August 2022

COMMUNITY FOREST MANAGEMENT PLAN

Village of Ballston Spa, New York

Prepared for:

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ACKNOWLEDGMENTS

This project supports the Village of Ballston Spa's vision to promote and enhance community well-being through public tree conservation and improved forest management practices. This *Community Forest Management Plan* offers expertise in preserving and expanding urban canopy so the environmental, economic, and social benefits it provides continue for generations.

The Village of Ballston Spa is thankful to have been granted funds from the New York State Department of Environmental Conservation (DEC) Urban and Community Forest Grant to complete a tree inventory and community forest management plan. This grant works to increase public awareness of the importance of trees and helps communities develop and implement comprehensive tree management plans to create healthy forests while enhancing quality of life for residents.

The village also recognizes the support of the following people and groups:

Village of Ballston Spa Board of Trustees:
Mayor Frank Rossi, Jr.
Trustee Elizabeth Kormos
Trustee Ben Baskin
Trustee Shawn Raymond
Trustee Bernadette VanDeinse-Perez
Jeff Gawrys, Head of Department of Public Works

Park and Tree Board:
Mike Tower, Chair
Kristopher Williams
Caitlin Parwana
Ray Otten
Judy Esposito
Ed Hersh

Notice of Disclaimer: Inventory data provided by Davey Resource Group, Inc. "DRG" are based on visual recording at the time of inspection. Visual records do not include individual testing or analysis, nor do they include aerial or subterranean inspection. DRG is not responsible for the discovery or identification of hidden or otherwise non-observable hazards. Records may not remain accurate after inspection due to the variable deterioration of inventoried material. DRG provides no warranty with respect to the fitness of the urban forest for any use or purpose whatsoever. Clients may choose to accept or disregard DRG's recommendations or to seek additional advice. Important: know and understand that visual inspection is confined to the designated subject tree(s) and that the inspections for this project are performed in the interest of facts of the tree(s) without prejudice to or for any other service or any interested party.

10-Year Tree Resource Maintenance Schedule

EXECUTIVE SUMMARY

This Village of Ballston Spa *Community Forest Management Plan*, written by Davey Resource Group, Inc. "DRG", focuses on quantifying the benefits provided by the inventoried tree resource and addressing its maintenance needs. DRG completed a tree inventory for The Village of Ballston Spa in September 2021 and analyzed the inventory data to understand the structure of the village's inventoried tree resource. DRG also estimated the economic values of some of the various environmental benefits provided by this public tree resource by analyzing inventory data with i-Tree Eco and recommended a prioritized management program for future tree care.

The functions of Ballston Spa's 1,127 inventoried trees provide benefits with an estimated total value of $5,000 annually. The functions of Ballston Spa's inventoried tree population throughout its trees' lifetimes are worth over $2 million. Supporting and funding proactive maintenance of the public tree resource is a sound long-term investment that will reduce tree management costs over time.

High priority tree removal and pruning is costly, accounting for the larger budget in Year 1 of the ten-year schedule, as shown in Figure 1. After high priority work has been completed, budgets are expected to decrease and stabilize as tree management transitions from reactive to proactive maintenance. This also reduces the number of new elevated risk trees over time by preventing deteriorating conditions of trees with initial minor defects.

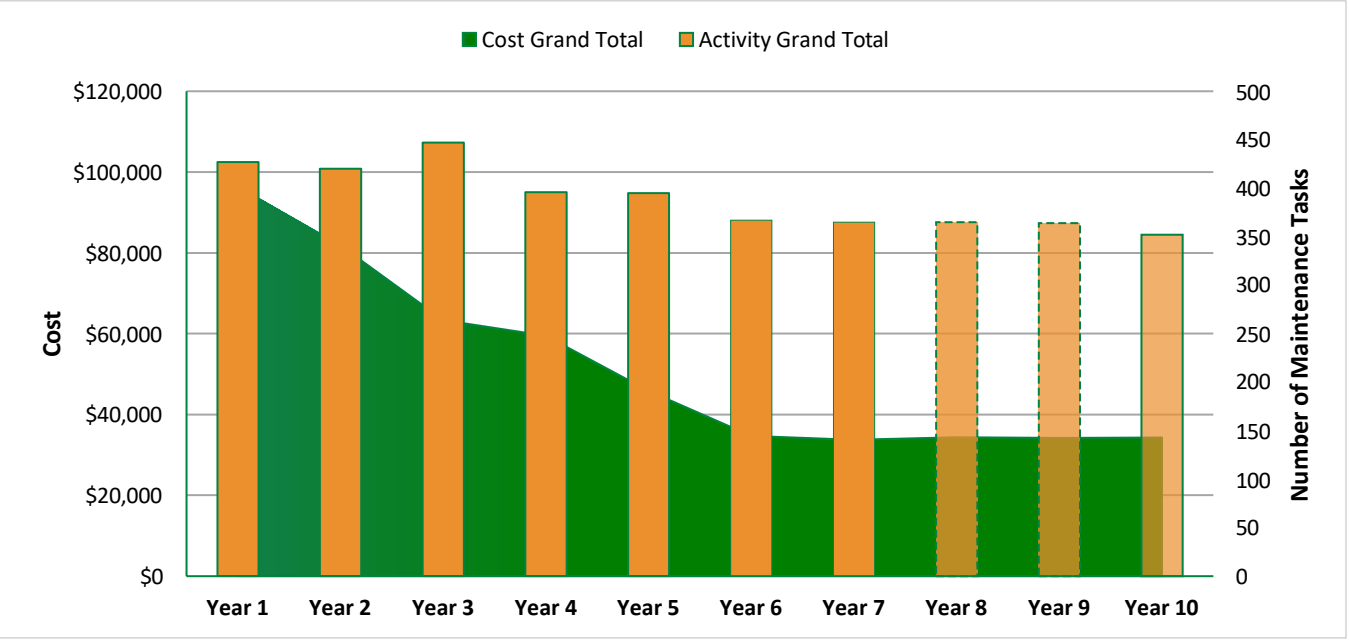


Figure 1. Total cost and number of activities for each year during the 10-year maintenance plan.

Recommended Maintenance Types

Tree Removal

Trees designated for removal have defects that cannot be cost-effectively or practically corrected. Most of the trees in this category have a large percentage of dead crown.

Total = 163 trees

High Priority = 2 trees

Moderate Priority = 14 trees

Low Priority = 89 trees

Stumps = 58

Priority Pruning

Priority pruning removes defects such as Dead and Dying Parts or Broken and/or Hanging Branches. Pruning the defected branch(es) can lower risk associated with the tree while promoting healthy growth.

Total = 442 trees

High Priority = 0 trees

Moderate Priority = 20 trees

Low Priority = 422 trees

Routine Pruning Cycle

Over time, routine pruning of Low and Moderate Risk trees can minimize reactive maintenance, limit instances of elevated risk, and provide the basis for a robust risk management program.

Total = 922 trees

Number in cycle each year = 92 trees

Young Tree Training Cycle

Younger trees can have branch structures that lead to potential problems as the tree ages, requiring training to ensure healthy growth. Training is completed from the ground with a pole pruner or pruning shear.

Total = 80 trees

Number in cycle each year = 27 trees

Tree Planting

Planting new trees in areas that have poor canopy continuity is important, as is planting trees where there is sparse canopy, to ensure that tree benefits are distributed evenly across the city.

Total new plantings each year=82 trees

Routine Tree Inspection

Routine inspections are essential to uncovering potential problems with trees and should be performed by a qualified arborist who is trained in the art and science of planting, caring for, and maintaining individual trees.

Total trees (excluding those already recommended for removal) =1,022

Number in walk-by assessment cycle each year of 5-year cycle= 204 trees

INTRODUCTION

Ballston Spa is located southwest of Saratoga Springs in Saratoga County. The village has a rich history, dating back to 1771, when it was first settled. Ballston Spa was once famous for its water springs, which were used in hospitals for its healing properties.

The historic village is now home to approximately 5,469 residents. The Park and Tree Board of Ballston Spa serve the community by working to maintain and improve the trees along the street rights-of-way (ROW) and throughout public parks and properties. The Village's dedicated staff are looking to implement a proactive tree care and maintenance program, along with a planting plan, to ensure the Village's residents continue benefitting from the public trees in their community for generations to come.

Past urban forestry projects, including Arbor Day tree plantings on Front Street with the Ballston Spa Tree Board, the Mayor, and business owners, have demonstrated Ballston Spa's commitment to sustaining the public tree resource with higher levels of tree care. Ballston Spa has also recently been designated a Tree City USA community and has created an advisory Park and Tree Board to help oversee and manage their urban forest.

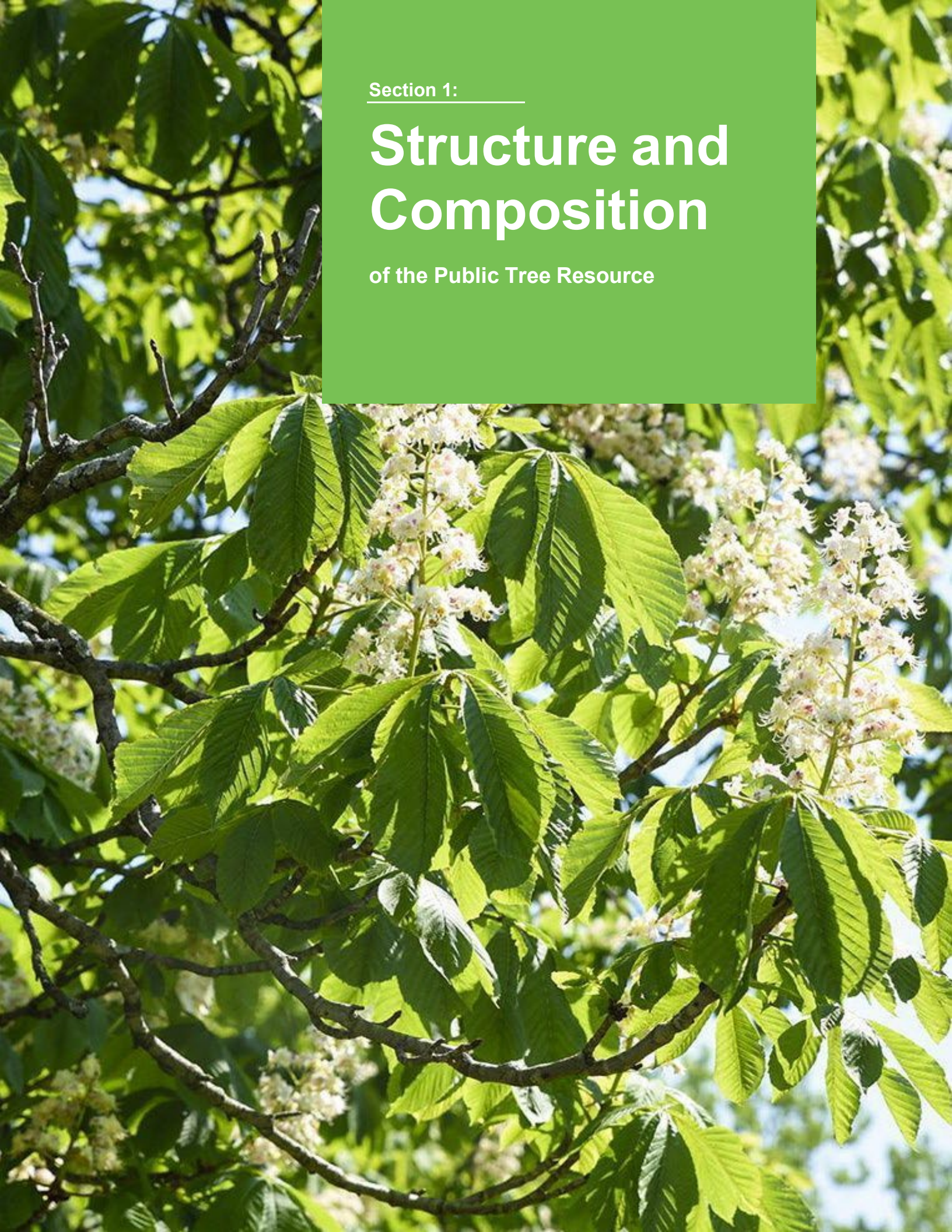
The Community Forest Management Plan (CFMP) provides insight into the spatial extent, structure, and composition of the Village of Ballston Spa's Forest resource. The findings and recommendations of this CFMP will support a deeper understanding of the Village of Ballston Spa's Forest resources, guide strategic planning and funding advocacy efforts, and assist the Board of Trustees and the Park and Tree Board and its partners in expanding and maintaining a sustainable and resilient public forest.

RECOMMENDED APPROACH TO TREE MANAGEMENT

An effective approach to tree resource management follows a proactive and systematic program that sets clear and realistic goals, prescribes future action, and periodically measures progress. A robust urban forestry program establishes tree maintenance priorities and utilizes modern tools, such as a tree inventory accompanied by TreeKeeper® or other asset management software.

In September 2021, the Village of Ballston Spa, New York worked with DRG to inventory its public trees and develop this management plan. Consisting of five sections, this plan considers the diversity and condition of the inventoried tree population and provides a prioritized system for managing the village's public tree resource.

- *Section 1: Structure and Composition of the Public Tree Resource* summarizes the inventory data with trends representing the current state of the tree resource.
- *Section 2: Functions and Benefits of the Public Tree Resource* summarizes the estimated value of several benefits provided to the community by public trees' various functions.
- *Section 3: Recommended Management of the Public Tree Resource* details a prioritized management program and provides an estimated budget for recommended maintenance activities over a 5-year period.
- *Section 4: Comprehensive Planting Plan,* summarizes best management practices for procuring, planting, and maintaining young trees, along with general recommendations on the size and species of trees for each vacant site.
- *Section 5: Trees and Sidewalk Plan,* summarizes design strategies and construction techniques to improve the relationship and longevity of trees growing near sidewalks



Section 1:

Structure and Composition

of the Public Tree Resource

SECTION 1: STRUCTURE AND COMPOSITION OF THE PUBLIC TREE RESOURCE

In September 2021, DRG arborists collected site data on trees, stumps, and planting sites along the street ROW along with some small parks and public spaces. Of the total 1,671 sites inventoried, 1,127 trees were inventoried along with 58 stumps and 486 future planting sites. Figure 2 breaks down the total sites inventoried by type. See Appendix A for details about DRG's methodology for collecting site data.

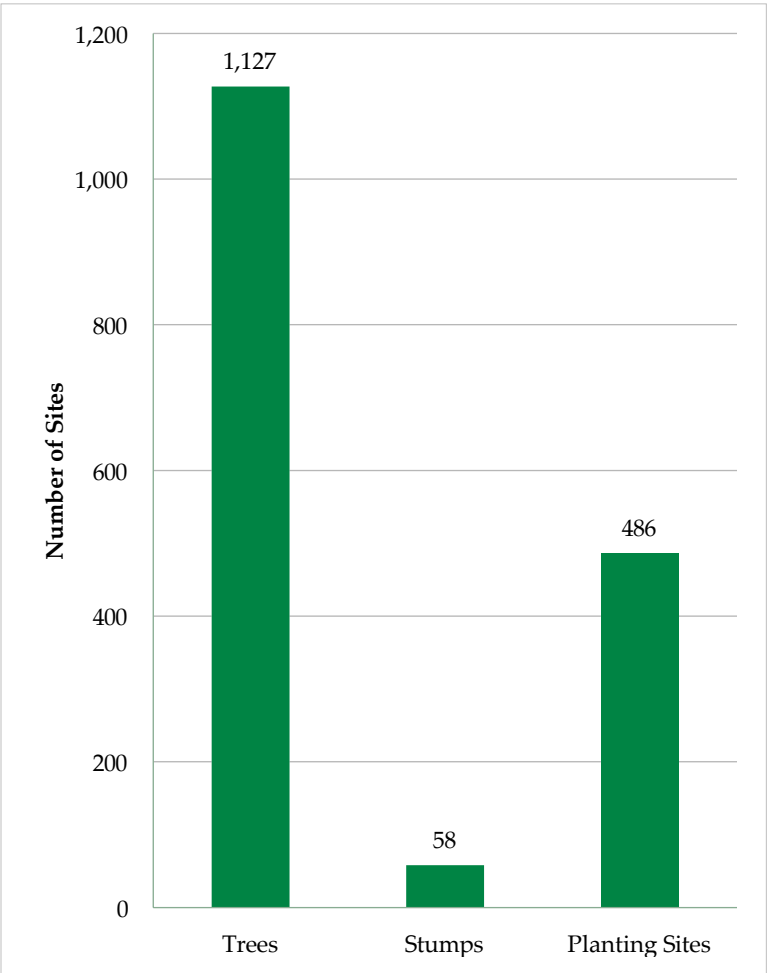


Figure 2. Number of inventoried sites by location and type.

