlined in this section, at no additional cost to the City.

3.22 PRUNING

A. Pruning trees shall be limited to addressing structural defects as shown in details; follow recommendations in book “Structural Pruning: A Guide for the Green Industry” published by Urban Tree Foundation, Visalia, CA.

B. All pruning shall be performed by a person experienced in structural tree pruning.

C. Pruning shall be done with clean, sharp tools.

D. Immediately before or after planting only prune dead, badly bruised, broken, or crossing limbs.

E. Except for plants specified as multi-stemmed or as otherwise instructed by the City Urban Forester, preserve or create one central leader.

F. Pruning of large trees shall be done using pole pruners, or, if needed, from a ladder or hydraulic lift to gain access to the top of the tree. Do not climb in newly planted trees. Small trees can be structurally pruned by laying them over before planting. Pruning may also be performed at the nursery prior to shipping.

G. No tree paint or sealants shall be used.

H. Remove and replace excessively pruned or malformed stock resulting from improper pruning that occurred in the nursery or after.

3.23 CLEAN UP

A. Removal and disposal of tree and woody vegetation debris.

1. The Contractor shall remove and dispose of all debris resulting from the work at each job site, including, but not limited to: excess planting soil, subsoil, mulch, plants, and packaging. Each job site is to be left in a condition equal to or better than that which existed prior to the execution of work order. The Contractor shall be solely responsible for disposal of all debris.

2. The City reserves the right to retain all debris, chips and wood from work completed on City of Somerville trees at no cost to the City. The City reserves the right to use this material in any way it sees fit.

B. Restoration of work areas and cleanup.

1. Immediately clean up any spilled or tracked soil, fuel, oil, trash or debris deposited by the Contractor from all surfaces within the project or on public right of ways and neighboring property. Ensure that mulch is confined to planting beds.

2. All areas damaged during the process of the work shall be the responsibility of the Contractor and who shall restore the disturbed and damaged areas to a condition satisfactory to the City Urban Forester. This may include, but not be limited to tilling, grading, paving, fertilizing, mulching, etc.

3. The Contractor shall also be responsible for any other damage caused by his or her process of work operations and shall dispose of all rubbish, excess soil, etc., as directed by the City Urban Forester, all of which shall be done at no expense to the City of Somerville.

4. For trees planted in brick sidewalks or for tree wells that are surrounded by stone cobbles, bricks and/or cobbles will be replaced around the edges of the tree well to match the pattern of the surrounding sidewalk and the other tree wells along the street. Reuse the bricks/cobbles that were set aside prior to planting.

3.24 WATER METER AND BACKFLOW PREVENTION DEVICES

A. When hydrants are being used, the Somerville Water System must be protected with backflow device and necessary fittings as per Massachusetts Department of Environmental Protection (DEP) Regulations 310 CMR 22.22 and as per the Somerville Water Department. Somerville-specific water meters and backflow devices must be used for any and all hydrant use operations. The Somerville Water Department is located at 1 Franey Rd., and can be reached at 617-625-6600 extension 5850, or water@somervillema.gov.

3.25 WARRANTY

A. Trees will be warrantied for a minimum period of time of two (2) years after the initial acceptance. Trees planted in the Spring shall be alive and in satisfactory growth on June 1 of the second year after planting [*ex.* trees planted in Spring 2021 shall be warrantied until June 1, 2023]. Tree planted in the Fall shall be alive and in satisfactory growth on November 30 of the second year after planting [*ex.* trees planted in Fall 2021 shall be warrantied until November 30, 2023].

B. During the warranty period, provide all maintenance for all plantings. Tree care and maintenance shall begin immediately after planting and throughout the warranty period to keep the plants in a healthy state and the planting areas clean and neat until final acceptance. Maintenance throughout the warranty period shall include, but is not limited to, the following:

1. **Straightening and resetting plants to proper grades**:

    a. Maintain all plants in a plumb position throughout the warranty period. Reset any plants that have settled or are leaning as soon as the condition is noticed, and straighten all trees that move out of plumb. Plants to be straightened shall be excavated and the root ball moved to a plumb position, and then re-backfilled. Do not straighten plants by pulling the trunk with guys

2. **Watering**:

    a. Provide all water required to keep soil within and around the root balls at optimum moisture content for plant growth.

    b. Each tree shall be watered at least once per week during the growing season (see Sections 3.17 WATERING (INSTALLATION THROUGH FINAL ACCEPTANCE) and 3.18 WATERING (2-YEAR WARRANTY PERIOD) of this specification), except when rainfall provides sufficient moisture.

    c. Check soil moisture and root ball moisture with a soil moisture meter on a regular basis and record moisture readings. Do not over water. Contact the City Urban Forester to approve any adjustments to the watering schedule.

    d. Maintain all drip irrigation bags and keep them optimally operational.

3. **Weeding**:

    a. Keep all tree wells free of weeds. Hand-remove all weeds; chemical weed control is not permitted.

4. **Mulch replacement**:

    a. Refresh mulch as directed by the City Urban Forester to maintain complete coverage, but do not over mulch. At no time shall the overall mulch thickness be greater than 3 inches. Do not apply mulch within 2 to 3 inches of the trunks of any trees. Replacement mulch shall meet the requirements of the original approved material.

5. **Pruning**:
    a. Remove cross over branching, shorten or remove developing co dominant leaders, dead wood and winter-damaged branches. Unless directed by the City Urban Forester, do not shear plants or make heading cuts.
    b. At the end of the warranty period each tree must be free of dead branches and shall be pruned for good structure based on industry standards and as directed by the City Urban Forester.
6. **Treating for insect pests and diseases**:
    a. Maintain disease, insects and other pests at manageable levels. Manageable levels shall be defined as damage to plants that may be noticeable to a professional but not to the average person. Use least invasive methods to control plant disease and insect outbreaks. The City Urban Forester must approve in advance the use of all chemical pesticide applications. The use of neonicotinoid insecticides is strictly prohibited.
7. **Repairing and replacing tree stakes, guys, and anchors**:
    a. Maintain plant guys in a taught position.
    b. Complete removal of stakes and guy wires: at the end of 1 year after planting, the Contractor shall remove from the site the stakes and guying materials from all trees, unless otherwise directed by the City Urban Forester, at no additional charge to the City.
8. **Trash removal**:
    a. Remove all trash and debris from all tree wells and maintain the wells in a neat and tidy appearance.
9. **Plant replacement**:
    a. Replace all plants that are defective, as defined in the warranty provisions, as soon as the plant decline is obvious and in suitable weather and season for planting as outlined in above sections. Plants that become defective during the maintenance period shall be covered and replaced under the warranty provisions.

C. The City Urban Forester, at his/her discretion, may require the Contractor to address tree planting related issues as they develop.

D. Maintain a detailed log of all maintenance activities including types of tasks, date of task, types and quantities of materials and products used, watering times and amounts, and number of each crew. Periodically review the logs with the City Urban Forester, and submit a copy of the logs monthly.

E. Notify the City Urban Forester in writing if maintenance, including watering, is not sufficient to maintain plants in a healthy condition. Such notification must be made in a timely period so that the City Urban Forester may take corrective action. Notification must define the maintenance needs and describe any recommended corrective action.

1. In the event that the Contractor fails to visit the site and/or notify, in writing, the City Urban Forester of maintenance needs, lack of maintenance shall not be used as grounds for voiding or modifying the provisions of the warranty.

F. The Contractor shall meet with the City Urban Forester semi-annually during the warranty period to inspect the plantings and shall take immediate action to identify potential problems and undertake corrective measures.

G. At the end of the warranty period attend a hand-over meeting to formally transfer the responsibilities of maintenance to the City Urban Forester. Provide all information on past maintenance activities and provide a list of critical tasks that will be needed over the next 12 months. Provide all maintenance logs. Make the Contractor's Supervisor available for a minimum of one year after the end of the warranty period to answer questions about past maintenance.

H. Defective work shall be corrected immediately after becoming apparent, weather and season permitting. The City Urban Forester shall be notified immediately of any plants that die during the warranty period. Dead plants shall be removed at once regardless of the cause of death at no additional charge to the City. Replacement of dead trees will be done immediately if during the specified installation season. If dead tree has been removed out of planting season, the Contractor shall wait until the beginning of the subsequent planting season, at which time the replacement tree will be planted. If tree to be replaced is a fall hazard species the Contractor shall wait until the beginning of the spring planting season, at which time the replacement tree will be planted.

I. The Contractor will be responsible for all labor, equipment and materials cost associated with the planting of the replacement plants. When this determination has been made the Contractor shall not be entitled to any further payment for the planting of the replacement plant outside of the payment for the original plant installation.

J. At the end of the warranty period, the Contractor and the City will meet to inspect the plants to determine if they are acceptable. To be accepted, the work must be in like-new condition. Each tree must exhibit the form typical to its species with at least 75% of its original canopy viable. Any plant that has lost its leader will be rejected.

K. Based on the inspection, the City will prepare a list of deficiencies in the work. When the deficiencies are corrected to the City's satisfaction, the City will issue a written notice that the warranty period has ended.

3.26 REPLACEMENTS

A. During the warranty period, dead, unsightly or unhealthy trees should be removed promptly and replaced by the Contractor as required by the City Urban Forester.

B. Vandalized trees should be brought to the attention of the City Urban Forester.

C. Replacements shall conform to requirements in the Specifications and shall be replaced as many times as necessary to ensure the establishment of healthy plants. Replacements shall be maintained and guaranteed for two years from the time of replacement, per the terms of the Warranty Period.

3.27 SEMI-FINAL INSPECTION

A. Semi-Final inspection will be made by the City Urban Forester upon completion of all planting work specified herein.

B. Upon written notice from the Contractor, the City Urban Forester shall perform a semi-final inspection to review the work.

   1. Notification shall be at least 5 business days prior to the anticipated inspection dates.

C. The Contractor may offer for acceptance the entire project or a completed readily defined area, if approved by the City Urban Forester. All work in the Contract shall be found in neat, clean and safe condition.

3.28 SEMI-FINAL ACCEPTANCE

A. The City Urban Forester will notify Contractor in writing of acceptance in whole or in part of work, exclusive of maintenance and possible replacement of trees subject to warranty, or of requirements for completion if deficiencies exist. Work will not be submitted for payment without the City Urban Forester’s written acceptance. Semi-final acceptance can only occur after the 30 day post-installation watering (2x per week) has been completed and confirmed.

B. The plant Warranty Period begins at date of written notification of semi-final acceptance from the City Urban Forester.

3.29 END OF WARRANTY FINAL INSPECTION AND ACCEPTANCE

A. At the end of the warranty and maintenance period, and upon written application from the Contractor, the City Urban Forester shall observe the work and establish that all provisions of the contract are complete and the work is satisfactory, including watering and maintenance.

B. Prior to final acceptance, any dead, missing or unhealthy trees shall be replaced. If a substantial number of plants are unsatisfactory, missing or dead, acceptance will not be granted until replacements are made and the Contractor's responsibility for the maintenance and warranty (which will require extension) is completed.

C. If the work is satisfactory, the maintenance period will end on the date of the final observation.

D. If the work is deemed unsatisfactory, the maintenance period will continue at no additional expense to the City until the work has been completed, observed, and approved by the City Urban Forester.

RECOMMENDED SPECIES

This list contains the trees that the city currently installs as street trees. Alternative varieties or cultivars may be considered by the City Urban Forester.

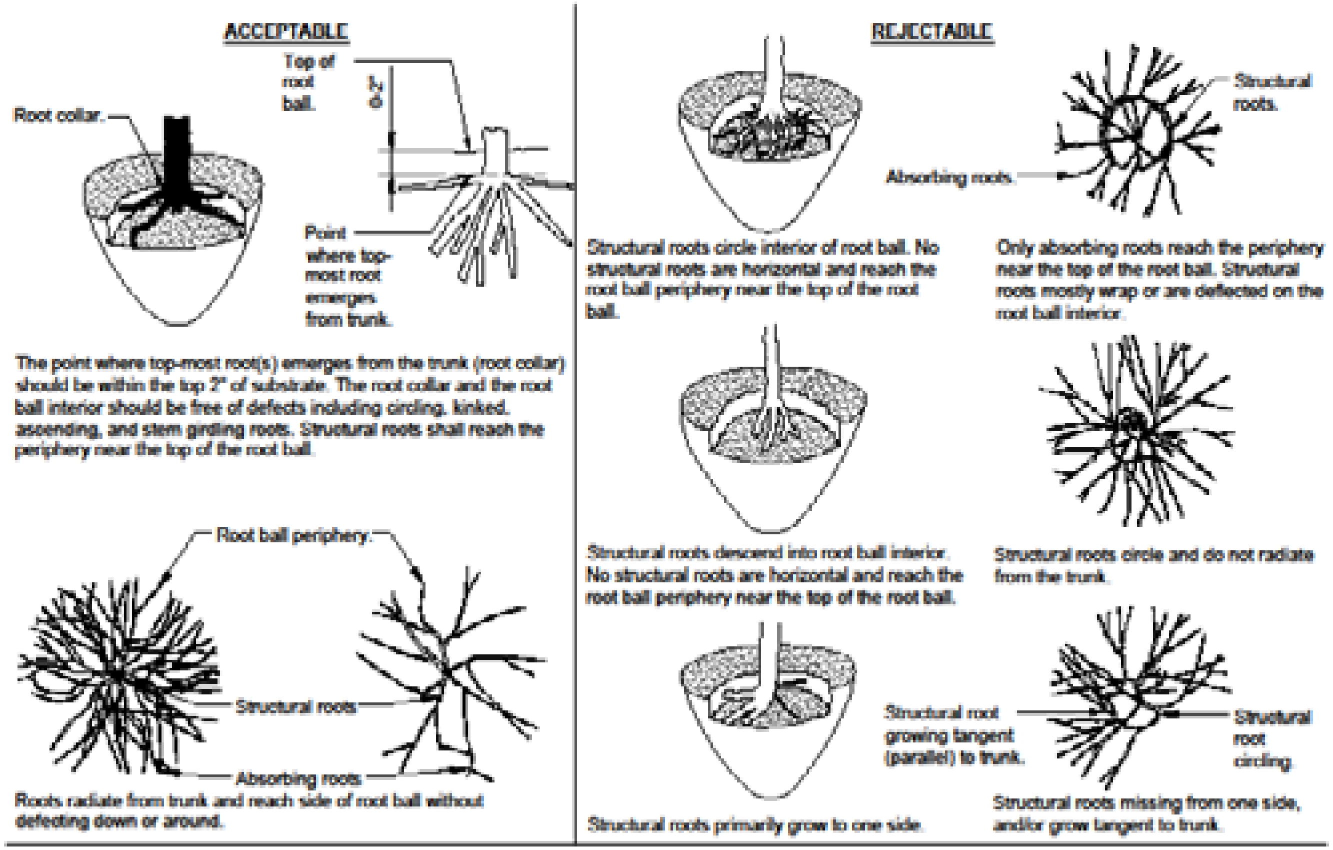
Shade Tree (no wires present)

Species	Preferred Cultivars	Height (feet)
Red maple (*Acer rubrum*)*	Redpointe®, Red Sunset®, many others	40-60
Armstrong Red maple (*Acer* x *freemanii*)*		50-70
River birch (*Betula nigra*)		40-70
European Hornbeam (*Carpinus betulus*)	Brownstone, Franz Fontaine, Fastigata	30-60
Sugarberry (*Celtis laevigata*)	All Seasons	60-80
Hackberry (*Celtis occidentalis*)	Magnifica	40-60
Katsuratree (*Cercidiphyllum japonicum*)		40-60
Hardy Rubber Tree (*Eucommia ulmoides*)		40-60
Ginkgo (*Ginkgo biloba*)	Autumn Gold, Presidential Gold	40-80
Honeylocust (*Gleditsia triacanthos*)*	Halka, Perfection, Shademaster®, Skyline®, Street Keeper	30-70
Kentucky coffeetree (*Gymnocladus dioicus*)	Espresso, Stately Manor	60-75
Sweetgum (*Liquidambar styraciflua*)	Rotundiloba	60-75
Tuliptree (*Liriodendron tulipifera*)		70-90
Dawn redwood (*Metasequoia glyptostroboides*)		70-100
London planetree (*Platanus* x *acerifolia)*	Bloodgood, Columbia, Exclamation, Liberty	70-100
Fire cherry (*Prunus pennsylvanica*)		50-80
Black cherry (*Prunus serotina*)		50-60
Sawtooth oak (*Quercus acutissima*)		40-60
Swamp White oak (*Quercus bicolor*)		60-80
Shingle oak (*Quercus imbricaria*)		50-60
Chestnut oak (*Quercus montana*)		60-70
Pin oak (*Quercus palustris*)		60-70
Willow oak (*Quercus phellos*)		40-60
Red oak (*Quercus rubra*)		60-75
Japanese pagoda tree (*Styphnolobium japonicum*)	Regent	50-75
American linden (*Tilia americana*)	Douglas, Fastigiata, Legend, Redmond	60-80
Littleleaf linden (*Tilia cordata*)	Greenspire®, Prestige®	60-70
Silver linden (*Tilia tormentosa*)	Green Mountain, Sterling Silver	50-70
American elm (*Ulmus americana*)	Jefferson (*NOT Princeton, NOT Pioneer*)	50-70
Chinese elm (*Ulmus parvifolia*)	Allee®, Athena®, many others	40-60
Elm cultivars (*Ulmus* spp.)	Accolade®, Emerald Sunshine®, Homestead, Prospector	40-60
Japanese Zelkova (*Zelkova serrata*)	Green Vase, Village Green	50-80

Ornamental Tree (overhead wires present)

Species	Preferred Cultivars	Height (feet)
Trident maple (*Acer buergerianum*)*	Streetwise®	20-35
Hedge maple (*Acer campestre*)*	Queen Elizabeth	25-30
Paperbark maple (*Acer griseum*)*		20-30
Miyabe maple (*Acer miyabei*)*		30-40
Amur maple (*Acer tataricum* subsp. *ginnala*)*		15-25
Three-flower maple (*Acer triflorum*)*		20-30
Shantung maple (*Acer truncatum*)*		20-25(30)
Serviceberry (*Amelanchier* spp.)	Autumn Sunset, Cumulus, White Pillar	15-30
American hornbeam (*Carpinus caroliniana*)		20-30(50)
Eastern redbud (*Cercis canadensis*)		20-30
Corneliancherry dogwood (*Cornus mas*)		20-25
Hawthorn (*Crategus* spp.)	Princeton Sentry, Winter King, Crimson Cloud	20-30
Amur maackia (*Maackia amurensis*)		20-30
Osage orange (*Maclura pomifera* var inermis)	Thornless and fruitless cultivars	30-50
Crabapple spp (*Malus* spp.)	*Malus* x *zumi,* Donald Wyman, Spring Snow	15-25
Persian ironwood (*Parrotia persica*)	Jennifer Teates, Vanessa	20-40
Purpleleaf plum (*Prunus cerasifera*)	Atropurpurea, Newport, Thundercloud	15-30
European birdcherry (*Prunus padus*)		30-40
Sargent cherry (*Prunus sargentii*)	Accolade	40-50
Kwanzan cherry (*Prunus serrulata* 'Kwanzan')		25-40
Snowgoose cherry (*Prunus serrulata* 'Snowgoose')		20
Higan cherry (*Prunus subhirtella*)	Autumnalis, Autumnalis Rosea	20-40
Common chokecherry (*Prunus virginiana*)	Shubert	20-30
Okame cherry (*Prunus* x *incamp* 'Okame')		20-30
Yoshino cherry (*Prunus* x *yeodensis*)	Akebono	(25)40-50
Japanese tree lilac (*Syringa reticulata*)	Ivory Silk	20-30
Turkish filbert (*Corylus colurna*)		40-50
Black gum (*Nyssa sylvatica*)		30-50
American Hophornbeam (*Ostrya virginiana*)		25-40
Golden raintree (*Koelreuteria paniculata*)		30-40

*Note: the City of Somerville ***only rarely*** plants Honeylocust or Maple species.