A total of 1,624 trees, stumps, and planting sites were collected along Ballston Spa's ROW and public spaces and parks. These public spaces and parks included Wiswall Park, Village Pool, Ballston Area Recreation Commission, Victory Circle Park, Veterans Park, Public Library, Ballston Area Community Center, the Fire Station, Iron Spring Park, Jim Tedisco Trail, and Kelly Park.

SPECIES, GENUS, AND FAMILY DISTRIBUTION

The 10-20-30 rule is a common standard for tree population distribution, in which a single species should compose no more than 10% of the tree population, a single genus no more than 20%, and a single family no more than 30% (Santamour 1990). This standard was developed partially in response to tragedies such as the demise of vast swaths of American elm (*Ulmus americana*) after the introduction of Dutch elm disease to the United States (see side panel, "Resilience Through Diversity"). It provides a valuable guideline to help protect urban forests from pests, diseases, extreme weather events, and climate change.

Figure 3 shows Ballston Spa's distribution of the most abundant tree species inventoried along street ROW and in parks compared to the 10% threshold. Norway maple (*Acer platanoides*), including the Crimson King cultivar, is the most abundant tree species inventoried in the ROW and comprise just over one-fourth (26%) of the inventoried ROW trees (Figure 3). Eastern white pine (*Pinus strobus*) and red maple (*Acer rubrum*) were the second most abundant ROW trees, each comprising 10% of the inventoried tree population which is the maximum recommended percentage for a given species. Sugar maple (*A. saccharum*) and Norway spruce (*Picea abies*) were the fourth and fifth most abundant trees and their populations do not comprise more than 10% of the inventoried population.

Figure 4 shows the town's distribution of the most abundant tree genera inventoried along streets and in parks. Maple (*Acer*) comprise almost half the inventoried street trees at 45% of the population, with no other genera coming close to the 20% single-genus threshold. Having one genera comprise that much of a population can be detrimental to an area if a disease or invasive insect were to attack that population. Maple are susceptible to attacks from the invasive Asian longhorned beetle and spotted lanternfly, and if those insects were to spread to Ballston Spa, they could potentially destroy half of the tree population.

RESILIENCE THROUGH DIVERSITY

The Dutch elm disease epidemic of the 1930s provides a key historical lesson on the importance of diversity (Karnosky 1979). The disease killed millions of American elm trees, leaving behind enormous gaps in the urban canopy of many Midwestern and Northeastern communities. In the aftermath, ash trees became popular replacements and were heavily planted along city streets. History repeated itself in 2002 with the introduction of the emerald ash borer into America. This invasive beetle devastated ash tree populations across the Midwest. Other invasive pests spreading across the country threaten urban forests, so it's vital that we learn from history and plant a wider variety of tree genera to develop a resilient public tree resource.

Ash trees in an urban forest killed by emerald ash borer.

USDA Forest Service (2017)

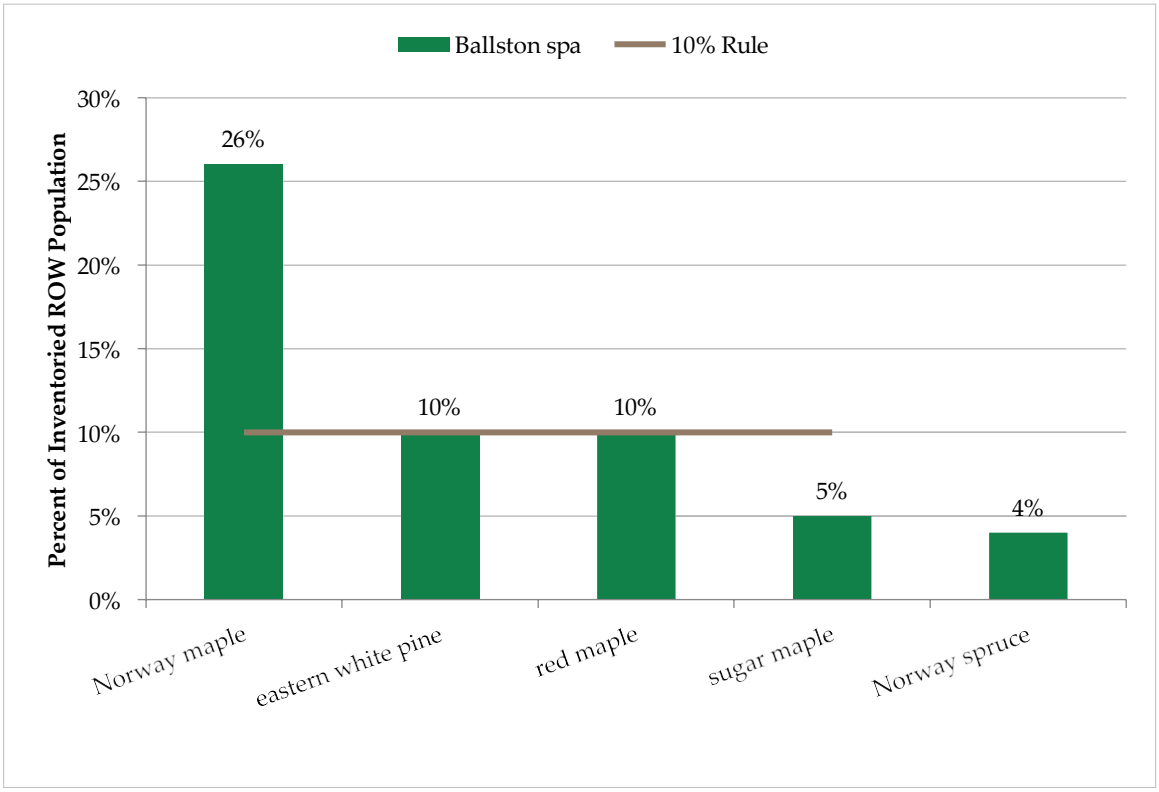


Figure 3. Five most abundant species among the inventoried trees.

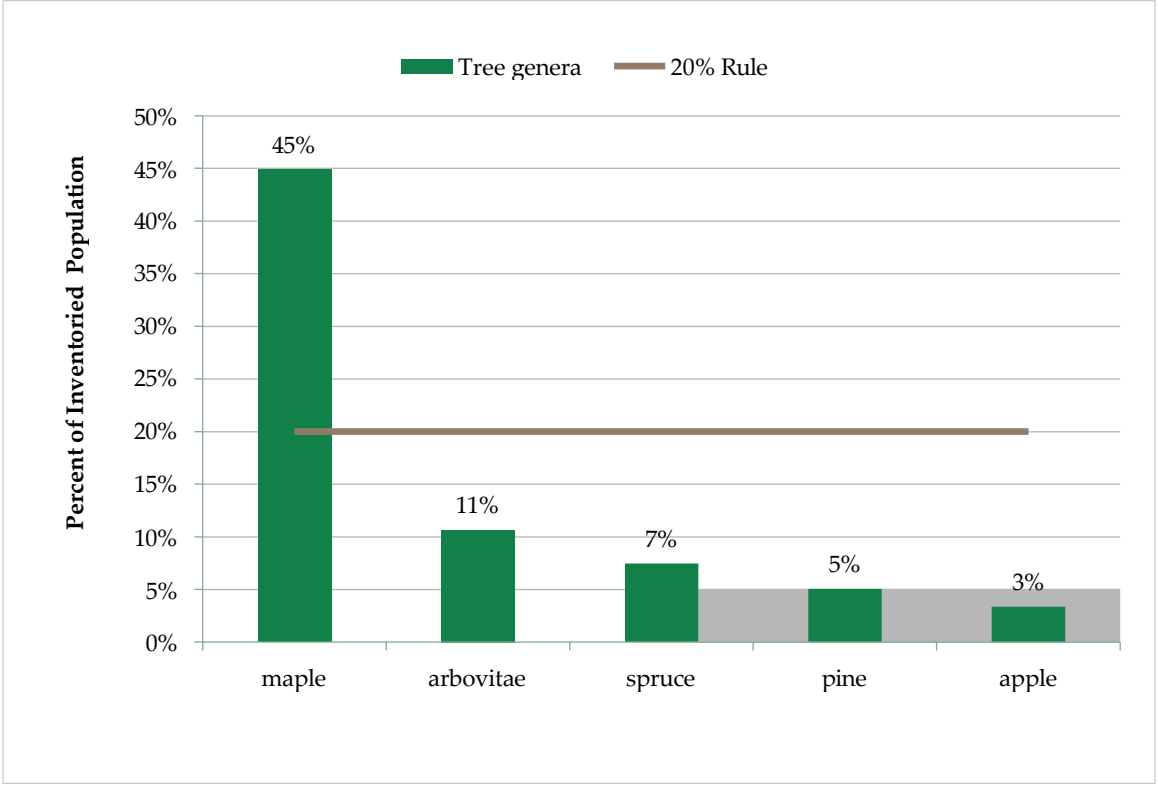


Figure 4. Five most abundant genera among the inventoried trees.

Figure 5 shows the village's distribution of the most abundant tree families inventoried compared to the 30% threshold. Predictably, the Sapindaceae family, to which maple (*Acer*) belong, comprises 45% of the inventoried trees, exceeding the 30% single-family threshold. No other tree family comes close to the 30% family rule in Ballston Spa.

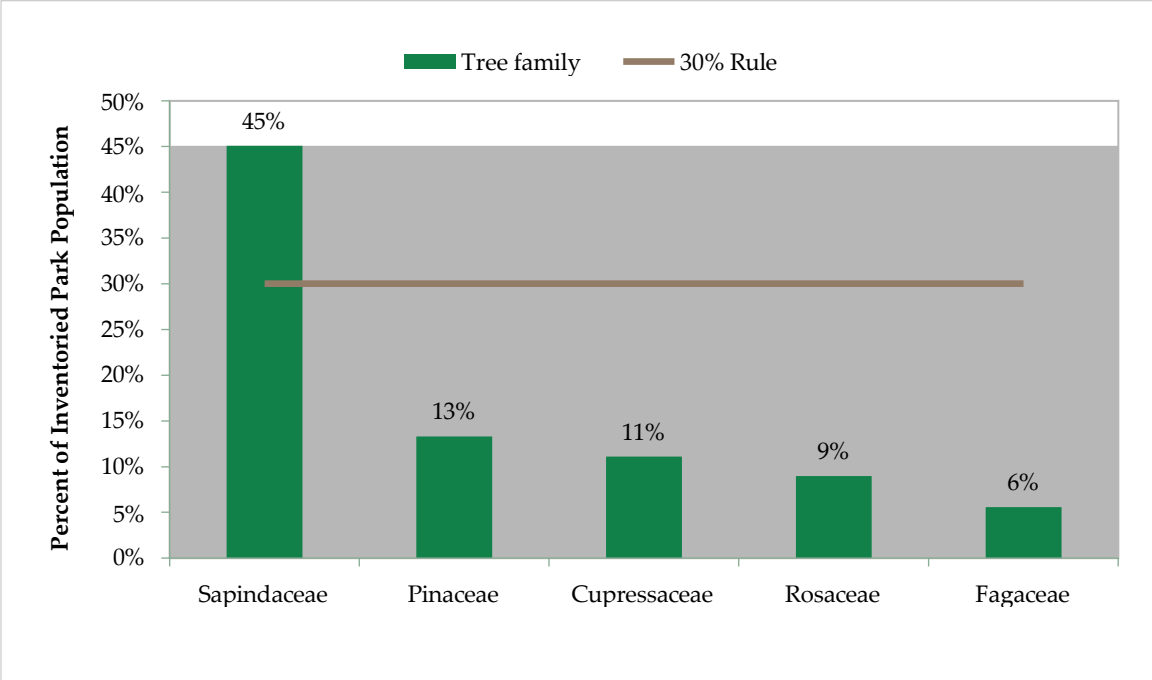


Figure 5. Family distribution of inventoried trees.

Species, Genus, and Family Distribution Recommendations

The species, genus, and family distribution of an urban tree population can be a useful metric for gauging the ability of the urban forest to resist disruption by pests, diseases, extreme weather, and climate change, as well as the forest's resilience, or ability to recover from these disruptions (Ordóñez & Duinker 2014). For example, certain pests, like emerald ash borer (EAB, *Agrilus planipennis*), target a single genus (ash, *Fraxinus* spp.) as their host, and different species of trees have varying susceptibility to extreme weather events (Hauer et al. 2006, Duryea & Kampf 2007), which will become more common as climate change continues. An urban forest with low species, genera, or family diversity is more likely to be damaged by pest, disease, weather, and climate disruptions due to the presence of large populations of highly susceptible trees. It is also likely to be less resilient, or less capable of recovering from such disturbances, since large portions of the urban forest may be eliminated or damaged by these disturbances. Cultivating diversity on the species, genus, and family levels can help mitigate the effects of disturbances and ensure a thriving urban forest for generations to come.

Ballston Spa's tree population has an overabundance of maple, particularly Norway maple, red maple, and sugar maple. The village should aim to reduce or temporarily halt new plantings of maple trees to help reduce the overabundance of these trees and reduce the risk of significant damage to the urban forest in the event of disturbances. Ballston Spa should focus on using the 486 available planting sites to increase tree diversity and bring the tree composition as close to the 10-20-30 rule as possible. Along with tree plantings, the Village of Ballston Spa should focus on monitoring vulnerable tree species and genera for signs and symptoms of the diseases and pests discussed in the next section.

PEST AND DISEASE SUSCEPTIBILITY

Early diagnosis of disease and infestation is essential to ensuring the health and continuity of Ballston Spa's public tree resource. See Appendix B for additional information about the pests listed below and websites where more information can be found.

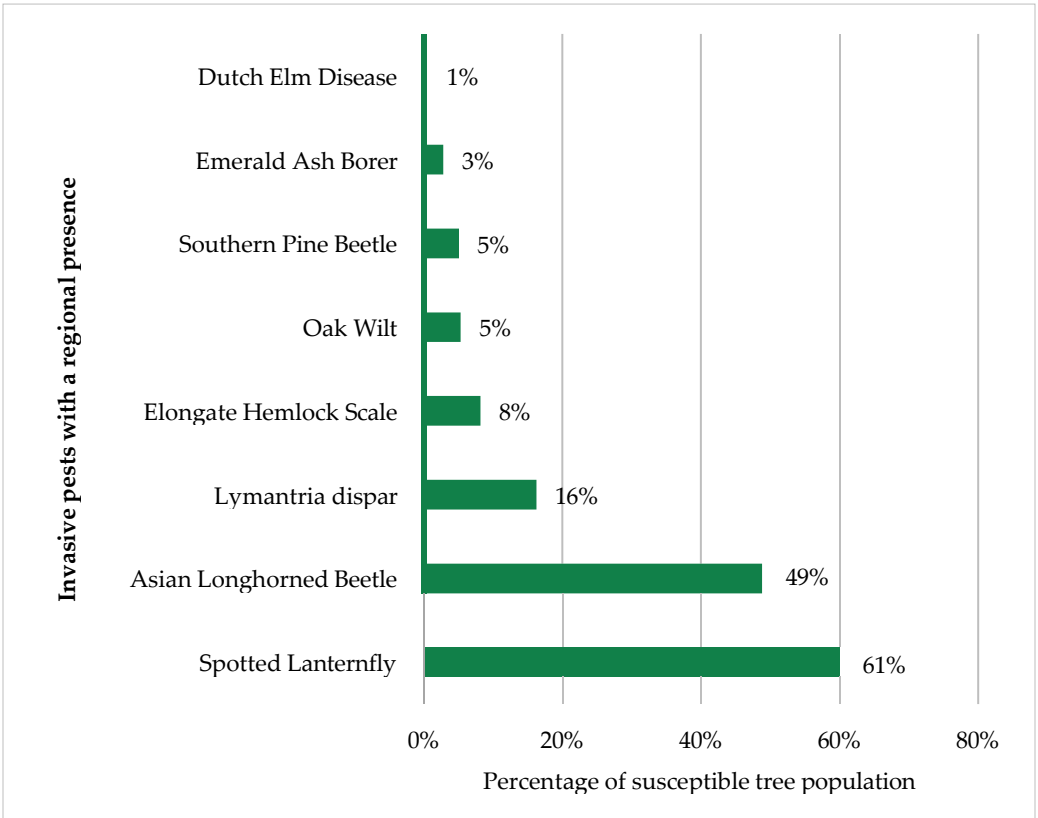


Figure 6. Tree resource susceptibility to invasive pests and disease of regional concern.

Figure 6 shows the percent of inventoried trees susceptible to some of the known pests of concern and disease in and around New York state. It is important to remember that this figure only represents data collected during the inventory. Many more trees throughout Ballston Spa, especially those on private property, may be susceptible to hosting these invasive pests and disease. While certain invasive species may not currently be present in the Ballston Spa area, there is potential for infestation due to the pests' and disease's regional presence and rapid dispersal ability.

At 61%, more than half of the inventoried trees are potentially susceptible to spotted lanternfly (SLF, *Lycorma delicatula*), and 49% of the inventoried trees are susceptible to Asian longhorned beetle (ALB, *Anoplophora glabripennis*). A further 16% of trees are susceptible to Spongy Moth (*Lymantria dispar)* (LDD, formerly called European gypsy moth). Smaller populations of trees are susceptible to elongate hemlock scale (EHS, *Fiorina externa*), oak wilt (*Bretziella fagacearum*), southern pine beetle (SPB, *Dendroctonus frontalis*), emerald ash borer (EAB, *Agrilus planipennis*), and Dutch elm disease (DED, *Ophiostoma novo-ulmi*). EHS, oak wilt, SPB, EAB, and DED are not major concerns in Ballston Spa due to the very small populations of suitable host trees present within the village.

Pest Susceptibility Recommendations

Ballston Spa has large populations of trees that are susceptible to SLF, ALB, and LDD including maple and oak. These insect pests are generalists and can feed on a wide range of tree species. Although planting a more diverse array of new trees may help to protect the urban forest from these species somewhat, a more effective solution may be to monitor the village's trees on a routine basis to find early signs and symptoms of these and other pest species and diseases. Early detection of pest infestations and disease outbreaks provide an opportunity for more effective and efficient management of the problem. Prompt action upon discovery of an insect or pest infestation is crucial. Having plans and funding in place to handle potential future insect and pest outbreaks in the village is critical to ensure that Ballston Spa's tree resource is protected from such damage in the future. For further discussion of invasive species management.

DEFECT OBSERVATIONS

For each tree inventoried, DRG recorded the defect for which risk was assessed. Defect observations were limited to the following categories:

- Dead and dying parts
- Broken and/or hanging branches
- Cracks
- Branch attachment
- Missing or decayed wood
- Tree architecture
- Root problems
- Other

Table 1. Tree defects and failure size for trees included in the inventory.

Defect	Number of Trees	Percent of Trees
Broken and/or Hanging Branches	66	6%
Cracks	17	2%
Dead and Dying Parts	666	59%
Missing or Decayed Wood	64	6%
None	90	8%
Other	12	1%
Root Problems	10	1%
Tree Architecture	103	9%
Branch attachment	99	9%
Total	1,127	100%

The most recorded defect among all trees was dead and dying parts – 59% of trees were recorded with this defect. This indicates that most trees which present a hazard to the public could be mitigated through pruning. The second two most recorded defects were branch attachment and tree architecture which each accounted for 9% of the recorded defects. These issues can be mitigated early on in a trees life by performing training pruning which trains the trees to grow in a more structurally sound way.

Defect Observation Recommendations

When considering the defect recorded for each tree, there are two important qualifiers to keep in mind. First, the categories are broadly inclusive. For example, the dead and dying parts category can include trees with just one or two smaller diameter dead limbs as well as trees found with large-diameter dead limbs or entire sections of dead canopy. Therefore, inferences on overall tree condition or risk rating cannot be derived solely from the presence or absence of a defect recorded during the inventory. Second, an inventoried tree may have multiple defects; the 2021 inventory recorded only the defect most likely to result in failure within a year. If multiple defects were likely to cause failure within a year, the defect with the greater risk attached to it was recorded. These two qualifiers are important to keep in mind when considering urban forest management planning and the prioritization of maintenance or monitoring activities.

Photograph 1. Tree in Ballston Spa with weakly attached branches and included bark. Co-dominant stems undermine the structural integrity of the tree, increasing branch failure.

The fact that dead and dying parts was the most recorded defect during the inventory indicates that many instances of elevated risk or significant/severe consequences of tree failure could be mitigated through pruning or removal, where necessary. The number of trees with deadwood as a significant defect could be reduced over time by employing a proactive routine pruning cycle to assess and provide pruning for trees at least once every decade.

Poor branch attachments and tree architecture are much more challenging defects to mitigate once a tree is mature. Doing so often requires removing large diameter leads or branches which provides greater opportunities for decay due to larger pruning wounds, as well as affecting the crown balance of the tree and potentially damaging its aesthetic and functional value. These types of defects should ideally be addressed when trees are young and the defect size is small, during a young tree training cycle, with structural pruning. Doing so would help to reduce the number of mature trees in the future with these defects.

CONDITION

Multiple factors affecting condition were considered for each tree, including root characteristics, branch structure, trunk, canopy, foliage condition, and the presence of pests, among others. The condition of each inventoried tree was rated by the collecting arborist as either Good, Fair, Poor, or Dead. The general health of the inventoried tree population was characterized by the most prevalent condition assigned during the inventory.

Figure 7 shows that most of the inventoried ROW trees were recorded in Fair condition (70%). Good condition was the second most common rating among inventoried trees, with 17% of the inventoried street trees rated in this condition. A small portion of the tree population was considered Poor or Dead (13% total). Only 2% of inventoried trees were considered Dead.

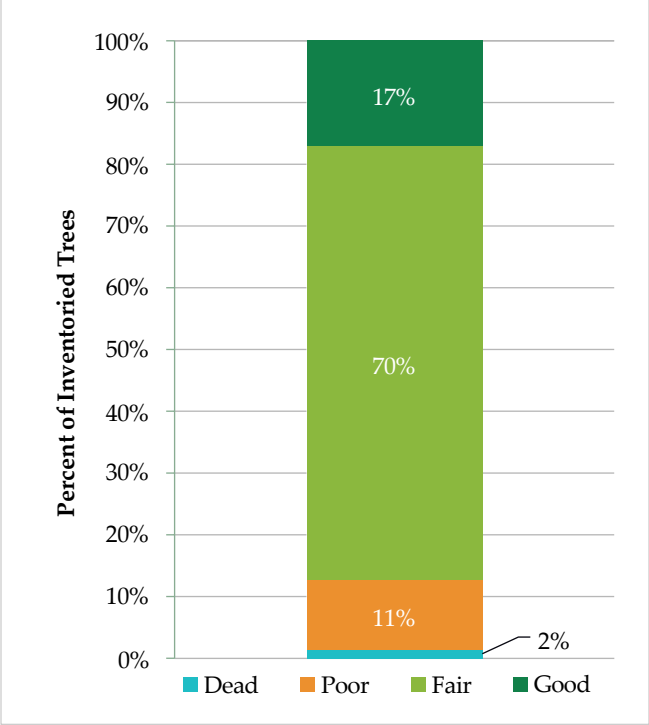


Figure 7. Condition of inventoried trees.

Overall, the inventoried tree population had predominantly Good or Fair condition ratings, with low numbers of trees in Poor or Dead condition meaning the tree population is healthy overall.

Condition Recommendations

Condition alone should not be used to prioritize maintenance activities. Use asset management software, such as TreeKeeper®, to prioritize Poor condition or Dead tree removals with a High Risk rating. Younger trees rated in Fair or Poor condition may benefit from structural pruning to improve their health over time. Pruning should follow *ANSI A300 (Part 1)* guidelines. 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 likely require corrective pruning and intensive plant health care to improve their vigor and should be monitored for worsening conditions. Trees rated as Fair condition may benefit from pruning to remove dead or defective limbs; improved structure may elevate their condition with time and care.

RELATIVE AGE DISTRIBUTION

Analysis of a tree population's relative age distribution is performed by assigning age classes to the size classes of inventoried trees. Size is used as a proxy for age because of the difficulty of accurately and rapidly measuring tree age in the field. Since tree species have different lifespans and mature at different diameters, exact tree age cannot be determined from diameter size class alone, but size classifications can be extrapolated into relative age classes which can offer insight into the maintenance needs of Ballston Spa's tree resource. The inventoried trees were grouped into the following relative age classes:

- Young trees (0–8 inches diameter at breast height (DBH))
- Established trees (9–17 inches DBH)
- Maturing trees (18–24 inches DBH)
- Mature trees (greater than 24 inches DBH)

These size classes were chosen so that the inventoried tree resource can be compared to the ideal relative age distribution, which holds that the largest proportion of the inventoried tree population (approximately 40%) should be young trees, while a smallest proportion (approximately 10%) should be mature trees (Richards 1983).

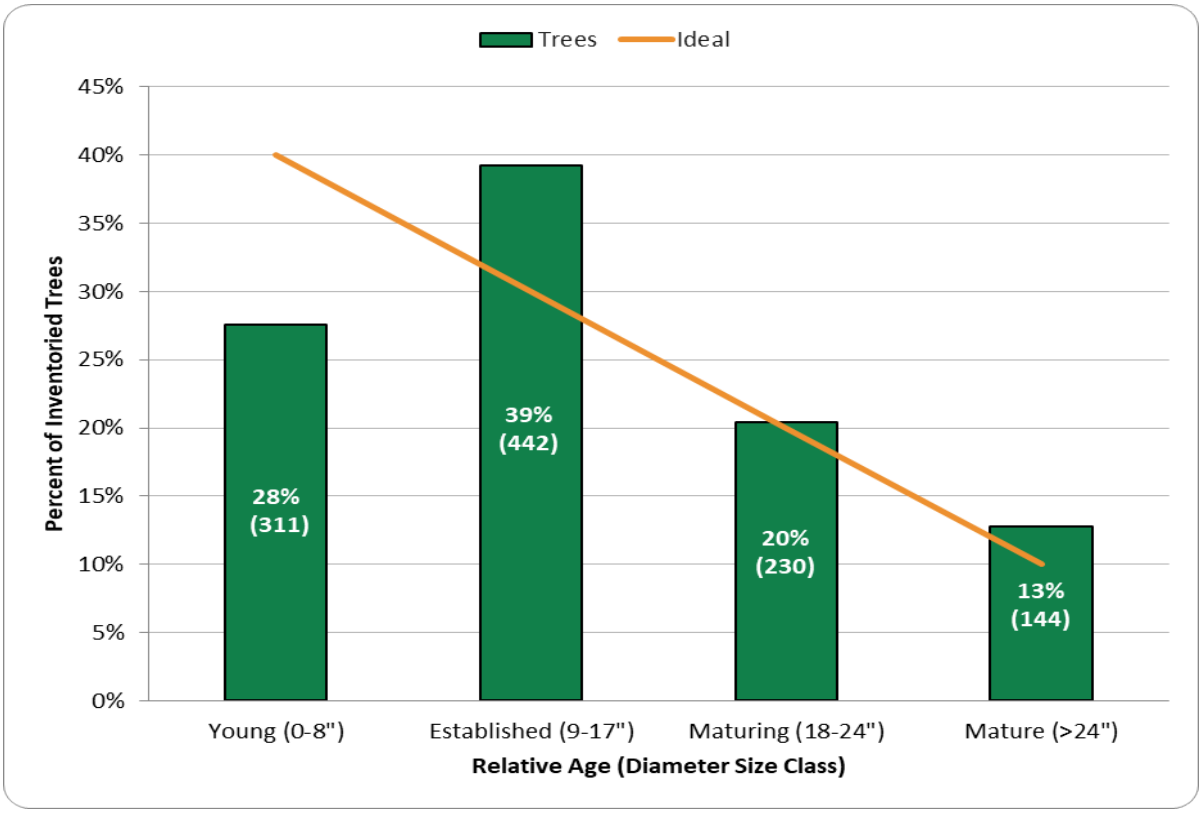


Figure 8. Relative age distribution of inventoried trees.

Figure 8 compares the relative age distribution of the inventoried tree population to the Richards' ideal distribution. The tree population is slightly off from the ideal with deviations from the 40-30-20-10 decreasing age distribution. There is an under-abundance of young trees (28% versus the ideal 40%) and established trees are slightly overabundant (39% versus the ideal 30%). Maturing trees are exactly at the ideal abundance of 20%, and mature trees are only slightly above the ideal abundance at 13% versus the ideal 10%.

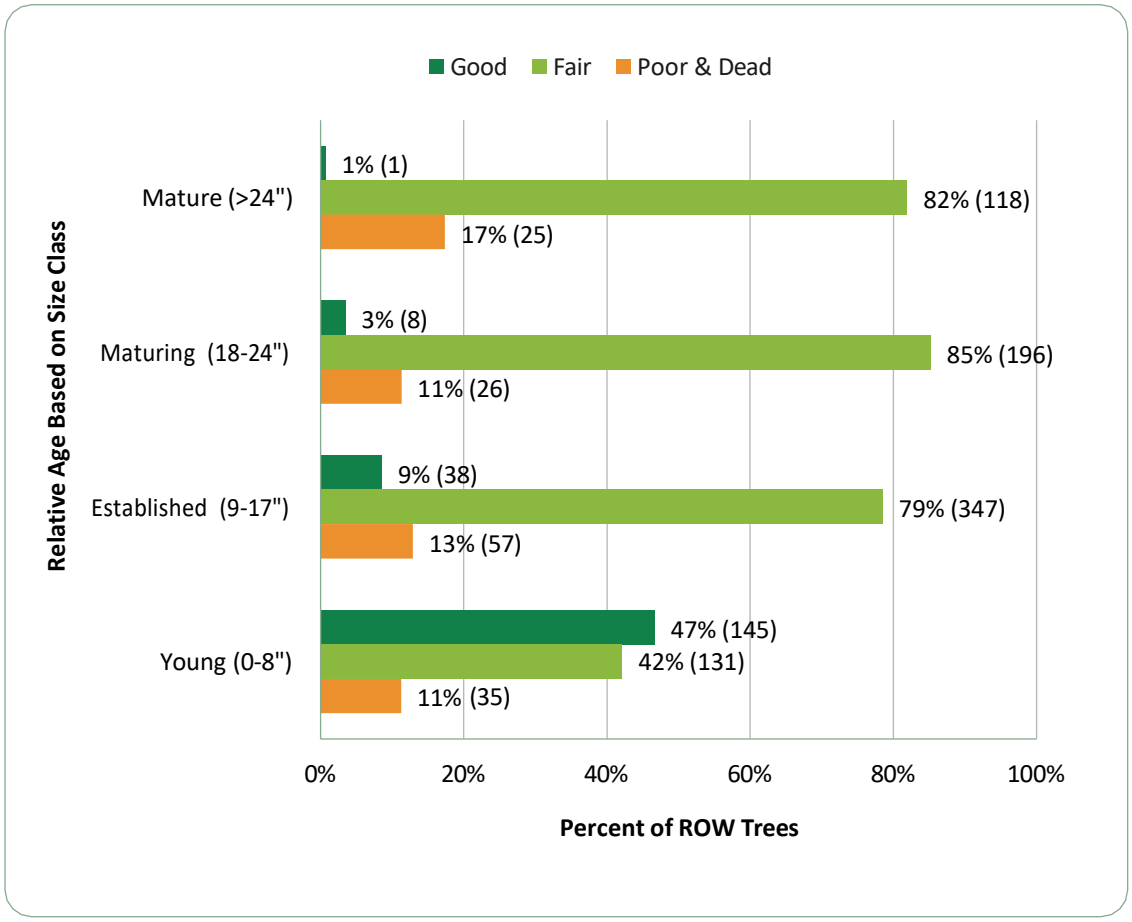


Figure 9. Condition of inventoried street trees by relative age class.