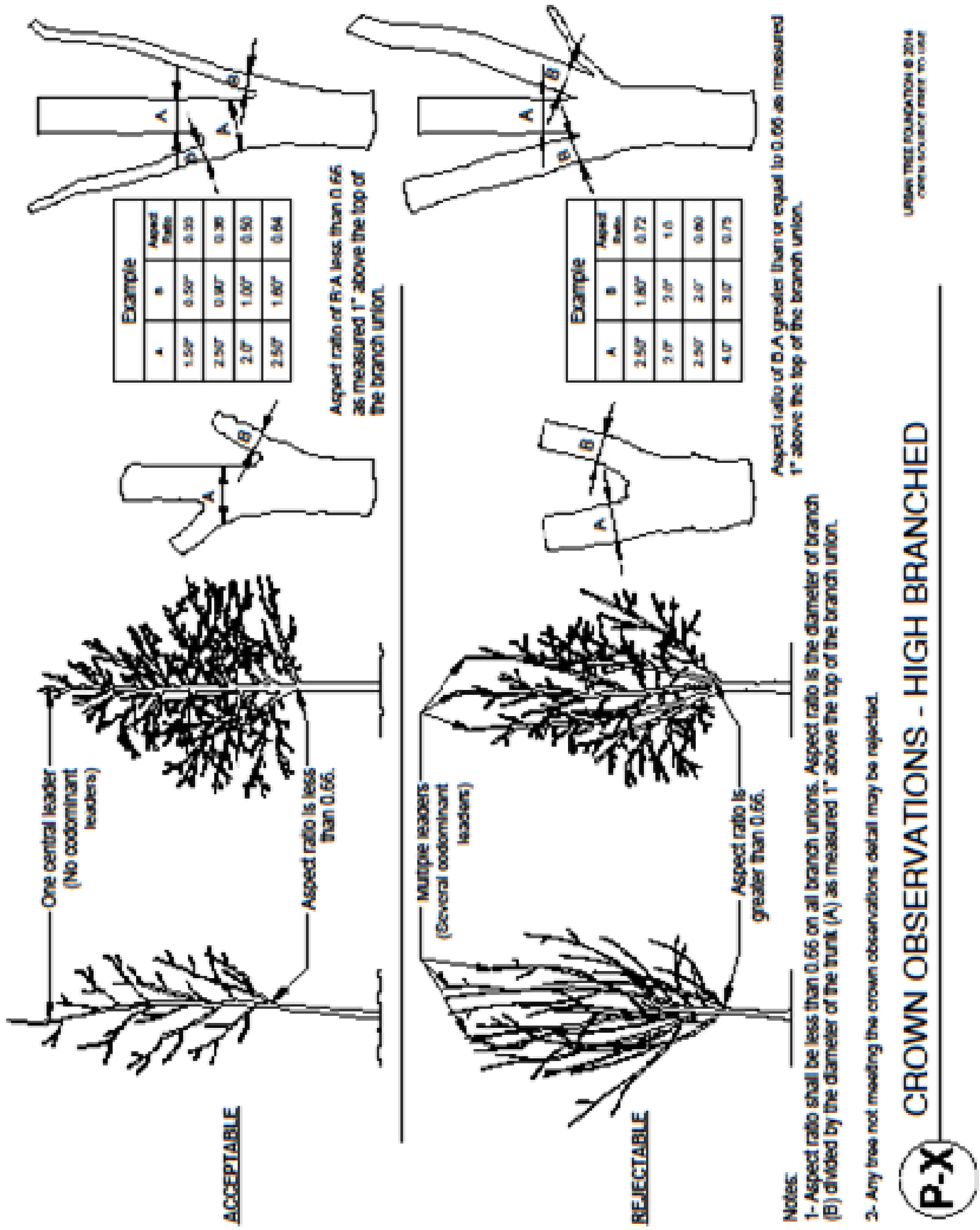


Notes:

1- Observations of roots shall occur prior to acceptance. Roots and soil may be removed during the observation process; substrate/soil shall be replaced after the observations have been completed.

2- See specifications for observation process and requirements.

P-X ROOT OBSERVATIONS DETAIL - BALLED AND BURLAPPED


ACCEPTABLE
One central leader (No codominant leaders)
Aspect ratio is less than 0.66.
Example
A | B | Aspect Ratio
1.50" | 0.50" | 0.33
2.50" | 0.90" | 0.36
2.0" | 1.00" | 0.50
2.50" | 1.60" | 0.64
Aspect ratio of B:A less than 0.66 as measured 1" above the top of the branch union.
REJECTABLE
Multiple leaders (Several codominant leaders)
Aspect ratio is greater than 0.66.
Example
A | B | Aspect Ratio
2.50" | 1.80" | 0.72
2.0" | 2.0" | 1.0
2.50" | 2.0" | 0.80
4.0" | 3.0" | 0.75
Aspect ratio of B:A greater than or equal to 0.66 as measured 1" above the top of the branch union.
Notes:
1- Aspect ratio shall be less than 0.66 on all branch unions. Aspect ratio is the diameter of branch (B) divided by the diameter of the trunk (A) as measured 1" above the top of the branch union.
2- Any tree not meeting the crown observations detail may be rejected.
P-X
CROWN OBSERVATIONS - HIGH BRANCHED
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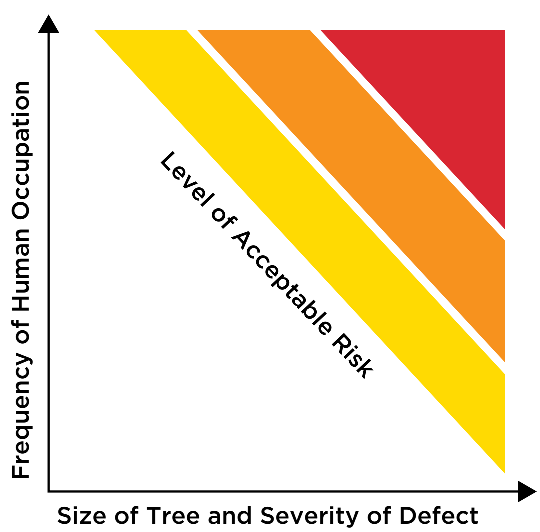
RISK ASSESSMENT AND PRIORITY AND PROACTIVE MAINTENANCE

Risk Assessment

Every tree has an inherent risk of tree failure or defective tree part failure. During the inventory, Davey Resource Group, Inc. (DRG) performed a Level 2 qualitative risk assessment for each tree and assigned a risk rating based on *ANSI A300 (Part 9)* (ANSI, 2011), and the companion publication *Best Management Practices: Tree Risk Assessment* (Smiley et al., 2011). Trees can have multiple failure modes with various risk ratings. One risk rating per tree was assigned during the inventory. The failure mode having the greatest risk served as the overall tree risk rating. The specified time period for the risk assessment is one year.



- ***Likelihood of Failure****—Identifies the most likely failure and rates the likelihood that the structural defect(s) will result in failure based on observed, current conditions.*
  - » **Improbable**—The tree or branch is not likely to fail during normal weather conditions and may not fail in many severe weather conditions within the specified time period.
  - » **Possible**—Failure could occur but is unlikely during normal weather conditions within the specified time period.
  - » **Probable**—Failure may be expected under normal weather conditions within the specified time period.
- ***Likelihood of Impacting a Target****—The rate of occupancy of targets within the target zone and any factors that could affect the failed tree as it falls towards the target.*
  - » **Very low**—The chance of the failed tree or branch impacting the target is remote.
    - Rarely used sites
    - Examples include rarely used trails or trailheads
    - Instances where target areas provide protection

» **Low**—It is not likely that the failed tree or branch will impact the target.

- Occasional use area fully exposed to tree
- Frequently used area partially exposed to tree
- Constant use area that is well protected

» **Medium**—The failed tree or branch may or may not impact the target.

- Frequently used areas that are partially exposed to the tree on one side
- Constantly occupied area partially protected from the tree

» **High**—The failed tree or branch will most likely impact the target.

- Fixed target is fully exposed to the tree or tree part

- ***Categorizing Likelihood of Tree Failure Impacting a Target***—*The likelihood for failure and the likelihood of impacting a target are combined in the matrix below to determine the likelihood of tree failure impacting a target.*

- ***Consequence of Failure***—*The consequences of tree failure are based on the categorization of target and potential harm that may occur. Consequences can vary depending upon size of defect, distance of fall for tree or limb, and any other factors that may protect a target from harm. Target values are subjective and should be assessed from the client's perspective.*

» **Negligible**—Consequences involve low value damage and do not involve personal injury.

- Small branch striking a fence
- Medium-sized branch striking a shrub bed
- Large tree part striking structure and causing monetary damage
- Disruption of power to landscape lights

» **Minor**—Consequences involve low to moderate property damage, small disruptions to traffic or communication utility, or very minor injury.

- Small branch striking a house roof from a high height
- Medium-sized branch striking a deck from a moderate height
- Large tree part striking a structure, causing moderate monetary damage
- Short-term disruption of power at service drop to house
- Temporary disruption of traffic on neighborhood street

» ***Significant***—Consequences involve property damage of moderate to high value, considerable disruption, or personal injury.

Likelihood of Failure	Likelihood of Impacting Target			
	Very Low	Low	Medium	High
Imminent	Unlikely	Somewhat likely	Likely	Very Likely
Probable	Unlikely	Unlikely	Somewhat likely	Likely
Possible	Unlikely	Unlikely	Unlikely	Somewhat likely
Improbable	Unlikely	Unlikely	Unlikely	Unlikely

- Medium-sized part striking a vehicle from a moderate or high height
- Large tree part striking a structure resulting in high monetary damage
- Disruption of distribution of primary or secondary voltage power lines, including individual services and street-lighting circuits
- Disruption of traffic on a secondary street

» **Severe**—Consequences involve serious potential injury or death, damage to high-value property, or disruption of important activities.

- Injury to a person that may result in hospitalization
- Medium-sized part striking an occupied vehicle
- Large tree part striking an occupied house
- Serious disruption of high-voltage distribution and transmission power line disruption of arterial traffic or motorways

- **Risk Rating**—The overall risk rating of the tree will be determined based on combining the likelihood of tree failure impacting a target and the consequence of failure in the matrix below.

Trees have the potential to fail in more than one way and can affect multiple targets.

Tree risk assessors will identify the tree failure mode having the greatest risk, and report that as the tree risk rating. Generally, trees with the highest qualitative risk ratings should receive corrective treatment first. The following risk ratings will be assigned:

» **None**—Used for planting and stump sites only.

» **Low**—The Low Risk category applies when consequences are "negligible" and likelihood is "unlikely"; or consequences are "minor" and likelihood is "somewhat likely." Some trees with this level of risk may benefit from mitigation or maintenance measures, but immediate action is not usually required.

» **Moderate**—The Moderate Risk category applies when consequences are "minor" and likelihood is "very likely" or "likely"; or likelihood is "somewhat likely" and consequences are "significant" or "severe." In populations of trees, Moderate Risk trees represent a lower priority than High or Extreme Risk trees.