Figure 9 cross analyzes the condition of the inventoried tree resource with its relative age distribution, providing insight into the inventoried population's stability. Nearly half (47%) the young trees were in Good condition at the time of inventory and 42% were in Fair condition. The number of trees in Good condition drastically decreased once trees grew past the young stage (9"+). Compared to the 42% of young trees in Good condition, only 9% of established trees are in Good condition and even less for maturing and mature trees (3% and 1%, respectively). Most trees in the maturing and mature age classes were in Fair condition (85% and 82%, respectively). The proportion of trees in Good condition generally decreased with increasing age class, while the proportion of trees in Fair condition generally increased with increasing age class. The percentage of Poor and Dead trees stays similar for each age class of young, established, maturing, and mature (11%, 13%, 11%, 17% respectively).

Relative Age Recommendations

Ballston Spa has a relatively ideal street tree age distribution, and the predominantly Fair or better condition ratings maintained across age classes indicate that young trees have a good chance of reaching maturity if they are well maintained. The village should continue to monitor the age distribution of its trees and increase planting efforts to prevent an underabundance of young trees in future. Retaining a large pool of young trees is important to preserving canopy continuity as mature and maturing trees age out of the tree population and are removed, as well as increasing canopy coverage in the village over time.

INFRASTRUCTURE CONFLICTS

In an urban setting, growing space for trees is limited both above and below ground. Trees in restricted growing spaces may conflict with infrastructure such as buildings, sidewalks, utility wires, and pipes, which can pose risks to public safety and require significant investments of time and money to mitigate. Existing or possible conflicts between trees and infrastructure recorded during the 2021 inventory included:

- *Overhead Utilities*—The presence or absence of overhead utilities was recorded for all sites. Only primary and secondary electrical lines were considered when determining if overhead utilities existed within the air space currently or potentially occupied by a tree crown. A tree was considered to have overhead utilities present if an overhead line ran within 10 feet (the minimum approach distance) of the tree crown. Selections for this field included 'Present and Conflicting', indicating that an overhead utility line was present within the minimum approach distance of the crown, 'Present and Not Conflicting', indicating that an overhead utility line was present but currently outside the minimum approach distance, or 'Not Present', indicating no utility lines were present.

Photograph 3. Tree in Ballston Spa that conflicts with power lines. Tree pruning done to minimize contact with power lines can decrease tree health and structure.

Table 2. Conflicts with overhead infrastructure recorded during the inventory.

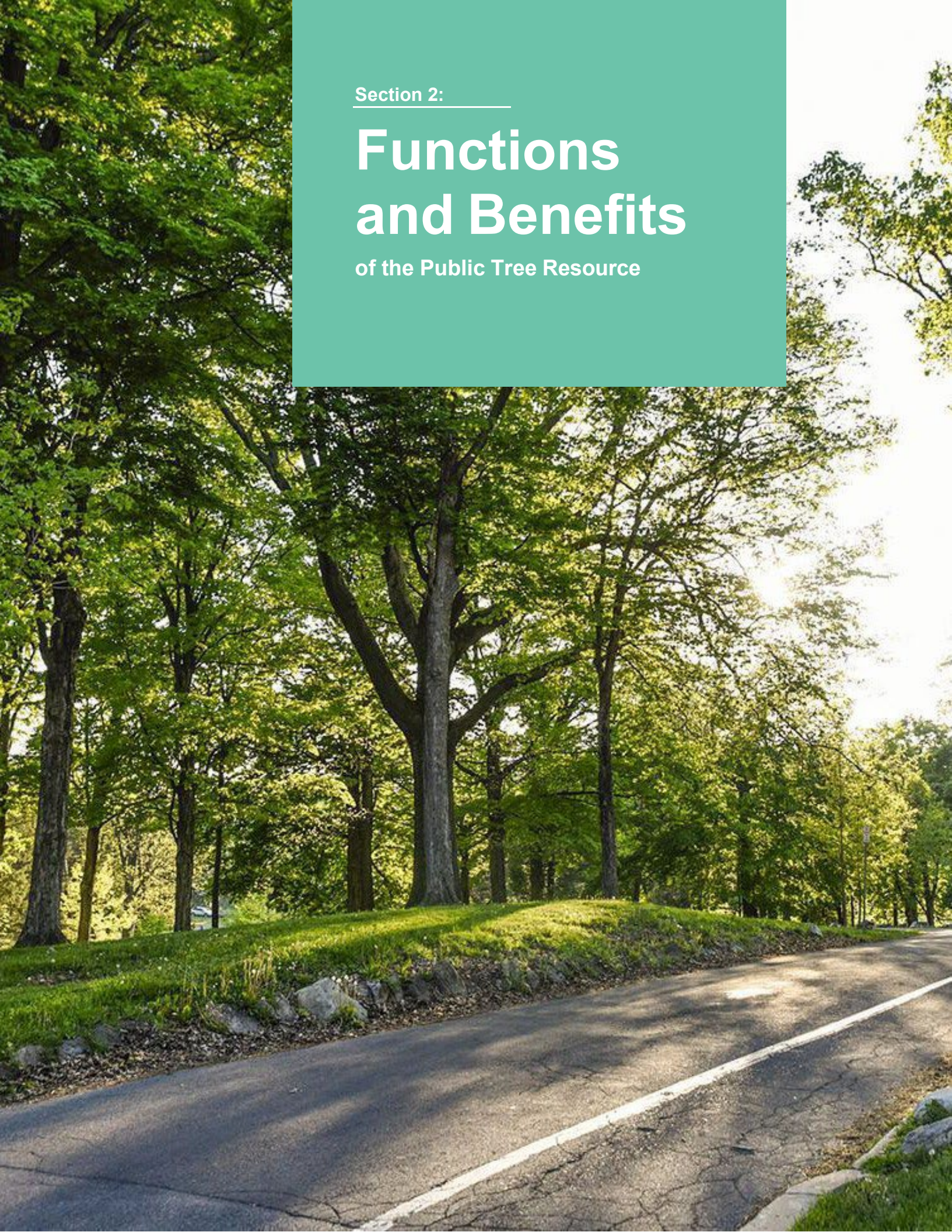
Overhead Utilities	Collected Sites	Percentage
Present and Conflicting	153	9%
Present and Not Conflicting	357	21%
Not Present	1,161	69%
Total	1,671	100%

Table 2 shows that 69% of trees were not located in sites where they could potentially come into conflict with overhead utility lines. However, nearly half of vacant sites and stumps (which can be considered potential planting sites should the stumps be removed), were located below overhead utilities (45% present utilities for stumps and vacant sites, not shown in Table 2).

Section 2:

Functions and Benefits

of the Public Tree Resource



SECTION 2: FUNCTIONS AND BENEFITS OF THE PUBLIC TREE RESOURCE

Trees provide a wide array of economic, environmental, and social benefits, which often exceed the cost associated with planting, maintaining, and removing them. Trees reduce air pollution, improve public health outcomes, reduce stormwater runoff, sequester, and store carbon, reduce energy use, and increase property value. The i-Tree Eco Software and other models in the i-Tree software suite, calculate the monetary value associated with the ecological services of the urban forest. Through this software, Ballston Spa can calculate the return on investment of their urban forest.

Environmental Benefits

- Trees decrease energy consumption and moderate local climates by providing shade and acting as windbreaks.
- Trees act as mini reservoirs, helping to slow and reduce the amount of stormwater runoff that reaches storm drains, rivers, and lakes. One hundred mature tree crowns intercept roughly 100,000 gallons of rainfall per year (U.S. Forest Service 2003a).
- Trees help reduce noise levels, cleanse atmospheric pollutants, produce oxygen, and absorb carbon dioxide.
- Trees can reduce street-level air pollution by up to 60% (Coder 1996). Lovasi (2008) suggested that children who live on tree-lined streets have lower rates of asthma.
- Trees stabilize soil and provide a habitat for wildlife.

Economic Benefits

- Trees in a yard or neighborhood increase residential property values by an average of 7%.
- Commercial property rental rates are 7% higher when trees are on the property (Wolf 2007).
- Trees moderate temperatures in the summer and winter, saving on heating and cooling expenses (North Carolina State University 2012, Heisler 1986).
- On average, consumers will pay about 11% more for goods in landscaped areas, with this figure being as high as 50% for convenience goods (Wolf 1998b, Wolf 1999, and Wolf 2003).
- Consumers also feel that the quality of products is better in business districts surrounded by trees than those considered barren (Wolf 1998b).
- The quality of landscaping along the routes leading to business districts had a positive influence on consumers' perceptions of the area (Wolf 2000).

Social Benefits

- Tree-lined streets are safer; traffic speeds and the amount of stress drivers feel are reduced, which likely reduces road rage/aggressive driving (Wolf 1998a, Kuo and Sullivan 2001a).
- Chicago apartment buildings with medium amounts of greenery had 42% fewer crimes than those without any trees (Kuo and Sullivan 2001b).
- Chicago apartment buildings with high levels of greenery had 52% fewer crimes than those without any trees (Kuo and Sullivan 2001a).
- Employees who see trees from their desks experience 23% less sick time and report greater job satisfaction than those who do not (Wolf 1998a).
- Hospital patients recovering from surgery who had a view of a grove of trees through their windows required fewer pain relievers, experienced fewer complications, and left the hospital sooner than similar patients who had a view of a brick wall (Ulrich 1984, 1986).
- When surrounded by trees, physical signs of personal stress, such as muscle tension and pulse rate, were measurably reduced within three to four minutes (Ulrich 1991).

I-TREE ECO ANALYSIS

i-Tree Eco utilizes tree inventory data along with local air pollution and meteorological data to quantify several of the functional benefits of a community's tree resource. By framing trees and their benefits in a way that everyone can understand, dollars saved per year, i-Tree Eco can help a community to understand trees as both a natural resource and an economic investment. Knowledge of the composition, functions, and monetary value of trees may help to inform planning and management decisions, assist in understanding the impact of those decisions on human health and environmental quality, and aid communities in advocating for the necessary funding to manage their vested interest in the public tree resource appropriately.

BENEFITS PROVIDED BY THE PUBLIC TREE RESOURCE

The i-Tree Eco analysis of the Village of Ballston Spa inventoried trees quantified the annual functional benefits of three critical ecosystem services that they provide: air pollution removal, carbon sequestration, and avoided surface runoff. It is important to note that many benefits provided by urban trees, such as reduction in energy use and various aesthetic benefits, were not modeled in this run of i-Tree Eco, and the actual value of benefits provided by the inventoried trees is likely much higher than what can be presented here.

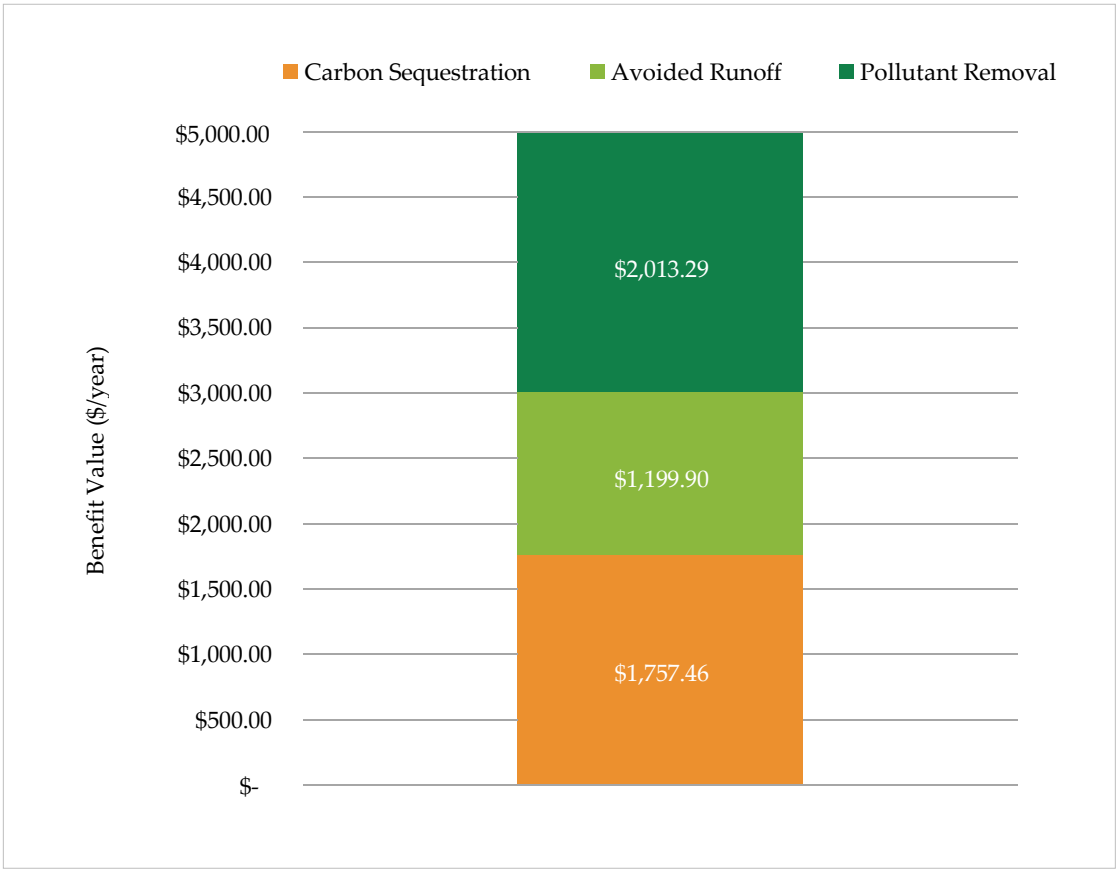


Figure 10. Estimated value of the annual benefits provided by inventoried trees.

The nearly $5,000 of annual functional benefits provided by Ballston Spa's inventoried tree population is an essential asset to the village (Figure 10). The inventoried trees in Ballston Spa remove around 420 lbs. of airborne pollutants each year (Tables 6), a service that is valued at $2,013. Reducing stormwater runoff decreases the risk of flooding and combined sewer overflow, both of which impact people, property, and the environment. The village's inventoried trees help to divert 134,277 gals. of runoff annually, a service valued at approximately $1,120. Carbon dioxide ($CO_2$) also impacts people, property, and the environment as the primary greenhouse gas driving climate change. The inventoried trees sequester around 10 tons (20,000 lbs.) of carbon derived from airborne CO_2 every year, a service valued at $1,757.

The replacement value, or cost of replacing existing trees with trees of similar size, species, and condition, of the village's inventoried tree population is estimated to be $2,007,101. Among the inventoried trees, five species account for around 52% of the total inventoried trees, 53% of the functional benefits it provides (see Table 3). If any of these dominant species were lost to invasive pests, disease, or other threats, the loss would have significant costs. It is therefore critical to routinely inspect village trees for signs of emergent disease, insect, or other problems and take steps to prevent wide-spread loss of valuable tree species. Promoting species diversity with future plantings will also help to increase the inventoried tree resource's resistance to and resilience after disturbances. Planting large-statured broadleaf tree species wherever possible will help to maximize potential environmental and economic benefits.

SEQUESTERING AND STORING CARBON

Trees are carbon sinks - the opposite of carbon sources. While carbon is emitted from cars and smokestacks, it is absorbed into trees during photosynthesis and stored in their tissues as they grow. The i-Tree Eco model estimates both the carbon sequestered each year and total carbon stored by the inventoried tree resource. Ballston Spa's inventoried trees collectively store nearly 914 tons (1,828,000 lbs.) of carbon, valued at $155,820. The most inventoried tree, Norway maple, accounts for 21% of the population and accounts for nearly a quarter of the carbon storage (220 tons or 24%). The population of maple, particularly Norway maple (*Acer platanoides*), Crimson King maple (*A. platanoides* 'Crimson king'), red maple (*A. rubrum*), sugar maple (*A. saccharum*), and silver maple (*A. saccharinum*), provided the greatest carbon storage benefits among the inventoried trees, storing a combined 574 tons of carbon (Table 3). Behind Norway maple, the second most inventoried tree, arborvitae (*Thuja occidentalis*), accounts for 10.5% of the inventoried tree population but accounts for only 1.5% of the carbon storage, a less beneficial carbon sink than the maple population. On a per-tree basis, maple and oak stored the most carbon, specifically silver maple (*A. saccharinum*, 2.35 tons/tree) and black oak (*Quercus velutina*, 1.42 tons/

Table 3. Summary of benefits provided by inventoried trees ranked by species abundance.

Most Common Trees Inventoried		Count	Percent of Total	Benefits Provided by Inventoried Trees				
				CO_2 Stored	CO_2 Sequestered	Avoided Runoff	Air Pollution Removed	Replacement Value
Common Name	Botanical Name		%	tons	tons/year	gal/year	lbs/year	Dollars
Norway maple	*Acer platanoides*	234	21.0%	220.3	2.9	36,297	120	$458,979
arborvitae	*Thuja occidentalis*	117	10.5%	13.5	0.3	1,039	0	$70,563
red maple	*Acer rubrum*	113	10.1%	123.8	1.8	19,826	60	$280,690
Crimson King maple	*Acer platanoides 'Crimson king'*	60	5.4%	76.1	1.0	8,528	20	$87,936
sugar maple	*Acer saccharum*	54	4.8%	71.0	0.5	8,964	20	$170,777
Norway spruce	*Picea abies*	47	4.2%	26.1	0.2	8,243	20	$112,643
eastern white pine	*Pinus strobus*	39	3.5%	14.4	0.2	3,659	20	$79,025
apple	*malus*	38	3.4%	5.0	0.1	566	0	$18,980
honeylocust	*Gleditsia triacanthos*	37	3.3%	27.7	0.4	3,422	20	$70,537
silver maple	*Acer saccharinum*	35	3.1%	82.4	0.6	13,554	40	$111,537
green ash	*Fraxinus pennsylvanica*	31	2.8%	9.3	0.2	3,403	20	$43,362
blue spruce	*Picea pungens*	31	2.8%	7.2	0.1	1,316	0	$32,925
Callery pear	*Pyrus calleryana*	26	2.3%	7.3	0.2	1,021	0	$21,767
black oak	*Quercus velutina*	23	2.1%	32.6	0.2	2,145	0	$49,869
littleleaf linden	*Tilia cordata*	23	2.1%	2.6	0.1	754	0	$17,987
All Other Trees Inventoried		208	18.6%	194	1.7	21,539	60	$379,526
Total		1,116	100%	914	10.3	134,277	420	$2,007,101

CONTROLLING STORMWATER

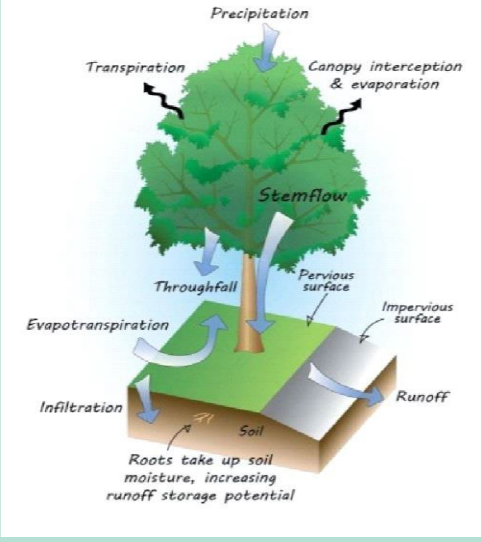
Trees intercept rainfall with their leaves and branches, helping lower stormwater management costs by avoiding runoff. The inventoried trees in the Village of Ballston Spa help divert 134,277 gals. of runoff annually, a benefit valued at approximately $1,200. Avoided runoff accounts for 24% of the annual functional benefits provided by Ballston Spa's public tree resource each year.

The population of Norway maple (*Acer platanoides*) provided the greatest benefits of 36,297 gals. diverted annually. On a per tree basis, silver maple (*Acer saccharinum*) provides the largest reductions in runoff at 387 gals. diverted per tree per year followed by Norway spruce (*Picea abies*) and red maple (*A. rubrum*), each diverting 175 gals. per tree per year.

IMPROVING AIR QUALITY

The inventoried tree population removes 420 lbs. of airborne pollutants, including sulfur dioxide (SO_2), carbon monoxide (CO), nitrogen dioxide (NO_2), ozone (O_3), and particulate matter ($PM_{2.5}$) annually. The estimated value of this benefit is $2,013 which is 41% of the value of all annual benefits estimated by i-Tree Eco. As shown in Figure 11, a small reduction of $PM_{2.5}$ is the most valuable reduction in airborne pollutants. The inventoried tree species population that provided the greatest air quality benefits was once again Norway maple (*Acer platanoides*), which removed 120 lbs. of airborne pollutants annually. On a per-tree basis, the trees which provided the greatest air quality benefits were silver maple (*A. saccharinum*, 1.14 lbs./tree/year) and green ash (*Fraxinus pennsylvanica*, 0.65 lb./tree/year).

CANOPY FUNCTIONS



Trees provide many benefits simply by existing, such as:

- Catching rainfall in their crown so it drips to the ground with less of an impact or flows down their trunk.
- Helping stormwater soak into the ground by slowing down runoff.
- Creating more pore space in the soil with their roots, helping stormwater to move through the ground.
- Cooling the surrounding landscape by casting shade with their canopy and releasing water from their leaves.
- Catching airborne pollutants on their leaves and absorbing them with their roots when they wash off in the rain.
- Transforming some pollutants into less harmful substances and preventing other pollutants from forming.

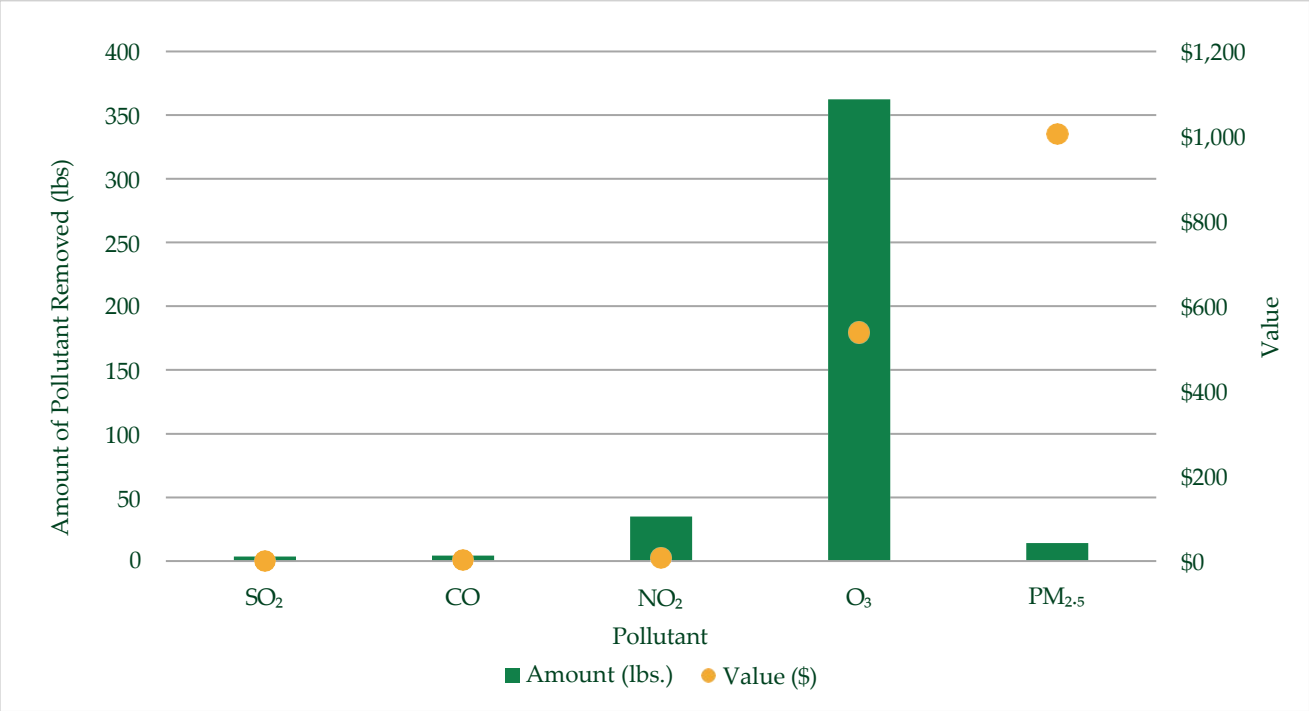


Figure 11. Estimated value of removing airborne pollution by weight and type.

REPLACEMENT VALUE

Replacement value is an estimate of the local cost of replacing an existing tree with a similar tree. It can help provide an estimate of the overall value of a tree population or individual tree. Collectively, Ballston Spa's inventoried tree population has a replacement value of $2,007,101, which averages to around $1,798 in replacement value per tree. The most valuable street tree species population is the population of Norway maple (*Acer platanoides*), likely due in part to the abundance of this species along the village's ROW. On a per-tree basis, the most valuable street trees were silver maple (*Acer saccharinum*, $3,187 per tree) and sugar maple (*A. saccharum*, $3,163 per tree).

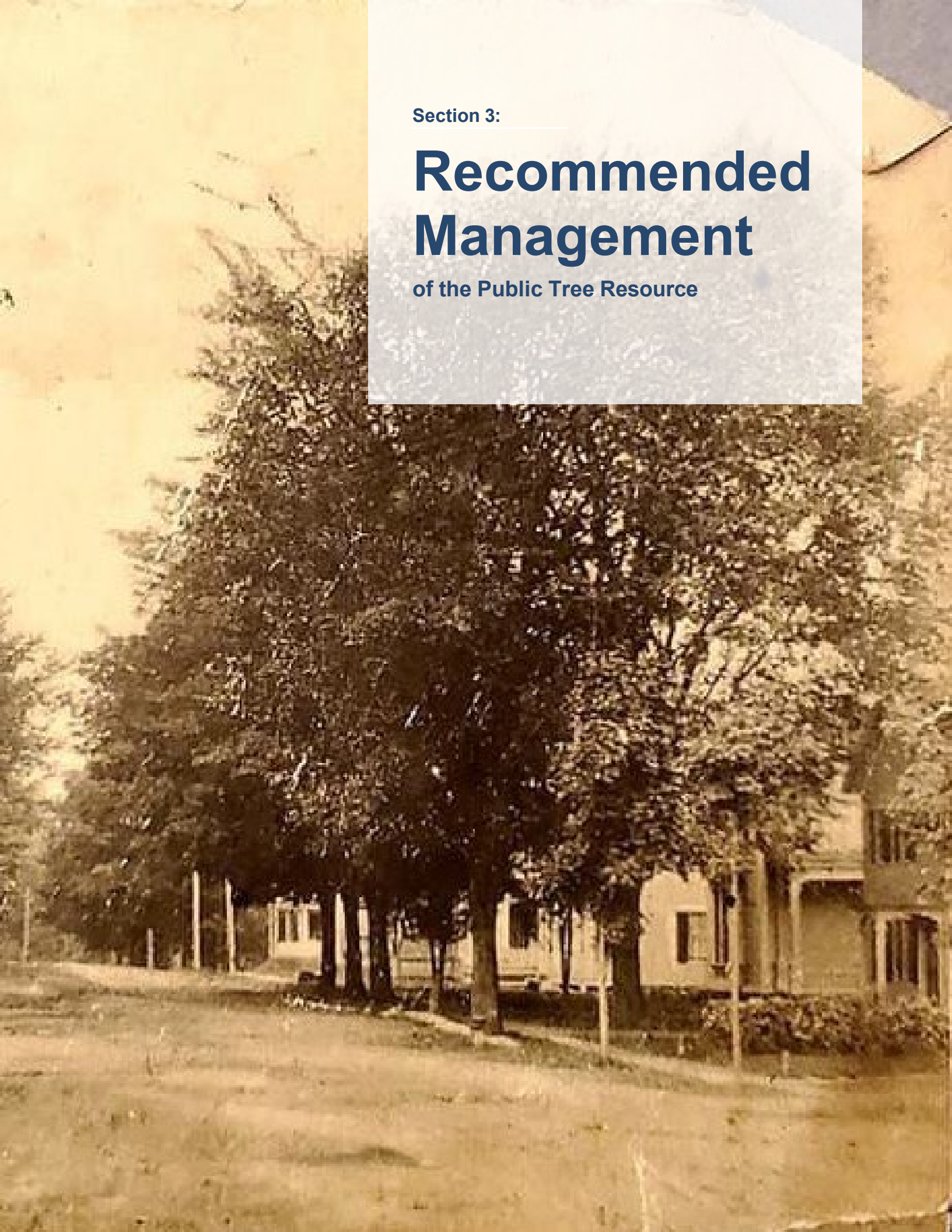
CONCLUSIONS

Overall, the Village of Ballston Spa's Street tree population of silver maple (*Acer saccharinum*) is the most valuable sub-population of the inventoried trees. Although silver maple only account for 3% of the inventoried trees, they stored the most CO_2/tree/year, they sequestered the second most CO_2/tree/year, they reduced the most runoff/tree/year, they removed the most airborne pollutants/tree/year, and they have the highest replacement value/tree. Ballston Spa should make sure to check this high-value tree population frequently for signs of pests or disease. When it is necessary to remove individuals of the species, the Village of Ballston Spa replace them with other large-stature, broadleaf trees, which tend to provide the most functional benefits to a community.

Section 3:

Recommended Management

of the Public Tree Resource



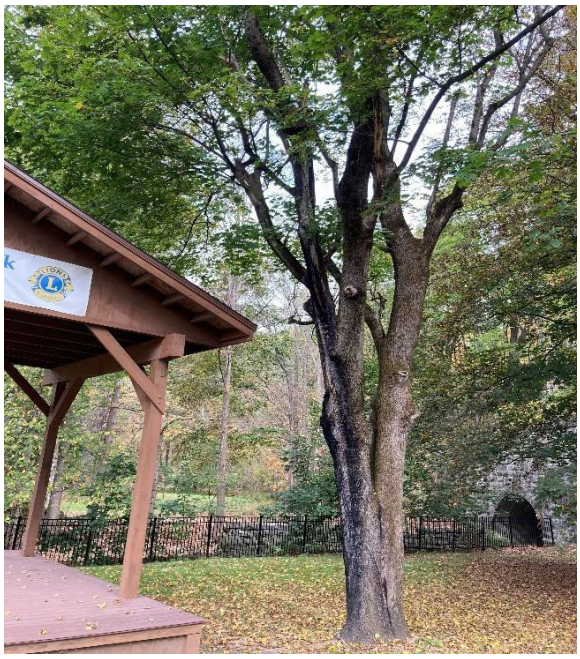
SECTION 3: RECOMMENDED MANAGEMENT OF THE PUBLIC TREE RESOURCE

During the inventory, both a risk rating and a recommended maintenance activity were assigned to each tree. DRG recommends prioritizing and completing each tree's recommended maintenance activity based on the assigned risk rating. This ten

-year tree management program takes a multi-faceted and proactive approach to tree resource management.