» **High**—The High Risk category applies when consequences are "significant" and likelihood is "very likely" or "likely," or

Likelihood of Failure	Consequences			
	Negligible	Minor	Significant	Severe
Very likely	Low	Moderate	High	Extreme
Likely	Low	Moderate	High	High
Somewhat likely	Low	Low	Moderate	Moderate
Unlikely	Low	Low	Low	Low

consequences are “severe” and likelihood is “likely.” In a population of trees, the priority of High Risk trees is second only to Extreme Risk trees.

» **Extreme—**The Extreme Risk category applies in situations where tree failure is imminent and there is a high likelihood of impacting the target, and the consequences of the failure are “severe.” In some cases, this may mean immediate restriction of access to the target zone area to avoid injury to people.

Trees with elevated (Extreme or High) risk levels are usually recommended for removal or pruning to eliminate the defects that warranted their risk rating. However, in some situations, risk may be reduced by adding support (cabling or bracing) or by moving the target away from the tree. DRG recommends only removal or pruning to alleviate risk. But in special situations, such as a memorial tree or a tree in a historic area, Somerville may decide that cabling, bracing, or moving the target may be the best option for reducing risk.

Determination of acceptable risk ultimately lies with city managers. Since there are inherent risks associated with trees, the location of a tree is an important factor in the determination and acceptability of risk for any given tree. The level of risk associated with a tree increases as the frequency of human occupation increases in the vicinity of the tree. For example, a tree located next to a heavily traveled street will have a higher level of risk than a similar tree in an open field.

Priority Maintenance

Identifying and ranking the maintenance needs of a tree population enables tree work to be assigned priority based on observed risk. Once prioritized, tree work can be systematically addressed to eliminate the greatest risk and liability first (Stamen 2011).

Risk is a graduated scale that measures potential tree-related hazardous conditions. A tree is considered hazardous when its potential risks exceed an acceptable level. Managing trees for risk reduction provides many benefits, including:

- Lower frequency and severity of accidents, damage, and injury
- Less expenditure for claims and legal expenses
- Healthier, longer-lived trees
- Fewer tree removals over time
- Lower tree maintenance costs over time

Regularly inspecting trees and establishing tree maintenance cycles generally reduce the risk of failure, as problems can be found and addressed before they escalate.

In the Urban Forest Management Plan, all tree removals and Extreme and High Risk prunes are included in the priority maintenance program.

Proactive Maintenance

Proactive tree maintenance requires that trees are managed and maintained under the responsibility of an individual, department, or agency. Tree work is typically performed during a cycle. Individual tree health and form are routinely addressed during the cycle. When trees are planted, they are planted selectively and with purpose. Ultimately, proactive tree maintenance should reduce crisis situations in the urban forest, as every tree in the inventoried population is regularly visited, assessed, and maintained. DRG recommends proactive tree maintenance that includes pruning cycles, inspections, and planned tree planting.

References

American National Standards Institute (ANSI). 2011. *ANSI A300 (Part 9)–2011, American National Standard for Tree Care Operations—Tree, Shrub, and Other Woody Plant Management Standard Practices (Tree Risk Assessment a. Tree Structure Assessment)*. Londonderry: Tree Care Industry Association, Inc.

Smiley, E.T., Matheny, N., Lilly, S. 2011. *Best Management Practices: Tree Risk Assessment.* International Society of Arboriculture [ISA].

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INVASIVE PESTS AND TREE DISEASES

In today's worldwide marketplace, the volume of international trade brings increased potential for pests and diseases to invade our country. Many of these pests and diseases have seriously harmed rural and urban landscapes and have caused billions of dollars in lost revenue and millions of dollars in clean-up costs. Keeping these pests and diseases out of the country is the number one priority of the United States Department of Agriculture's (USDA) Animal and Plant Inspection Service (APHIS).

Although some invasive species naturally enter the United States via wind, ocean currents, and other means, most invasive species enter the country with some help from human activities. Their introduction to the U.S. is a byproduct of cultivation, commerce, tourism, and travel. Many species enter the United States each year in baggage, cargo, contaminants of commodities, or mail.

Once they arrive, hungry pests grow and spread rapidly because controls, such as native predators, are lacking. Invasive pests disrupt the landscape by pushing out native species, reducing biological diversity, killing trees, altering wildfire intensity and frequency, and damaging crops. Some pests may even push species to extinction. The following sections include key pests and diseases that adversely affect trees in America at the time of this Urban Forest Management Plan's development. This list is not comprehensive and may not include all threats.

It is critical to the management of community trees to routinely check APHIS, USDA Forest Service, and other websites for updates about invasive species and diseases in your area and in our country so that you can be prepared to combat their attack.

APHIS, Plant Health, Plant Pest Program Information
www.aphis.usda.gov/plant_health/plant_pest_info

The University of Georgia, Center for Invasive Species and Ecosystem Health
www.bugwood.org

USDA National Agricultural Library
www.invasivespeciesinfo.gov/microbes

USDA Northeastern Areas Forest Service, Forest Health Protection
www.na.fs.fed.us/fhp

Asian Longhorned Beetle

Adult Asian longhorned beetle
Photograph courtesy of New Bedford Guide 2011

The Asian longhorned beetle (ALB, *Anoplophora glabripennis*) is an exotic pest that threatens a wide variety of hardwood trees in North America. The beetle was introduced in Chicago, New Jersey, and New York City, and is believed to have been introduced in the United States from wood pallets and other wood-packing material accompanying cargo shipments from Asia. ALB is a serious threat to America's hardwood tree species.

Adults are large (3/4- to 1/2-inch long) with very long, black and white banded antennae. The body is glossy black with irregular white spots. Adults can be seen from late spring to fall depending on the climate. ALB has a long list of host species; however, the beetle prefers hardwoods, including several maple species. Examples include: *Acer negundo* (box elder); *A. platanoides* (Norway maple); *A. rubrum* (red maple); *A. saccharinum* (silver maple); *A. saccharum* (sugar maple); *Aesculus glabra* (buckeye); *A. hippocastanum* (horsechestnut), *Betula* (birch), *Platanus* × *acerifolia* (London planetree), *Salix* (willow), and *Ulmus* (elm).

Dutch Elm Disease

Considered by many to be one of the most destructive, invasive diseases of shade trees in the United States, Dutch elm disease (DED) was first found in Ohio in 1930; by 1933, the disease was present in several East Coast cities. By 1959, it had killed thousands of elms. Today, DED covers about two-thirds of the eastern United States, including Massachusetts, and annually kills many of the remaining and newly planted elms (except for DED resistant varieties). The disease is caused by a fungus that attacks the vascular system of elm trees blocking the flow of water and nutrients, resulting in rapid leaf yellowing, tree decline, and death.

There are two closely-related fungi that are collectively referred to as DED. The most common is *Ophiostoma novo-ulmi*, which is thought to be responsible for most of the elm deaths since the 1970s. The fungus is transmitted to healthy elms by elm bark beetles. Two species carry the fungus: native elm bark beetle (*Hylurgopinus rufipes*) and European elm bark beetle (*Scolytus multistriatus*).

The species most affected by DED is the *Ulmus americana* (American elm).

Branch death, or flagging, at multiple locations in the crown of a diseased elm
Photograph courtesy of Steven Katovich, USDA Forest Service, Bugwood.org (2011)

Emerald Ash Borer

Close-up of the emerald ash borer
Photograph courtesy of APHIS (2011a)

Emerald ash borer (EAB) (*Agrilus planipennis*) is responsible for the death or decline of tens of millions of ash trees in 14 states in the American Midwest and Northeast. Native to Asia, EAB has been found in China, Japan, Korea, Mongolia, eastern Russia, and Taiwan. It likely arrived in the United States hidden in wood-packing materials commonly used to ship consumer goods, auto parts, and other products. The first official United States identification of EAB was in southeastern Michigan in 2002.

Adult beetles are slender and 1/2-inch long. Males are smaller than females. Color varies but adults are usually bronze or golden green overall with metallic, emerald-green wing covers. The top of the abdomen under the wings is metallic, purplish-red and can be seen when the wings are spread.

The EAB-preferred host tree species are in the genus *Fraxinus* (ash).

Herms et al. (2019) provides an overview of insecticide treatment options for controlling EAB.

Gypsy Moth

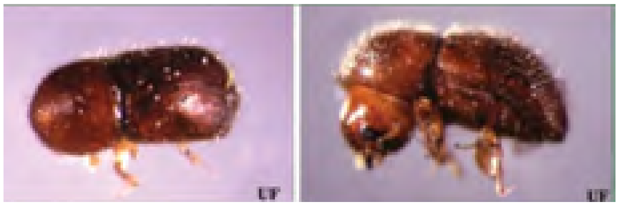
Close-up of male (darker brown) and female (whitish color) European gypsy moths
Photograph courtesy of APHIS (2011b)

The gypsy moth (GM) (*Lymantria dispar*) is native to Europe and first arrived in the United States in Massachusetts in 1869. This moth is a significant pest because its caterpillars have an appetite for more than 300 species of trees and shrubs. GM caterpillars defoliate trees, which makes the species vulnerable to diseases and other pests that can eventually kill the tree.

Male GMs are brown with a darker brown pattern on their wings and have a 1/2-inch wingspan. Females are slightly larger with a 2-inch wingspan and are nearly white with dark, sawtoothed patterns on their wings. Although they have wings, the female GM cannot fly.

The GMs prefer approximately 150 primary hosts but feed on more than 300 species of trees and shrubs. Some trees are found in these common genera: *Betula* (birch), *Juniperus* (cedar), *Larix* (larch), *Populus* (aspen, cottonwood, poplar), *Quercus* (oak), and *Salix* (willow).

Granulate Ambrosia Beetle



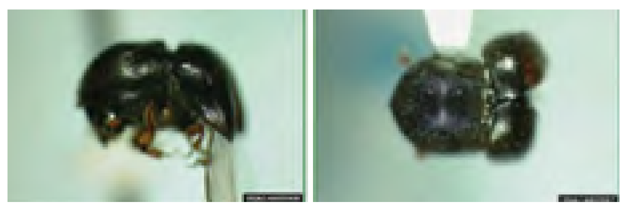
Adult granulate ambrosia beetle
Photograph courtesy of Paul M. Choate, University of Florida (Atkinson et al. 2011)

The granulate ambrosia beetle (*Xylosandrus crassiusculus*), formerly the Asian ambrosia beetle, was first found in the United States in 1974 on peach trees near Charleston, South Carolina. The native range of the granulate ambrosia beetle is probably tropical and subtropical Asia. The beetle is globally present in countries such as equatorial Africa, Asia, China, Guinea, Hawaii, India, Japan, New South Pacific, Southeast Indonesia, Sri Lanka, and the United States. In the United States, this species has spread along the lower Piedmont region and coastal plain to East Texas, Florida, Louisiana, and North Carolina. Populations were found in Oregon and Virginia in 1992, and in Indiana in 2002.