RISK MANAGEMENT AND RECOMMENDED MAINTENANCE

Every tree, regardless of condition, has an inherent risk of whole or partial tree failure. During the inventory, DRG performed a Level 2 qualitative risk assessment for each tree and assigned a risk rating based on ANSI A300 (*Part 9*) and the companion publication *Best Management Practices: Tree Risk Assessment* (ISA 2011). Trees can have multiple potential modes of failure, each with its own risk rating. The potential mode of failure with the highest risk rating was recorded for each tree during the 2021 tree inventory. The specified time frame for the risk assessment was one year. See Appendix C for further information on the risk assessment and rating system.



Photograph 4. Tree in Ballston Spa with weakly attached branches and included bark that is in close proximity to a permanent structure. The likelihood of impacting the target is high.

DRG recommends that tree maintenance activities are prioritized and completed based on the risk rating that was assigned to each tree during the inventory. Trees with High Risk ratings should be attended to first, followed by trees with a Moderate Risk rating, and trees with a Low Risk rating should be maintained once higher risk trees have been pruned or removed. The following sections describe the recommended maintenance activities for each risk rating category.

EXTREME AND HIGH PRIORITY RECOMMENDED MAINTENANCE

Pruning or removing trees with an elevated level of risk (i.e., High or Moderate Risk ratings) is strongly recommended to be prioritized and completed as soon as possible. In general, maintenance activities should be completed first for the largest diameter trees that pose the greatest risk. Once these trees are addressed, recommended tree maintenance activities should be completed for smaller diameter trees that pose the greatest risk. Addressing elevated risk trees in a timely and proactive manner often requires significant resources to be secured and allocated. However, performing this work expediently will mitigate risk, improve public safety, and reduce long-term costs.

Priority Pruning Recommendations

Elevated risk trees recommended for pruning should be pruned immediately based on the assigned risk rating, which generally requires removing defects such as dead and dying parts, broken and/or hanging branches, and missing or decayed wood that may be present in tree crowns, even when most of the tree is sound. In these cases, when pruning the defective parts can correct the problem, risk associated with the tree is reduced while promoting healthy growth.

The inventory identified 20 Moderate Risk trees in the street ROW in need of pruning (Figure 12). No trees in either the ROW or parks which were recommended for pruning had a High Risk rating. The diameter for trees with recommended priority pruning ranged between 11 and 50 DBH. Since there are no High Risk trees in need of pruning, these Moderate Risk trees should be pruned as soon as possible to reduce risk.

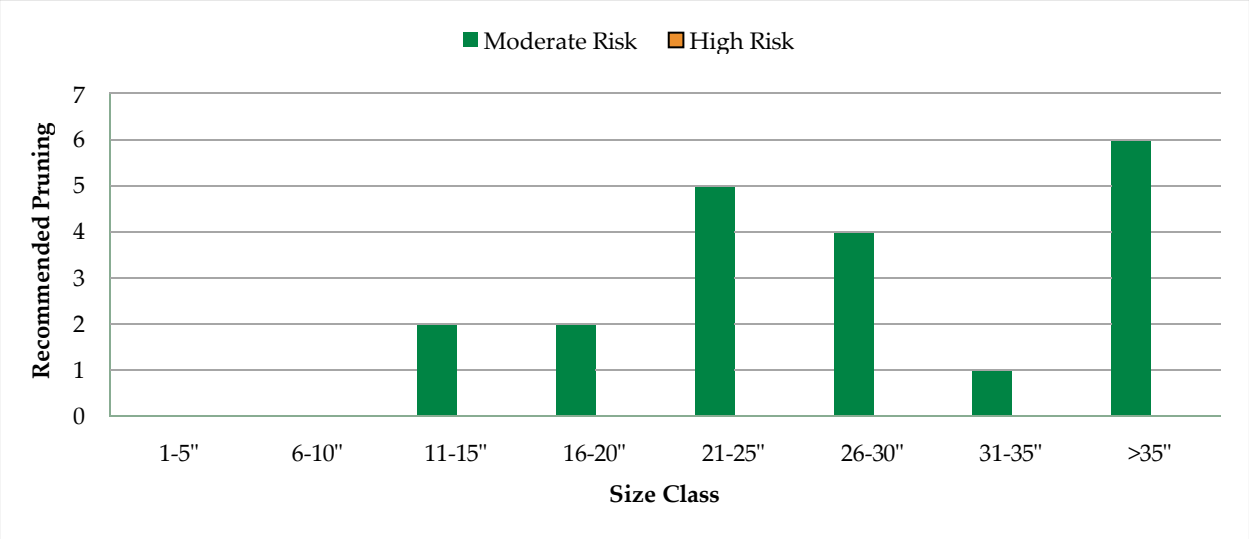


Figure 12. Street trees recommended for priority pruning.

Priority Removal Recommendations

DRG recommends that trees be removed when pruning will not correct their defects, eliminate the risks that their defects cause, or when corrective pruning would be cost-prohibitive. Trees with elevated risk ratings recommended for removal should be removed as soon as possible and prioritized based on their risk rating and size class.

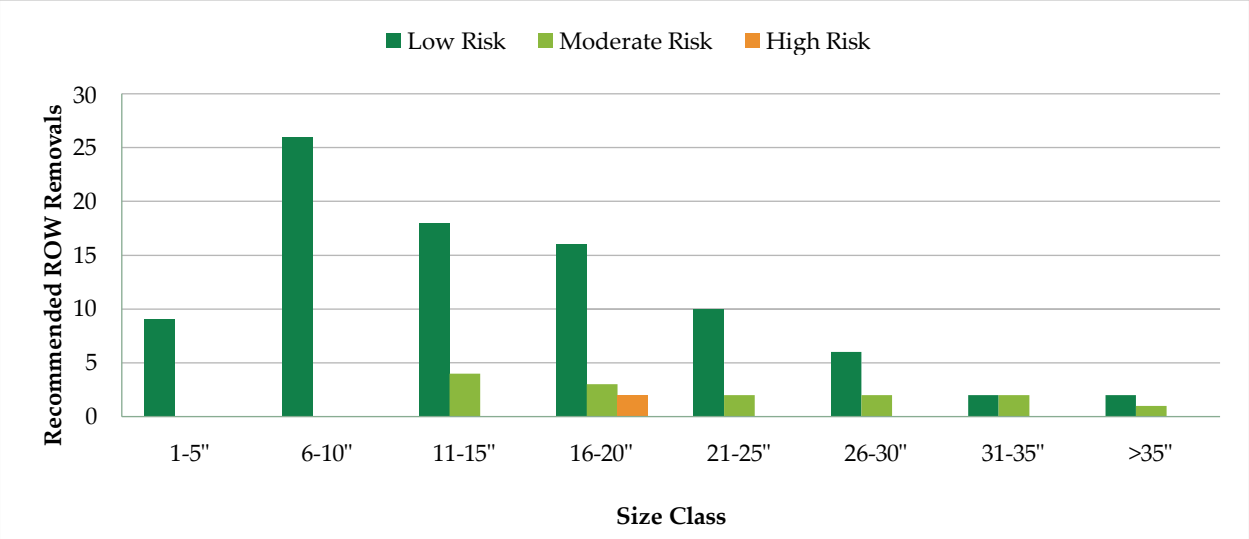


Figure 13. Street trees recommended for priority removal.

DRG identified 2 trees with a High Risk rating recommended for removal, 14 trees with Moderate Risk rating recommended for removal, and 105 trees with a Low Risk rating recommended for removal. The diameter size for priority removal trees ranged between 12 and 48 DBH.

Low risk tree removals pose little threat; these trees are generally small, dead, and/or poorly formed trees that need to be removed. Eliminating these trees will reduce breeding site locations for insects and diseases and will increase the aesthetic value of the area. Healthy trees growing in poor locations or undesirable species are also included in this category. Low Risk trees should be removed when convenient after all higher risk pruning and removals have been completed and may be performed concurrently with routine pruning.

FURTHER INSPECTION

The further inspection data field indicates whether a tree requires additional and/or future inspections to assess and/or monitor conditions that may cause it to become a risk to people, property, or other trees. Further inspections are beyond the scope of a standard tree inventory and can be one of the following:

- Multi-Year Annual Inspection (e.g., a tree which has a defect that may require further monitoring to determine whether it is a hazard).
- Advanced Risk Assessment (e.g., a tree with a defect requiring additional or specialized equipment for a Level 3 investigation).
- Insect/Disease Monitoring (e.g., a tree that appears to have an emerging insect or disease problem).
- No further inspection required.

In the ANSI A300 system, there are three levels of risk assessment. Each level is built on the one before it. The lowest level is designed to be a cost-effective approach to quickly identifying tree risk concerns, while the highest level is intended to provide in-depth information to make management decisions about an individual tree. These levels are:

- **Level 1:** Level 1 inspection is defined as a limited visual assessment, which is often conducted as a walk-through or windshield survey designed to identify obvious defects or specified conditions.
- **Level 2:** Level 2 inspection is defined as a basic assessment and is a detailed, 360-degree visual inspection of a tree and its surrounding site, and a synthesis of the information collected. All trees in the 2021 Bal Spa tree inventory were assessed to this level, provided that 360-degree access around the tree could be gained.
- **Level 3:** Level 3 inspection is an advanced assessment and is performed to provide detailed information about specific tree parts, defects, targets, or site conditions. A Level 3 inspection may use specialized tools or require the input of an expert.

DRG arborists found 5 trees recommended for multi-year annual inspection, 12 trees recommended for a Level 3 assessment, and 6 recommended for insect and disease monitoring.

Further Inspection Recommendations

DRG arborists found 5 trees recommended for annual inspections, 12 trees recommended for a Level 3 assessment, and 6 recommended for insect and disease monitoring. The trees recommended for a Level 3 risk assessment should be assessed by a TRAQ arborist as soon as possible to determine whether these trees require removal, pruning, or other corrective action to reduce the risk associated with their observed defects. Level 3 assessments may require specialized or additional equipment, such as bucket trucks, to access and assess tree defects.

Trees recommended for multi-year annual inspection should be assessed routinely to monitor their condition and look for signs of worsening defects that may merit intervention. Some of these trees will likely recover given time and will no longer need additional monitoring, while others may require removal if their defects worsen.

All trees recommended for insect/disease monitoring should be assessed to confirm the presence of damaging insects or diseases and should either be removed or treated, if necessary, to reduce the pest species load and improve the health of the public trees in Ballston Spa.

ROUTINE INSPECTIONS

Inspections are essential to uncovering potential problems with trees before they fail and cause damage to people or property. They should be performed by a qualified arborist who is trained in the art and science of planting, caring for, and maintaining individual trees. Arborists are knowledgeable about the needs of trees and are trained and equipped to provide proper care. Ideally, the arborist conducting routine inspections will be ISA Certified and will also hold the ISA Tree Risk Assessment Qualification credential.

Routine Inspection Recommendations

All public trees along the street ROW and in parks should be regularly inspected and maintained according to the results of these regular inspections. When trees need additional maintenance, they should be added to the work schedule immediately. The maintenance budget should also be updated to reflect the additional work. Use asset management software such as TreeKeeper® to update inventory data and schedule work records.

In addition to locating trees with unidentified defects, inspections also present an opportunity to look for signs and symptoms of pests and diseases. Ballston Spa has a large population of trees that are susceptible to pests and diseases, including maple (*Acer* spp.), oak (*Quercus* spp.), ash (*Fraxinus* spp.), apple (*Malus*), pine (*Pinus* spp.), and spruce (*Picea* spp.), among others. Routine inspections can also be used to update or add to the 2021 inventory. Keeping the inventory up to date is necessary to ensure that hazardous trees are handled in a timely fashion, to help predict adequate budgets, staff, and equipment for upcoming years, and to track progress toward the town's urban forestry goals.

DRG recommends that Ballston Spa perform routine inspections of inventoried trees by windshield survey (inspections performed from a vehicle) in line with *ANSI A300 (Part 9)* annually and after all severe weather events to identify defects with heightened risk, signs of pest activity, and symptoms of disease. However, based on discussions with the town's tree managers, DRG recommends that drive-by inspections be done concurrently with routine pruning work until budgets allow for more frequent inspections.

Level 2 assessments should be done routinely as well, ideally every 5 years or less, to identify defects and problems that are not readily noticeable during windshield (Level 1) surveys. Routine Level 2 inspections can be done as part of routine pruning, removal, and planting operations, or can be done as part of a contracted re-inventory of the village. Once priority pruning and removal work is complete, there may be sufficient funding available to begin doing Level 2 inventory updates.

ROUTINE PRUNING CYCLE

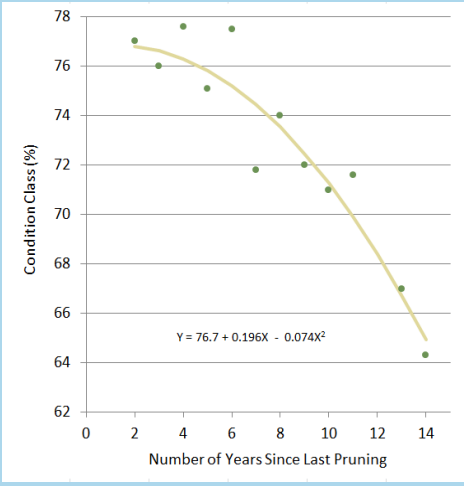
The routine pruning cycle includes all Low Risk trees that received a maintenance recommendation of prune or routine prune. These trees pose some risk but have a smaller defect size and/or a lower probability of impacting a target. Over time, routine pruning can minimize reactive maintenance, limit instances of elevated risk, and provide the basis for a robust risk management program.

Based on Miller and Sylvester's research (see side panel, "Proactive Pruning"), DRG recommends a ten-year routine pruning cycle to maintain the condition of the inventoried tree resource. However, it is not always possible to remain proactive with a ten-year cycle based on budgetary constraints, the size of the inventoried tree resource, or both. In these cases, extending the length of the routine pruning cycle is an option; however, best practice is to not exceed a 10-year pruning cycle. Tree condition has been shown to deteriorate significantly after 10 years without regular pruning as once-minor defects worsen, reducing tree health and potentially increasing risk (Miller and Sylvester 1981).

Routine Pruning Cycle Recommendations

DRG identified 922 trees that should be included in the routine pruning cycle as of the 2021 inventory. In future years, the number of trees in the routine pruning cycle will depend on several factors, including tree removals and new plantings or regeneration which have matured beyond the young tree training cycle. DRG recommends that the Routine Pruning cycle begins in Year One of the proposed ten-year program, after all Extreme and High Risk Recommended Maintenance is complete.

PROACTIVE PRUNING



Relationship between tree condition and years since previous pruning.

(adapted from Miller and Sylvester 1981)

Miller and Sylvester studied the pruning frequency of 40,000 street trees in Milwaukee, Wisconsin. Trees that had not been pruned for more than 10 years had an average condition rating 10% lower than trees that had been pruned in the previous several years. Their research suggests that a five-year pruning cycle is optimal for urban trees.

Routine pruning cycles help detect and correct most defects before they reach higher risk levels. DRG recommends that pruning cycles begin in the first year of the maintenance program.

DRG recommends two pruning cycles: a young tree training cycle and a routine pruning cycle. Newly planted trees will enter the young tree training cycle once they become established and will move into the routine pruning cycle when they reach maturity. A tree should be removed and eliminated from the routine pruning cycle when it outlives its usefulness.