Adults are small and have a reddish-brown appearance with a downward facing head. Most individuals have a reddish head region and a dark-brown to black elytra (hard casings protecting the wings). Light-colored forms that appear almost yellow have also been trapped. A granulated (rough) region is located on the front portion of the head and long setae (hairs) can be observed on the back end of the wing covers. Females are 2–2.5mm and males are 1.5mm long. Larvae are C-shaped with a defined head capsule.

The granulate ambrosia beetle is considered an aggressive species and can attack trees that are not highly stressed. It is a potentially serious pest of ornamentals and fruit trees and is reported to be able to infest most trees and some shrubs (azalea, rhododendron) but not conifers. Known hosts in the United States include: *Acer* (maple); *Albizia* (albizia); *Carya* (hickory); *Cercis canadensis* (eastern redbud); *Cornus* (dogwood); *Diospyros* (persimmon); *Fagus* (beech); *Gleditsia* or *Robinia* (locust); *Juglans* (walnut); *Koelreuteria* (goldenrain tree); *Lagerstroemia* (crape myrtle); *Liquidambar styraciflua* (sweetgum); *Liriodendron tulipifera* (tulip poplar); *Magnolia* (magnolia); *Populus* (aspen); *Prunus* (cherry); *Quercus* (oak); and *Ulmus parvifolia* (Chinese elm). *Carya illinoinensis* (pecan) and *Pyrus calleryana* (Bradford pear) are commonly attacked in Florida and in the southeastern United States.

Xm Ambrosia Beetle



Xm ambrosia beetle
Photograph courtesy of Michael C. Thomas, Florida Department of Agriculture and Consumer Services (Rabaglia et al 2003)

The Xm ambrosia beetle (*Xylosandrus mutilatus*), is native to Asia and was first detected in the United States in 1999 in traps near Starkville, Mississippi. By 2002, the beetle spread throughout Missouri and quickly became well-established in Florida. The species also has been found in Alabama, northern Georgia, and Texas. In addition to its prevalence in the southeastern United States, the Xm ambrosia beetle is currently found in China, India, Indonesia, Japan, Korea, Malaya, Myanmar, Papua New Guinea, Sri Lanka, Taiwan, and Thailand.

This species generally targets weakened and dead trees. Since the beetle attacks small diameter material, it may be commonly transported in nursery stock. Female adults are prone to dispersal by air currents and can travel 1–3 miles in pursuit of potential hosts. This active capability results in a broad host range and high probability of reproduction. The species is larger than any other species of *Xylosandrus* (greater than 3 millimeters) in the U.S. and is easily recognized by its steep declivity and dark brown to black elytra (hard casings protecting the wings). Larvae are white and c-shaped with an amber colored head capsule.

Known hosts in the U.S. include: *Acer* (maple); *Albizia* (silktree); *Benzoin* (northern spicebush); *Camellia* (camellia); *Carpinus laxiflora* (looseflower hornbeam); *Castanae* (sweet chestnut); *Cinnamomum camphora* (camphor tree); *Cornus* (dogwood); *Cryptomeria japonica* (Japanese cedar); *Fagus crenata* (Japanese beech); *Lindera erythrocarpa* (spicebush); *Machilus thurnbergii* (Japanese persea); *Ormosia hosiei* (ormosia); *Osmanthus fragrans* (sweet osmanthus); *Parabezion praecox*; *Platycarpa*; and *Sweitenia macrophylla* (mahogany).

Hemlock Woolly Adelgid

Hemlock woolly adelgids on a branch
Photograph courtesy of USDA Forest Service (2011a)

The hemlock woolly adelgid (HWA, *Adelges tsugae*) was first described in western North America in 1924 and first reported in the eastern United States in 1951 near Richmond, Virginia.

In their native range, populations of HWA cause little damage to the hemlock trees, as they have natural enemies that feed on them and there is a possibility that tree resistance has evolved with HWA. In eastern North America and in the absence of natural control elements, HWA attacks both *Tsuga canadensis* (eastern or Canadian hemlock) and *T. caroliniana* (Carolina hemlock), often damaging and killing them within a few years of becoming infested.

The HWA is now established from northeastern Georgia to southeastern Maine and as far west as eastern Kentucky and Tennessee.

Oak Wilt

Oak wilt symptoms on red and white oak leaves
Photograph courtesy of C.E. Seliskar, Bugwood.org

Oak wilt was first identified in 1944 and is caused by the fungus *Ceratocystis fagacearum*. While considered an invasive and aggressive disease, its status as an exotic pest is debated since the fungus has not been reported in any other part of the world. This disease affects the oak genus and is most devastating to those in the red oak subgenus, such as *Quercus coccinea* (scarlet oak), *Q. imbricaria* (shingle oak), *Q. palustris* (pin oak), *Q. phellos* (willow oak), and *Q. rubra* (red oak) (Rexrode & Brown, 1983). It also attacks trees in the white oak subgenus, although it is not as prevalent and spreads at a much slower pace in these trees.

Just as with DED, oak wilt disease is caused by a fungus that clogs the vascular system of oaks and results in decline and death of the tree. The fungus is carried from tree to tree by several borers common to oaks, but the disease is more commonly spread through root grafts. Oak species within the same subgenus (red or white) will form root colonies with grafted roots that allow the disease to move readily from one tree to another.

Pine Shoot Beetle

Mined shoot and common pine shoot beetle. Photograph courtesy of Gyorgy Csoka, Hungary Forest Research Institute, Bugwood.org

The pine shoot beetle (*Tomicus piniperda L.*), a native of Europe, is an introduced pest of Pinus (pine) in the United States. It was first discovered in the United States at a Christmas tree farm near Cleveland, Ohio in 1992. Following the first detection in Ohio, the beetle has been detected in parts of 19 states (Connecticut, Illinois, Indiana, Iowa, Maine, Maryland, Massachusetts, Michigan, Minnesota, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, Rhode Island, Vermont, Virginia, West Virginia, and Wisconsin).

The beetle attacks new shoots of pine trees, stunting the growth of the trees. The pine shoot beetle may also attack stressed pine trees by breeding under the bark at the base of the trees. The beetles can cause severe decline in the health of the trees and, in some cases, kill the trees when high populations exist.

Adult pine shoot beetles range from 3 to 5 millimeters long, or about the size of a match head. They are brown or black and cylindrical. The legless larvae are about 5 millimeters long with a white body and brown head. Egg galleries are 10–25 centimeters long. From April to June, larvae feed and mature under the pine bark in separate feeding galleries that are 4–9 centimeters long. When mature, the larvae stop feeding, pupate, and then emerge as adults. From July through October, adults tunnel out through the bark and fly to new or 1-year-old pine shoots to begin maturation feeding. The beetles enter the shoot 15 centimeters or less from the shoot tip and move upwards by hollowing out the center of the shoot for a distance of 2.5–10 centimeters. Affected shoots droop, turn yellow, and eventually fall off during the summer and fall.

P. sylvestris (Scots pine) is preferred, but other pine species, including *P. banksiana* (jack pine), *P. nigra* (Austrian pine), *P. resinosa* (red pine), and *P. strobus* (eastern white pine), have been infested in the Great Lakes region.

Sirex Woodwasp

Close-up of female Sirex Woodwasp
Photograph from Haugen & Hoebeke (2005)

Sirex woodwasp (*Sirex noctillio*) has been the most common species of exotic woodwasp detected at United States ports-of-entry associated with solid wood-packing materials. Recent detections of sirex woodwasp outside of port areas in the United States have raised concerns because this insect has the potential to cause significant mortality of pines. Awareness of the symptoms and signs of a sirex woodwasp infestation increases the chance of early detection, thus increasing the rapid response needed to contain and manage this exotic forest pest.

Woodwasps (or horntails) are large robust insects, usually 1.0 to 1.5 inches long. Adults have a spear-shaped plate (cornus) at the tail end; in addition, females have a long ovipositor under this plate. Larvae are creamy white, legless, and have a distinctive dark spine at the rear of the abdomen. More than a dozen species of native horntails occur in North America.

Sirex woodwasps can attack living pines, while native woodwasps attack only dead and dying trees. At low populations, sirex woodwasp selects suppressed, stressed, and injured trees for egg laying. Foliage of infested trees initially wilts, and then changes color from dark green to light green, to yellow, and finally to red, during the three to six months following attack. Infested trees may have resin beads or dribbles at the egg laying sites, but this is more common at the mid-bole level. Larval galleries are tightly packed with very fine sawdust. As adults emerge, they chew round exit holes that vary from 1/8 to 3/8 inch in diameter.

Southern Pine Beetle

Adult southern pine beetles
Photograph courtesy of Forest Encyclopedia Network (2012)

The southern pine beetle (SPB, *Dendroctonus frontalis*) is the most destructive insect pest of pine in the southern United States. It attacks and kills all species of southern yellow pines including *P. strobus* (eastern white pine). Trees are killed when beetles construct winding, S-shaped egg galleries underneath the bark. These galleries effectively girdle the tree and destroy the conductive tissues that transport food throughout the tree. Furthermore, the beetles carry blue staining fungi on their bodies that clog the water conductive tissues (wood), which transport water within the tree. Signs of attack on the outside of the tree are pitch tubes and boring dust, known as frass, caused by beetles entering the tree.

Adult SPBs reach an ultimate length of only 1/8 inch, similar in size to a grain of rice. They are short-legged, cylindrical, and brown to black in color. Eggs are small, oval-shaped, shiny, opaque, and pearly white.

Spotted Lanternfly

Profile of spotted lanternfly adult at rest
Photograph courtesy of USDA APHIS (2014)

The spotted lanternfly (SLF, *Lycorma delicatula*) is native to China and was first detected in Pennsylvania in September 2014. Spotted lanternfly feeds on a wide range of fruit, ornamental and woody trees, with tree-of-heaven being one of the preferred hosts. Spotted lanternflies are invasive and can be spread long distances by people who move infested material or items containing egg masses. If allowed to spread in the United States, this pest could seriously impact the country's grape, orchard, and logging industries.