Keep in mind that, while every tree should be assessed at least once during each rotation of the ten-year routine pruning cycle, not every tree will need pruning during each cycle. Therefore, the cost of conducting routine pruning of one-tenth of the village's trees will fluctuate year to year depending on the number of trees included in the cycle and the number and size of trees which actually require pruning during that cycle.

Figure 14. Trees recommended for inclusion in the routine pruning cycle as of the 2021 inventory.

YOUNG TREE TRAINING CYCLE

Trees included in the young tree training cycle are generally less than 8″ DBH. These younger trees may have branch structures that can lead to potential problems as the tree ages. Potential structural problems include 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, elevating its risk rating and creating potential liability.

The recommended length of a young tree training cycle is three years because young trees tend to grow at faster rates than mature trees. The young tree training cycle differs from the routine pruning cycle in that the young tree training cycle generally only includes trees that can be pruned from the ground with a pole pruner or pruning shear.

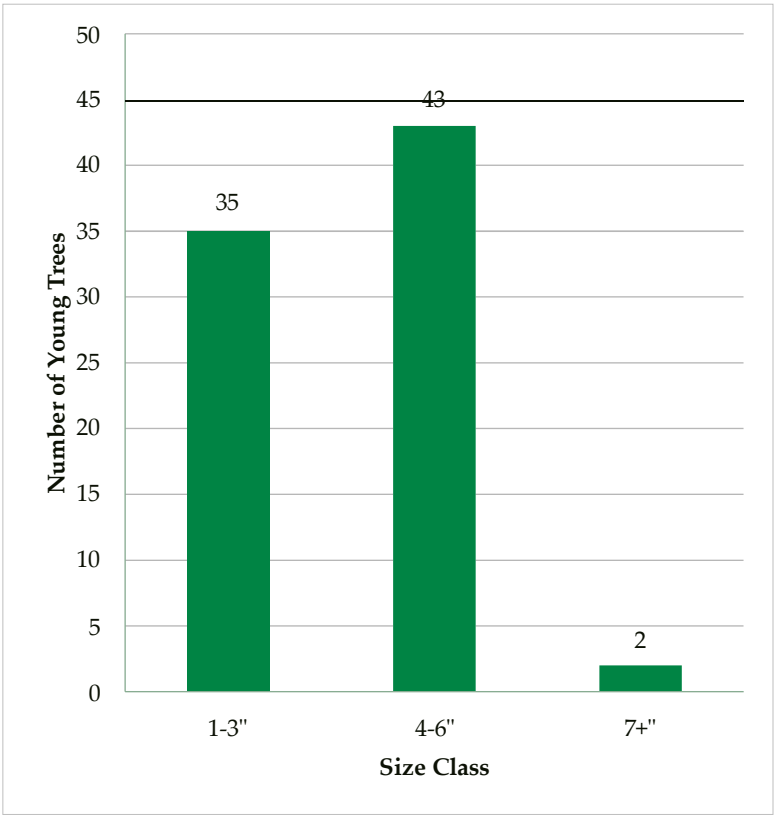


Figure 15. Young tree size classes recommended for training.

Young Tree Training Cycle Recommendations

DRG recommends that Ballston Spa implement a three-year young tree training cycle beginning in year one of the ten-year management plan. During the inventory, 80 trees were inventoried and recommended for young tree training. Since the town has so many young trees, the young tree training cycle is vital for the future condition of the inventoried tree population. DRG recommends that an average of 27 trees be trained with structural pruning each year. When new trees are planted, they should enter the young tree training cycle. In future years, the number of trees in the young tree training cycle will be based on tree planting efforts and growth rates of young trees.

TREE PLANTING AND STUMP REMOVAL

During the 2021 inventory, a total of 486 vacant sites suitable for tree planting were identified. Of the 486 vacant sites collected, 120 were suitable for a large-stature tree, 30 were suitable for a medium stature tree, and 336 could only support a small stature tree. The inventory also identified 58 stumps recommended for removal, with a wide range of sizes from 6 to 46 inches in diameter. Stump removals should occur when convenient and should be included in planting plans if the site would be feasible for planting after the stump is removed. It is generally convenient to remove all stumps in areas with scheduled tree planting work, so all available sites in an area can be stocked at once.

The "Right Tree in the Right Place" is a mantra for tree planting used by the Arbor Day Foundation and many utility companies nationwide. Trees come in many different shapes and sizes, and often change dramatically over their lifetimes. Before selecting a tree for planting, make sure it is the right tree—know how tall, wide, and deep it will be at maturity. 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 consider how a tree may impact existing utility lines and hardscape as it grows taller, wider, and deeper. If the tree at maturity will reach overhead lines, or conflict with sidewalks and curbs, it is best to choose another tree or a different location. DRG recommends that Ballston Spa site trees which will be large (greater than 50 feet tall at maturity) in sites with a minimum dimension of no less than 8 feet between hardscape features and never under or near overhead utilities. Trees which will be medium-sized (30 to 40 feet tall at maturity) should occupy sites with at least 6 feet between hardscape features and never under overhead utilities. Trees which will be small at maturity (15 to 30 feet tall) can be placed in sites with as little as 4 feet between hardscape features and may be located underneath overhead utilities. Further planting site selection criteria can be found in Section 4 of this plan.

Although tree planting is an important goal for any community, removal or pruning of elevated risk trees often takes precedence over tree planting. As priority work is completed and more budget is available, or as grant money is secured for planting projects, tree planting could easily be added to the annual maintenance plan. Tree planting is further discussed in the Ballston Spa Planting Plan prepared by DRG.

MAINTENANCE SCHEDULE AND BUDGET

Utilizing the 2021 Ballston Spa tree inventory data, an annual maintenance schedule and budget were developed detailing the recommended tasks to complete each year. DRG made budget projections using industry knowledge and public bid tabulations. A complete table of estimated costs for Ballston Spa's ten-year tree management program is provided in Table 5. Following this schedule can help shift tree maintenance activities from a reactive to a proactive tree care program.

To implement the maintenance schedule, Ballston Spa's tree maintenance budget should be:

- No less than $96,323 for the first year of implementation.
- No less than $81,783 for the second year.
- No less than $63,313 for the third year.
- No less than $59,431 for the fourth year.
- No less than $45,866 for the fifth year.
- No less than $34,645 for the remaining five years of the maintenance schedule.

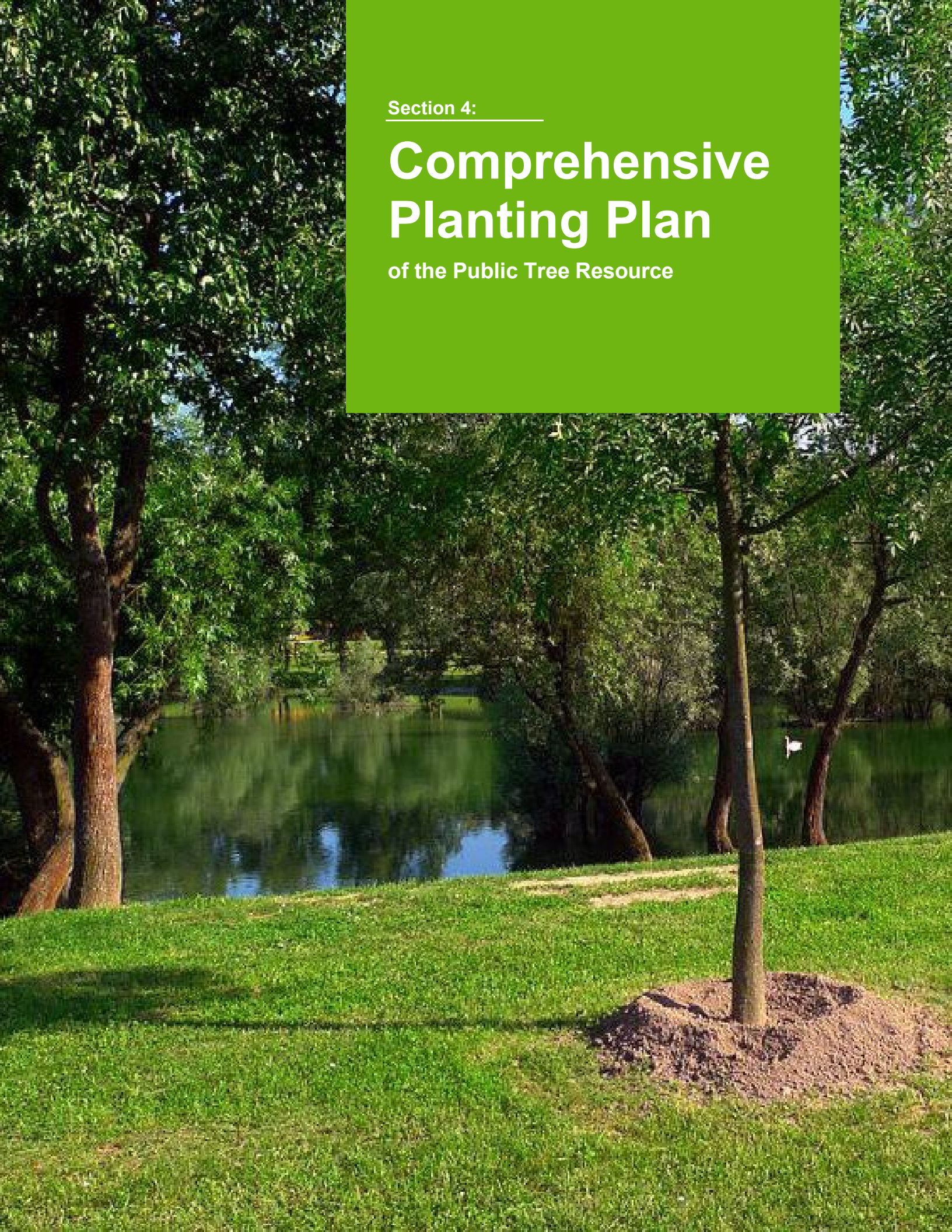
Note that, because Table 4 was assembled using contractor pricing estimates, actual costs of administering the ten-year maintenance program may be reduced by doing some or all the scheduled work in-house or applying for tree planting and maintenance grants. However, Table 4 does not include all tree care tasks that

could or should be undertaken by the village. Additional work such as pesticide treatments and staff training may be beneficial to add into the work schedule as budgets allow. The annual budget decreases over time as the backlog of tree and stump removals is dealt with. At that point, additional work, such as invasive species management, could be added to the schedule. If routing efficiencies and/or contract specifications allow more tree work to be completed in a given year, or if this maintenance schedule requires adjustment to meet budgetary or other needs, then it should be modified accordingly. Unforeseen situations such as severe weather events may arise and change the maintenance needs of trees. If maintenance needs change, then budgets, staffing, and equipment should be adjusted to meet the new demand.

Table 4. Estimated budget for recommended ten-year tree resource management program.

Activity Cost			Year 1		Year 2		Year 3		Year 4		Year 5		Year 6		Year 7		Year 8		Year 9		Year 10		Ten-Year Cost
Activity	Diameter	Cost/Tree	Count	Cost	Count	Cost	Count	Cost	Count	Cost	Count	Cost	Count	Cost	Count	Cost	Count	Cost	Count	Cost	Count	Cost	
High Priority Removals	1-5"	$90		$0		$0		$0		$0		$0		$0		$0		$0		$0		$0	$0
	6-10"	$225		$0		$0		$0		$0		$0		$0		$0		$0		$0		$0	$0
	11-15"	$575	2	$1,150		$0		$0		$0		$0		$0		$0		$0		$0		$0	$1,150
	16-20"	$1,080		$0		$0		$0		$0		$0		$0		$0		$0		$0		$0	$0
	21-25"	$1,820		$0		$0		$0		$0		$0		$0		$0		$0		$0		$0	$0
	26-30"	$2,430		$0		$0		$0		$0		$0		$0		$0		$0		$0		$0	$0
	31-35"	$2,900		$0		$0		$0		$0		$0		$0		$0		$0		$0		$0	$0
	>35"	$3,900		$0		$0		$0		$0		$0		$0		$0		$0		$0		$0	$0
Activity Total(s)			**2**	**$1,150**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**$1,150**
Moderate Priority Removals	1-5"	$90		$0		$0		$0		$0		$0		$0		$0		$0		$0		$0	$0
	6-10"	$225		$0		$0		$0		$0		$0		$0		$0		$0		$0		$0	$0
	11-15"	$575	4	$2,300		$0		$0		$0		$0		$0		$0		$0		$0		$0	$2,300
	16-20"	$1,080	3	$3,240		$0		$0		$0		$0		$0		$0		$0		$0		$0	$3,240
	21-25"	$1,820	2	$3,640		$0		$0		$0		$0		$0		$0		$0		$0		$0	$3,640
	26-30"	$2,430	2	$4,860		$0		$0		$0		$0		$0		$0		$0		$0		$0	$4,860
	31-35"	$2,900	2	$5,800		$0		$0		$0		$0		$0		$0		$0		$0		$0	$5,800
	>35"	$3,900	1	$3,900		$0		$0		$0		$0		$0		$0		$0		$0		$0	$3,900
Activity Total(s)			**14**	**$23,740**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**$23,740**
Low Priority Removals	1-5"	$90		$0		$0	9	$810		$0		$0		$0		$0		$0		$0		$0	$810
	6-10"	$225		$0		$0	26	$5,850		$0		$0		$0		$0		$0		$0		$0	$5,850
	11-15"	$575		$0		$0	18	$10,350		$0		$0		$0		$0		$0		$0		$0	$10,350
	16-20"	$1,080		$0	16	$17,280		$0		$0		$0		$0		$0		$0		$0		$0	$17,280
	21-25"	$1,820		$0	10	$18,200		$0		$0		$0		$0		$0		$0		$0		$0	$18,200
	26-30"	$2,430		$0		$0		$0	6	$14,580		$0		$0		$0		$0		$0		$0	$14,580
	31-35"	$2,900	2	$5,800		$0		$0		$0		$0		$0		$0		$0		$0		$0	$5,800
	>35"	$3,900	2	$7,800		$0		$0		$0		$0		$0		$0		$0		$0		$0	$7,800
Activity Total(s)			**4**	**$13,600**	**26**	**$35,480**	**53**	**$17,010**	**6**	**$14,580**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**$80,670**
Stump Removals	1-5"	$50		$0		$0		$0		$0		$0		$0		$0		$0		$0		$0	$0
	6-10"	$100		$0		$0		$0		$0	2	$200	3	$300	2	$200	2	$200	2	$200		$0	$1,100
	11-15"	$125		$0		$0		$0		$0		$0	2	$250	2	$250	2	$250	1	$125		$0	$875
	16-20"	$195		$0		$0		$0		$0	2	$390	3	$585	2	$390	2	$390	2	$390		$0	$2,145
	21-25"	$250		$0		$0		$0		$0		$0	2	$500	2	$500	2	$500	2	$500		$0	$2,000
	26-30"	$310		$0		$0		$0		$0		$0	2	$620	2	$620	2	$620	2	$620		$0	$2,480
	31-35"	$375		$0		$0		$0		$0		$0	1	$375	1	$375	1	$375	1	$375		$0	$1,500
	>35"	$425		$0		$0		$0		$0	1	$425	2	$850	2	$850	2	$850	2	$850		$0	$3,825
Activity Total(s)			**0**	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**5**	**$1,015**	**15**	**$3,480**	**13**	**$3,185**	**13**	**$3,185**	**12**	**$3,060**	**0**	**$0**	**$13,925**
High Priority Pruning	1-5"	$62		$0		$0		$0		$0		$0		$0		$0		$0		$0		$0	$0
	6-10"	$126		$0		$0		$0		$0		$0		$0		$0		$0		$0		$0	$0
	11-15"	$183		$0		$0		$0		$0		$0		$0		$0		$0		$0		$0	$0
	16-20"	$223		$0		$0		$0		$0		$0		$0		$0		$0		$0		$0	$0
	21-25"	$275		$0		$0		$0		$0		$0		$0		$0		$0		$0		$0	$0
	26-30"	$312		$0		$0		$0		$0		$0		$0		$0		$0		$0		$0	$0
	31-35"	$415		$0		$0		$0		$0		$0		$0		$0		$0		$0		$0	$0
	>35"	$450		$0		$0		$0		$0		$0		$0		$0		$0		$0		$0	$0
Activity Total(s)			**0**	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**$0**