Adult spotted lanternflies are approximately 1 inch long and one-half inch wide, and they have large and visually striking wings. Their forewings are light brown with black spots at the front and a speckled band at the rear. Their hind wings are scarlet with black spots at the front and white and black bars at the rear. Their abdomen is yellow with black bars. Nymphs in their early stages of development appear black with white spots and turn to a red phase before becoming adults. Egg masses are yellowish-brown in color, covered with a gray, waxy coating prior to hatching.

The spotted lanternfly lays its eggs on smooth host plant surfaces and on non-host material, such as bricks, stones, and dead plants. Eggs hatch in the spring and early summer, and nymphs begin feeding on a wide range of host plants by sucking sap from young stems and leaves. Adults appear in late July and tend to focus their feeding on tree-of-heaven (*A. altissima*) and grapevine (*Vitis vinifera*). As the adults feed, they excrete sticky, sugar-rich fluid similar to honeydew. The fluid can build up on plants and on the ground underneath infested plants, causing sooty mold to form.

Sudden Oak Death

Drooping tanoak shoot
Photograph courtesy of Indiana Department of Natural Resources (2012)

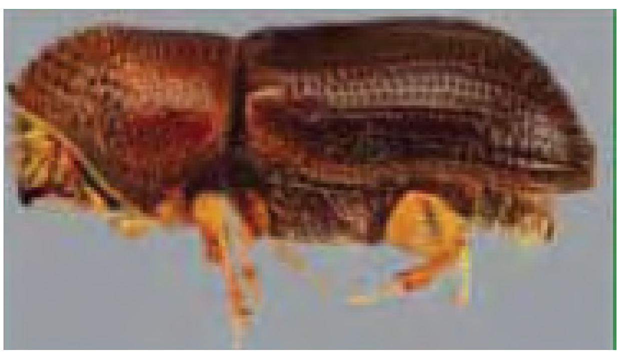
The causal agent of sudden oak death (SOD, also known as *Phytophthora* canker disease), *Phytophthora ramorum*, was first identified in 1993 in Germany and the Netherlands on ornamental rhododendrons. In 2000, the disease was found in California. Since its discovery in North America, SOD has been confirmed in forests in California and Oregon and in nurseries in British Columbia, California, Oregon, and Washington. SOD has been potentially introduced into other states through exposed nursery stock. Through ongoing surveys, APHIS continues to define the extent of the pathogen's distribution in the United States and limit its artificial spread beyond infected areas through quarantine and a public education program.

Identification and symptoms of SOD may include large cankers on the trunk or main stem accompanied by browning of leaves. Tree death may occur within several months to several years after initial infection. Infected trees may also be infested with ambrosia beetles (*Monar-*

thrum dentiger and *M. scutellarer*), bark beetles (*Pseudopityophthorus pubipennis*), and sapwood rotting fungus (*Hypoxylon thouarsianum*). These organisms may contribute to the death of the tree. Infection on foliar hosts is indicated by dark grey to brown lesions with indistinct edges. These lesions can occur anywhere on the leaf blade, in vascular tissue, or on the petiole. Petiole lesions are often accompanied by stem lesions. Some hosts with leaf lesions defoliate and eventually show twig dieback.

This pathogen is devastating to *Quercus* (oaks) but also affects several other plant species.

Thousand Cankers Disease



Walnut twig beetle, side view
Photograph courtesy of USDA Forest Service (2011b)

A complex disease referred to as Thousand Cankers disease (TCD) was first observed in Colorado in 2008 and is now thought to have existed in Colorado as early as 2003. TCD is considered to be native to the United States and is attributed to numerous cankers developing in association with insect galleries. TCD results from the combined activity of the *Geosmithia morbida* fungus and the walnut twig beetle (WTB, *Pityophthorus juglandis*). The WTB has expanded both its geographical and host range over the past two decades, and coupled with the *Geosmithia morbida fungus, Juglans* (walnut) mortality has manifested in Arizona, California, Colorado, Idaho, New Mexico, Oregon, Utah, and Washington. In July 2010, TCD was reported in Knoxville, Tennessee. The infestation is believed to be at least 10 years old and was previously attributed to drought stress. This is the first report east of the 100th meridian, raising concerns that large native populations of *J. nigra* (black walnut) in the eastern United States may suffer severe decline and mortality.

The tree species preferred as hosts for TCD are walnuts.

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Tree Emergency Plan Worksheet

For: Urban and Community Foresters, Community Leaders, Public Works and Parks Departments, Planners, Councils, and other Public Officials

1. Early Warning System/Weather Forecasting Service — Use an early warning procedure to enhance mitigation: communicate with the National Weather Service, a consulting meteorological firm, a designated television weather channel, or the local police department. With a procedure in place, you should have at least three hours of lead time before most tree damaging weather strikes.

Staff Lead: ______________________________
Contact Name: ______________________________
Address: ______________________________
Phone: ______________________________
Mobile: ______________________________
Fax: ______________________________
Email: ______________________________
Website: ______________________________
Description of services provided:

2. Local Emergency Manager – Lead contact for a community and responsible for emergency planning and response activities.

Name: ______________________ **Phone:** ______________________
Mobile: ______________________

Role(s):

3. Public Relations Coordinator — This is the individual responsible for primary public relations, media contacts, citizen information and communications about the natural disaster. (Must have full knowledge of damage, community issues and capabilities, and be able to make decisions.)

Name: ______________________ **Phone:** ______________________
Mobile: ______________________

Alternate(s):
Name: ______________________ **Phone:** ______________________
Mobile: ______________________
Name: ______________________ **Phone:** ______________________
Mobile: ______________________

4. Disaster Planning and Response Team Members: Your team should include: mayor, selected department heads including specialists in public relations and purchasing, public works specialists (streets, wood utilization and disposal, fleet manager), utilities, parks department, other local government heads, meteorologist, local emergency managers. Include creative people on your team that can think beyond barriers that may be up. Get media involved in planning so they understand what your cleanup priorities are after a storm. Someone involved with public tree management should be part of the community emergency management team. It is critical to include individuals who can make fiscal and administrative decisions because this team will most likely serve in the storm operations command center.

Name:	Role/Responsibility:
1.	Mayor
2.	Fire Chief
3.	Director of Public Works
4.	Utility Representative
5.	Public Relations Representative
6.	City Council
7.	County Emergency Management
8.	Police Chief
9.	Director of Parks
10.	
11.	
12.	
13.	
14.	
15.	
16.	
17.	
18.	
19.	

5. Available Disaster Response Staff and Crews: Identify and list all municipal staff and crews available for disaster response work. Consider forestry and parks departments, public works, engineering, streets and sanitation, etc. Where possible, establish teams that can be responsible for specific disaster response activities (primary route clearing, assistance to utility crews, manage debris staging sites, distribute equipment, etc.)

Staff Name:	Role/Responsibility:
1.	
2.	
3.	
4.	
5.	
6.	
7.	
8.	
9.	
10.	
11.	
12.	
13.	
14.	
15.	
16.	
17.	
18.	
19.	
20.	

6. Emergency Call Out Procedure — phone contact tree for staff.

Name: ______________________ **Will Contact — Name:** ______________________
Phone: ______________________
Mobile: ______________________

Name: ______________________
Phone: ______________________
Mobile: ______________________

Name: ______________________
Phone: ______________________
Mobile: ______________________

Name: ______________________ **Will Contact — Name:** ______________________
Phone: ______________________
Mobile: ______________________

Name: ______________________
Phone: ______________________
Mobile: ______________________

Name: ______________________
Phone: ______________________
Mobile: ______________________

Name: ______________________ **Will Contact — Name:** ______________________
Phone: ______________________
Mobile: ______________________

Name: ______________________
Phone: ______________________
Mobile: ______________________

Name: ______________________
Phone: ______________________
Mobile: ______________________

Name: ______________________ **Will Contact — Name:** ______________________
Phone: ______________________
Mobile: ______________________

Name: ______________________
Phone: ______________________
Mobile:

7. Primary transportation and evacuation corridors and routes for emergency vehicles. Identify and map for reference. Have map available and accessible, and review and update annually.

8. Critical power transmission corridor restoration sites (medical treatment centers). Identify and map for reference. Have map available and accessible, and review and update annually.

9. Identify who is responsible for decision making and priority response setting for multiple life threatening situations.

Name:_______________________________ Phone:____________________________
Pager:________________________________ Mobile:____________________________

10. Tree Damage Clean-up Priorities — List areas that need attention after life threatening situations are abated. Share this information with key staff the will be answering phone calls from residents, businesses, etc. Create a work order form for use when receiving calls.

1.

2.

3.

4.

5.

6.

7.

8.

9.

10.

11. Procedure for Debris Staging and Removal — Identify several areas for staging and processing debris. Establish a contract or agreement securing each site. Choose a processing site that is large, flat, well-drained and accessible to roads that can support truck weights of at least 9 tons per axle. Identify ways to protect significant trees or cultural resources during processing. Potential sites include undeveloped park, industrial, cemetery, fairgrounds, agency and state land. Large parking lots (even paved lots) work well. Remember to consider noise implications near residential areas. Identify multiple sites. Annually reconfirm access and availability to these sites. Make sure the site is large enough for safety considerations (flying debris from tub grinders), if possible, identify sites that can be secured (fencing).

Site 1 – Location: ____

Contact Name/Role:

Phone: Mobile:

Site 2 – Location: ____

Contact Name/Role:

Phone: Mobile:

Site 3 – Location: ____

Contact Name/Role:

Phone: Mobile:

12. Debris and Brush Removal from Private Property — Identify how you will address this issue. A major storm makes it difficult for private property owners to remove brush and debris. Make a decision at the municipal level allowing for debris collection. Determine if your city has adequate equipment and staff available to accomplish this often enormous task. It is critical that you provide guidelines for residents. Specify the types, amounts and piling arrangement of the materials that you will accept. Cities can also assist private homeowners who must contract with private companies for trimming and removal by preparing a list of companies that are licensed, professionally trained and insured.

Person Responsible: ____
Phone: ______________________________ **Mobile:**______________________________

Minor Storm Policy:

Major Storm Policy:

Listing of available tree care companies:

13. Identify Wood Utilization Options – Develop a list of companies and resources that can process the wood material generated from storm damage. When possible, establish a contract for utilization services.

Wood Utilization Contract: **Company/Organization:**

Phone: Mobile:
Utilization Service Contract: Yes / No
Description of Service:

Wood Utilization Contract: **Company/Organization:**

Phone: Mobile:
Utilization Service Contract: Yes / No
Description of Service:

14. Equipment Listing (available in-house) — Develop a list of public works and parks department equipment and vehicles available for tree clean up work. Keep it current. Include wood chippers, aerial bucket trucks, refuse packers, loaders, supervisory vehicles, chain saws, barricade and lighting equipment, hand saws and pole pruners on the list.

Person Responsible: ____
Phone:____________________ **Mobile:**______________________________________

Equipment Available	**Quantity**	**Department/Contact**
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		

15. Additional Equipment and Assistance Sources — In an emergency, your city administrator may authorize the lease or rental of additional equipment for storm clean-up work. Make a list of potential vendors and keep it current. For certain equipment and assistance needs, it is critical to establish an emergency contract. Guaranteed access to large tub grinders and multiple additional tree trimming crews would be services to guarantee via an emergency contract. The city administrator may also authorize tree contractors to supplement city crews. Assemble a list of licensed and insured potential tree service contractors. Your neighbor cities may be unaffected by a storm that strikes your city. Establish a system to contact neighbor cities that could send staff and equipment to assist you in cleaning up your city.

Person Responsible: ____
Phone:____________________ **Mobile:**_______________________________________

Equipment Available	Quantity	Department/Contact
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		

Emergency Contract:

Organization: Contact Name:
Phone: Mobile:

Emergency Contract:

Organization: Contact Name:
Phone: Mobile:

Emergency Contract:

Organization: Contact Name:
Phone: Mobile:

16. Staff, Crew Organization and Equipment Needs – In an emergency, staff members may need to lead crews from other departments or of private contractors. Determine staff who can function in this manner.

Name	Crew#	Equipment Needed

17. Individual(s) Responsible for Record Keeping — This person does documentation and cost accounting during and after disasters. Note – define a specific accounting code for each storm event. If you define a specific code for each storm event, it will allow for effective accounting.

Name: Phone:
Mobile:

Name: Phone:
Mobile:

Storm Accounting Code:

18. Individual(s) Responsible for Damage Assessment and Damage Survey Reports — This person is familiar with FEMA and Division of Emergency Management procedures and prepares the reports needed for public assistance.

Name: Phone:
Mobile:

Name: Phone:
Mobile:

19. Disaster Budget (identify potential activities to anticipate costs)

Personnel Regular Time:
Overtime:
Equipment Owned:
Equipment Contracted:
Contracted Work:
Operational Supplies:
Disposal/Recycling:

Administrative Costs (Overhead):

20. Funding Information from Past Storms — review costs from past storms to anticipate costs for future storms and establish funding needs.

Storm: ______________________ **Date**: ______________________

Activity	**Cost**
Personnel Regular Time	
Overtime	
Equipment Owned	
Equipment Contracted	
Contracted Work	
Operational Supplies	
Disposal/Recycling	
Administrative Costs (Overhead)	
TOTAL	

Storm: ______________________ **Date**: ______________________

Activity	**Cost**
Personnel Regular Time	
Overtime	
Equipment Owned	
Equipment Contracted	
Contracted Work	
Operational Supplies	
Disposal/Recycling	
Administrative Costs (Overhead)	
TOTAL	

21. Individual(s) and/or Organization(s) responsible for community regreening efforts:
Develop a list of contacts for use in efforts to regreen the community after storm events.

Name/Organization: Phone:
Mobile:
Organization Role:

Name/Organization: Phone:
Mobile:
Organization Role:

Name/Organization: Phone:
Mobile:
Organization Role:

Name/Organization: Phone:
Mobile:
Organization Role:

22. Listing of community and neighborhood groups that promote and support community regreening efforts

Group: Representative: Phone: Mobile:

Group: Representative: Phone: Mobile:

Group: Representative: Phone: Mobile:

Group: Representative: Phone: Mobile:

Group: Representative: Phone: Mobile:

Group: Representative: Phone: Mobile:

23. Community urban forestry comprehensive management plan —

Comprehensive forest management is your best defense against storms. Well planted and cared for trees stand up to weather better than neglected trees. Develop or modify a forest management plan to include information related to disaster preparedness. Identify critical activities such as hazard tree removal, tree pruning cycles, annual tree care needs, etc.

Name: Completed:

24. Community tree risk management plan — A tree risk management plan will provide the community with a systematic approach to accurately identify moderate to high risk trees, an initiate the timely removal or corrective treatment of hazardous trees. Communities that carry out tree risk management strategies will likely see reductions in damage after storms. Go to: http://www.na.fs.fed.us/spfo/pubs/uf/utrmm/index.htm

Name: Completed:

25. Storm Damage Assessment – If a storm is significant enough to receive a formal disaster declaration, state and/or federal funding may be available. To assist communities in the process of applying for reimbursement for storm associated costs, it is important to be able to quickly develop an estimate of damage. Consider using the Storm Damage Assessment Protocol as a tool prior to a storm. This protocol allows a community to provide an assessment of damage in a simple, credible and efficient manner. Go to: http://www.umass.edu/urbantree/icestorm/

Name: Completed:

26. Contacts for additional assistance in natural disaster planning, response and recovery:

	Name	Phone
Area or District Forester		
University Extension Agent		
Consulting Foresters		
City Foresters of Neighboring Cities:		
Other		

(Worksheet Prepared by: Lisa Burban (USDA Forest Service), Jim Hermann (Minneapolis Park and Recreation Board), and Katie Himanga (Heartwood Forestry) – Updated May, 2006. Worksheet available on-line at: http://www.na.fs.fed.us/urban/ucfdisasters/tree_emerg_plan/treeemerplanwksheet.htm)

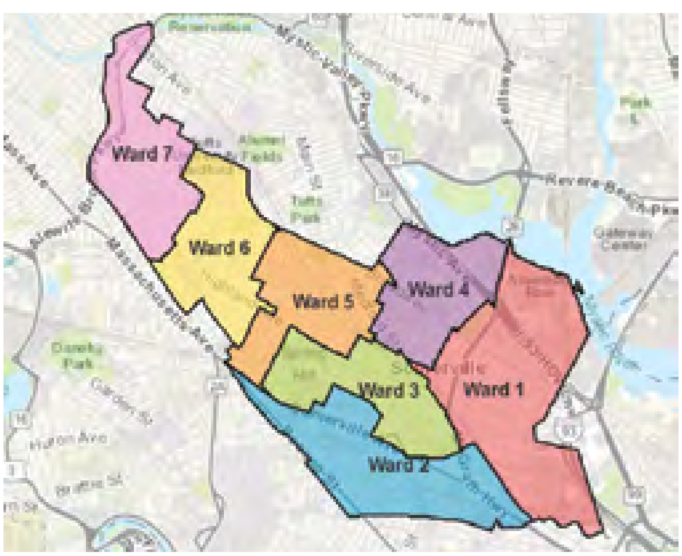
POTENTIAL PLANTABLE AREA BY WARD

Section 1.1: Somerville's Tree Canopy presents the results of a canopy cover analysis for the City of Somerville, as well as an analysis of the potential realistic plantable areas in the city. The amount of tree canopy and potential plantable space in each Ward is shown in **Table 1.4** (reproduced from *Section 1.1: Somerville's Tree Canopy*)

Table 1.4. Amount of Tree Canopy and Potential Plantable Space in Somerville by Ward.

Ward	Ward Area (acres)	2018 Canopy Cover (acres)	2018 Canopy Cover (%)	Potential Plantable Space (acres)	Maximum Canopy Cover (%)*
1	642.9	51.4	8.0%	29.2	12.5%
2	434.5	45.0	10.4%	11.1	12.9%
3	298.8	57.4	19.2%	5.1	20.9%
4	296.0	45.0	15.2%	11.2	19.0%
5	316.4	56.9	18.0%	5.0	19.6%
6	319.3	69.5	21.8%	10.8	25.1%
7	335.4	67.5	20.1%	15.8	24.9%

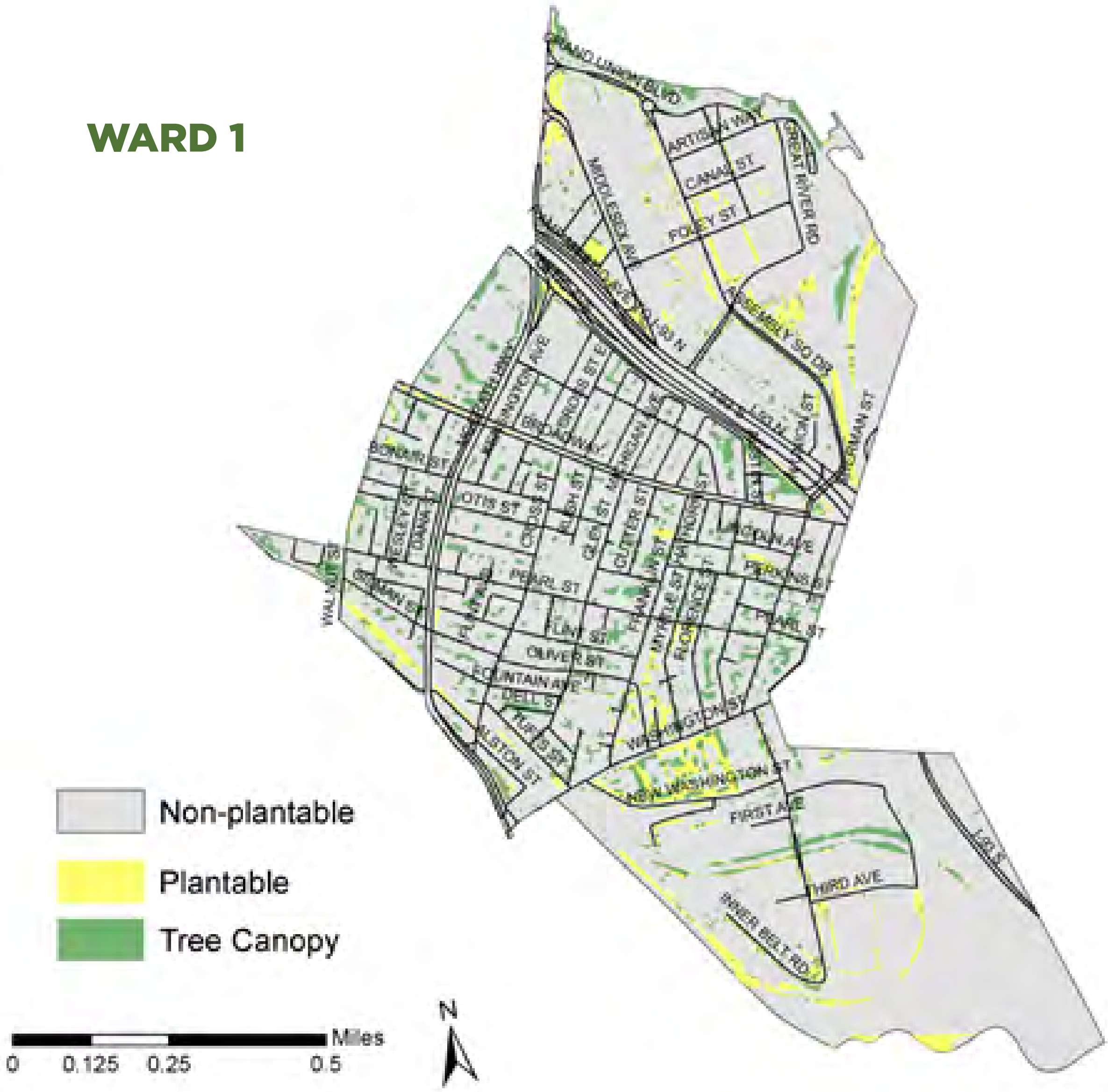
*Calculated as the sum of 2018 Canopy Cover + Potential Plantable Space



The City of Somerville is organized into seven (7) electoral wards.

To better visualize the extent and locations of the canopy cover and potential realistic plantable areas, maps for each of the seven Wards in Somerville are shown on the following pages.

WARD 1

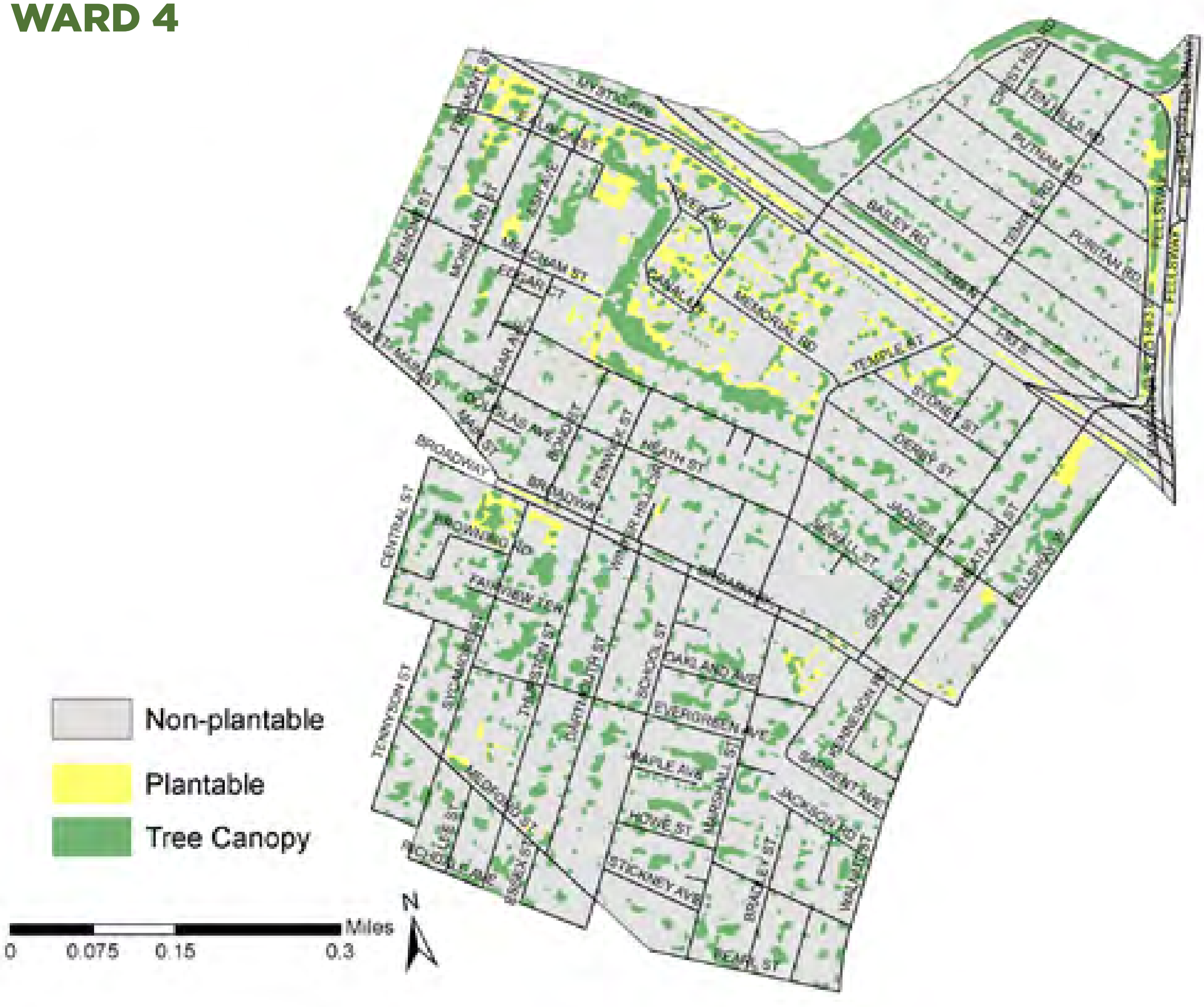


WARD 2

WARD 3


HIGHLAND AVE
CENTRAL ST
RICHDALE AVE
MONTROSE ST
MADISON ST
HIGHLAND AVE
PORTER ST
CAMBRIA ST
OSGOOD ST
BERKELEY ST
AVON ST
SUMMER ST
MEDFORD ST
PRESCOTT ST
PUTNAM ST
GRANDVIEW AVE
PLEASANT AVE
SUMMIT AVE
MONROE ST
ATHERTON ST
SOMERVILLE AVE
CHURCH ST
COLUMBUS AVE
WASHINGTON ST
PROSPECT HILL
Non-plantable
Plantable
Tree Canopy
Miles
0
0.075
0.15
0.3
N

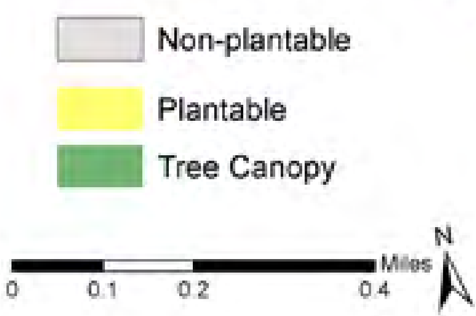
WARD 4



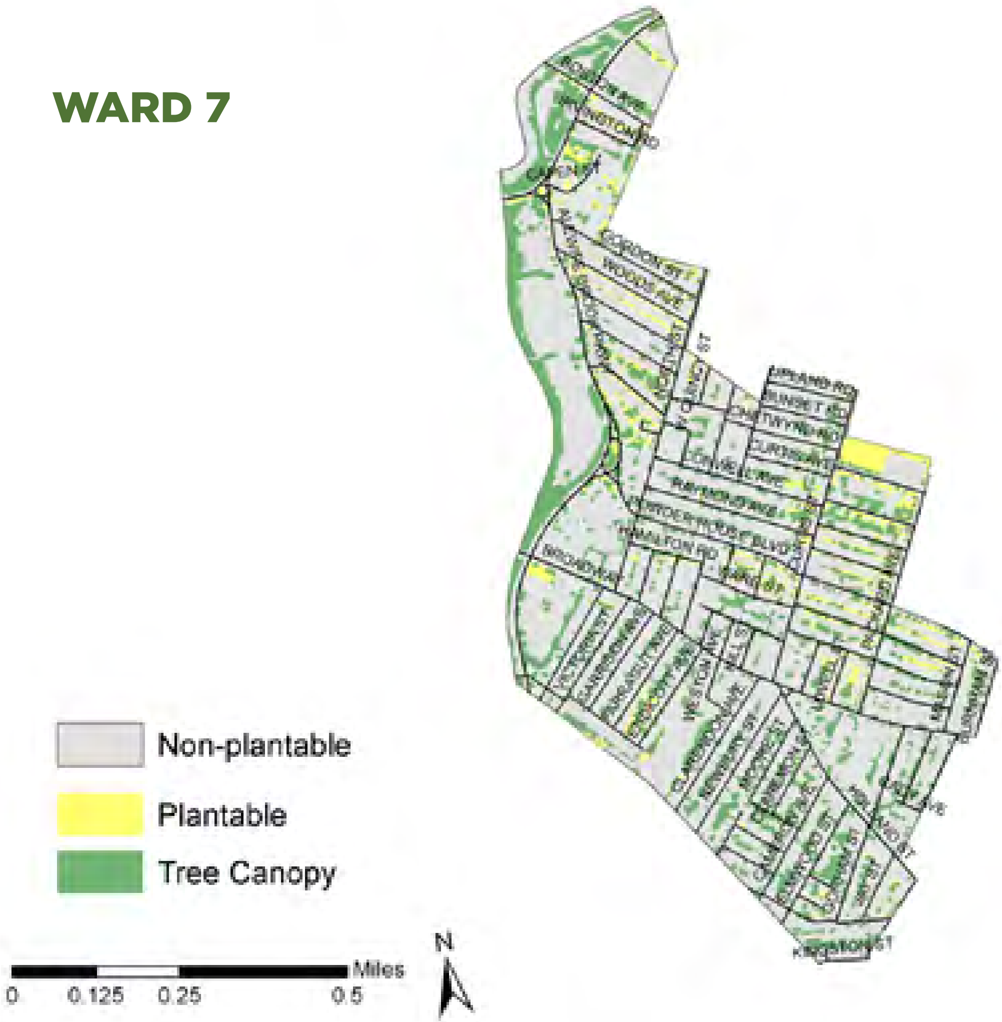
WARD 5

WARD 6


POWDER HOUSE BLVD
TALBOT AVE
WALKER ST
BROADWAY
SIMPSON AVE
HALL AVE
KINGSTON ST
HIGHLAND AVE
SPENCER AVE
WINDSOR RD
CEDAR ST


Non-plantable
Plantable
Tree Canopy
Miles
0
0.1
0.2
0.4
N

WARD 7



City of Somerville
Massachusetts

URBAN FOREST

MANAGEMENT PLAN

2021

Appendix files can be found on the
City of Somerville Urban Forestry website:

https://www.somervillema.gov/urbanforestry