Activity Cost			Year 1		Year 2		Year 3		Year 4		Year 5		Year 6		Year 7		Year 8		Year 9		Year 10		Ten-Year Cost
Activity	Diameter	Cost/Tree	Count	Cost	Count	Cost	Count	Cost	Count	Cost	Count	Cost	Count	Cost	Count	Cost	Count	Cost	Count	Cost	Count	Cost	
Moderate Priority Pruning	1-5"	$62		$0		$0		$0		$0		$0		$0		$0		$0		$0		$0	$0
	6-10"	$126		$0		$0		$0		$0		$0		$0		$0		$0		$0		$0	$0
	11-15"	$183	2	$366		$0		$0		$0		$0		$0		$0		$0		$0		$0	$366
	16-20"	$223	2	$446		$0		$0		$0		$0		$0		$0		$0		$0		$0	$446
	21-25"	$275	5	$1,375		$0		$0		$0		$0		$0		$0		$0		$0		$0	$1,375
	26-30"	$312	4	$1,248		$0		$0		$0		$0		$0		$0		$0		$0		$0	$1,248
	31-35"	$415	1	$415		$0		$0		$0		$0		$0		$0		$0		$0		$0	$415
	>35"	$450	6	$2,700		$0		$0		$0		$0		$0		$0		$0		$0		$0	$2,700
Activity Total(s)			**20**	**$6,550**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**0**	**$0**	**$6,550**
Further Inspection	Level 3 Risk Assessment	$400	12	$4,800		$0		$0		$0		$0		$0		$0		$0		$0		$0	$4,800
	Annual/ Multi-year Inspections	$65	5	$325	5	$325	5	$325	5	$325	5	$325	5	$325	5	$325	5	$325	5	$325	5	$1,625	$4,550
	Insect and Disease Monitoring	$30	6	$180	6	$180	6	$180	6	$180	6	$180	6	$180	6	$180	6	$180	6	$180	6	$1,080	$2,700
Activity Total(s)			**17**	**$5,305**	**5**	**$325**	**5**	**$325**	**5**	**$325**	**5**	**$325**	**11**	**$505**	**11**	**$0**	**11**	**$505**	**11**	**$505**	**11**	**$3,575**	**$4,550**
Young Tree Training (3-year Cycle)	1-8"	$5	27	$135	27	$135	27	$135	27	$135	27	$135	27	$135	27	$135	27	$135	27	$135	27	$135	$1,350
Activity Total(s)			**27**	**$135**	**27**	**$135**	**27**	**$135**	**27**	**$135**	**27**	**$135**	**27**	**$135**	**27**	**$0**	**27**	**$135**	**27**	**$135**	**27**	**$135**	**$1,350**
Routine Pruning (10-year Cycle)	1-5"	$62	9	$558	9	$558	9	$558	9	$558	9	$558	9	$558	9	$558	9	$558	9	$558	9	$558	$5,580
	6-10"	$126	19	$2,394	19	$2,394	19	$2,394	19	$2,394	19	$2,394	19	$2,394	19	$2,394	19	$2,394	19	$2,394	19	$2,394	$23,940
	11-15"	$183	22	$4,026	22	$4,026	22	$4,026	22	$4,026	22	$4,026	21	$3,843	21	$3,843	21	$3,843	21	$3,843	21	$3,843	$39,345
	16-20"	$223	21	$4,683	21	$4,683	21	$4,683	21	$4,683	21	$4,683	20	$4,460	20	$4,460	20	$4,460	20	$4,460	20	$4,460	$45,715
	21-25"	$275	23	$6,325	23	$6,325	23	$6,325	22	$6,050	22	$6,050	0	$0	0	$0	0	$0	0	$0	0	$0	$31,075
	26-30"	$312	11	$3,432	11	$3,432	11	$3,432	10	$3,120	10	$3,120	0	$0	0	$0	0	$0	0	$0	0	$0	$16,536
	31-35"	$415	7	$2,905	7	$2,905	7	$2,905	6	$2,490	6	$2,490	0	$0	0	$0	0	$0	0	$0	0	$0	$13,695
	>35"	$450	5	$2,250	5	$2,250	5	$2,250	4	$1,800	4	$1,800	0	$0	0	$0	0	$0	0	$0	0	$0	$10,350
Activity Total(s)			**117**	**$26,573**	**117**	**$26,573**	**117**	**$26,573**	**113**	**$25,121**	**113**	**$25,121**	**69**	**$11,255**	**69**	**$11,255**	**69**	**$11,255**	**69**	**$11,255**	**69**	**$11,255**	**$186,236**
Tree Planting and Maintenance	Purchasing	$75	82	$6,150	82	$6,150	82	$6,150	82	$6,150	82	$6,150	82	$6,150	82	$6,150	82	$6,150	82	$6,150	82	$6,150	$61,500
	Planting & Watering	$130	82	$10,660	82	$10,660	82	$10,660	82	$10,660	82	$10,660	82	$10,660	82	$10,660	82	$10,660	82	$10,660	82	$10,660	$106,600
	Mulching	$30	82	$2,460	82	$2,460	82	$2,460	82	$2,460	82	$2,460	82	$2,460	82	$2,460	82	$2,460	82	$2,460	82	$2,460	$24,600
Activity Total(s)			**246**	**$19,270**	**246**	**$19,270**	**246**	**$19,270**	**246**	**$19,270**	**246**	**$19,270**	**246**	**$19,270**	**246**	**$19,270**	**246**	**$19,270**	**246**	**$19,270**	**246**	**$19,270**	**$192,700**
Activity Grand Total			**427**		**421**		**448**		**397**		**396**		**368**		**366**		**366**		**365**		**353**		**$2,089**
Cost Grand Total				**$96,323**		**$81,783**		**$63,313**		**$59,431**		**$45,866**		**$34,645**		**$33,710**		**$34,350**		**$34,225**		**$34,235**	**$517,881**



Section 4:

Comprehensive Planting Plan

of the Public Tree Resource

SECTION 4: COMPREHENSIVE PLANTING PLAN

STATEMENT OF PURPOSE

The purpose of this *Public Tree Planting Plan* is to provide guidelines for the implementation of an organized public tree planting effort in the Village of Ballston Spa, New York. The public tree inventory and subsequent *Community Forestry Management Plan* prepared by DRG in 2018–2021 provides information on suitable planting locations along with general recommendations on the size and species of trees for each site. This Planting Plan, in turn, provides specific and in-depth guidelines for the future plantings, allowing for more effective use of tree care funds and more accurate budget projections. Implementation of this planting plan will aid in increasing canopy cover and prioritizing planting areas with sparse canopy cover.

Photograph 5: Tree Planting in Ballston Spa

The 2021 Village of Ballston Spa tree inventory identified a total of 486 potential vacant planting sites. The identification and analysis of these sites will inform future development of Ballston Spa's urban forest and community. Data analysis of site density and distribution will allow the village to target planting efforts in geographic locations that maximize community benefits.

SCOPE

This document discusses the findings of the viable public street planting sites by DRG and provides a comprehensive action plan for the Village of Ballston Spa's inventoried planting sites. The Planting Plan includes a brief analysis of the current tree population, the environment in which they grow, and needs of the urban forest. The scope of this discussion includes:

- A brief analysis of the public street tree inventory and species composition.
- Recommendations for the specific planting needs; related to species diversity, site restrictions, functionality of the urban forest, and canopy cover.
- A ten-year budget for the planting program and training pruning program.

UNDERSTANDING POTENTIAL PLANTING SITES AND PARAMETERS

Potential planting sites, also called "vacant sites", are located by street and address. The sites are defined as areas suitable for tree planting within the existing ROW, as defined above. Typically, the size of each site is determined by the growing space available and the presence of overhead wires, and are spaced accordingly:

- *Small vacant sites:* The smallest dimension of the planting site is between 3 to 5 feet; 20 feet is kept between existing infrastructure or surrounding trees.

- *Medium vacant sites:* The smallest dimension of the planting site is between 6 to 8 feet; 30 feet is kept between existing infrastructure or surrounding trees.
- *Large vacant sites:* The smallest dimension of the planting site is 8 feet and greater; 40 feet is kept between existing infrastructure or surrounding trees.

Planting site parameters are determined based on an original agreement utilizing the experience from the Village of Ballston Spa's personnel and DRG Inventory Urban Foresters. Some of these parameters are:

- No planting of a tree within 30 feet of any intersection or crosswalk.
- No planting of a tree within 50 feet of any stop signs.
- No planting of a tree within 10 feet of any fire hydrant, streetlight, utility pole, or underground utility (i.e., gas or sewer line).
- No planting of a tree within 10 feet of any driveway or walkway.
- Sites should not obstruct important traffic signs.
- Sites should not obstruct major road signage.

The overall landscape and existing planting scheme was also taken into account for the spacing and sizes of recommended planting sites. Where any types of overhead utility wires exist, planting sites are recorded as small, regardless of the available growing space. The shortest dimension in length and width (in feet) of each growing space type is noted in the inventory. The growing space size can be a limiting factor of the growth and natural habit of trees, and dictates which species are suitable for any given site. It is most beneficial ecologically and economically to plant the largest tree possible in each site.

Utilities

The presence of all overhead utility lines is noted in the inventory. These include, but are not limited to, power, telephone, and cable lines. Where any overhead wires exist, the planting site is recorded as small, regardless of the available growing space size or type, to avoid unnecessary future maintenance and interference with the lines.

SUGGESTED SPECIES CHARACTERIZATION

A list of suggested species is provided in the management plan and is meant to be a guideline for selecting which species to plant during future street tree plantings. 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 a site suitable to sustain the tree's natural habit. Ballston Spa's suggested tree species list can be found in Appendix E.

PRIORITY PLANTING BY INVENTORIED SITES

The Village of Ballston Spa's tree inventory identified 486 vacant planting sites, of which 336 were for small vacant sites, 30 were medium, and 120 were large vacant sites (see Figure 16).

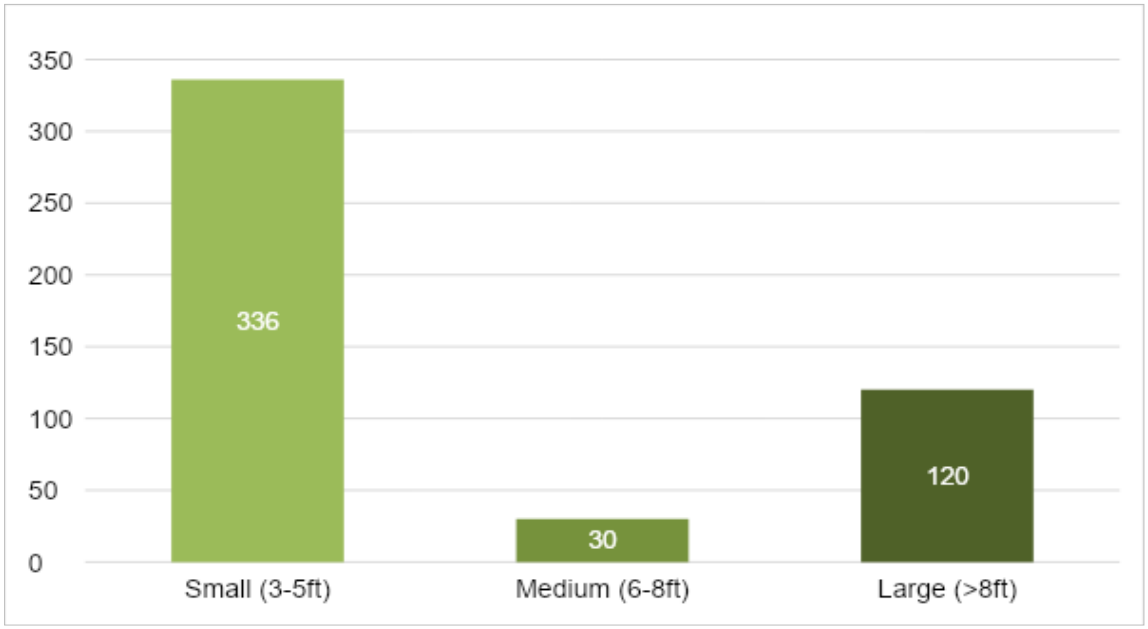


Figure 16. Vacant planting sites.

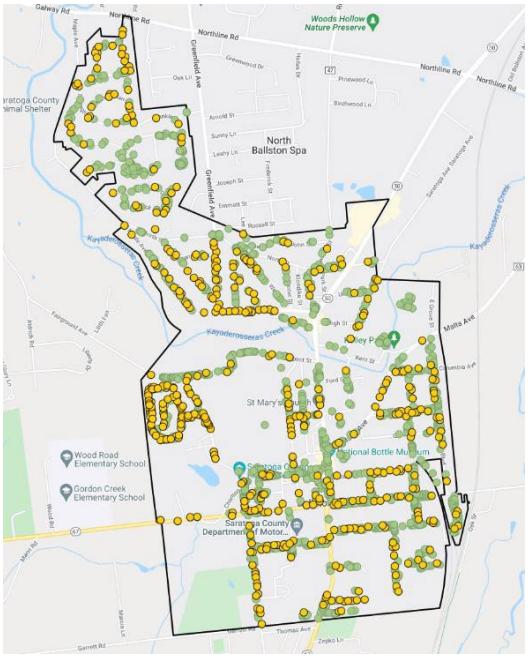
Locations with a high density of vacant planting sites are generally areas with less existing overall canopy cover and thus good candidates for new planting initiatives. Planting in areas with a high density of vacant sites will help save costs through increased operational efficiencies during installation and will also help maximize benefits to the community and the urban forest. Planting on high traffic streets with a greater proportion of vacant sites to trees should be prioritized for planting.

Fairground Avenue and Crestline Drive

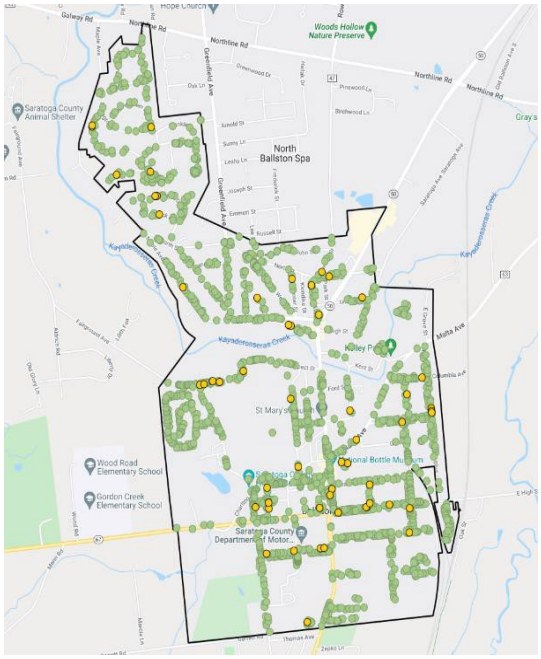
Division Street and Maple Avenue

STUMPS

Within the public tree inventory of Ballston Spa, 58 stumps were identified. Once removed, these areas can be used as tree planting sites. Based on the inventory findings, trees recommended for removal with High or Moderate Risk ratings should be removed as soon as possible and replaced as much as possible. Stump removals however, because of the lower risk, should be spread out over time as costs allow.



Vacant planting sites in the Village of Ballston Spa, highlighted in yellow.



Stumps located in the Village of Ballston Spa, highlighted in yellow.

PLANTING CONSIDERATIONS

Site Characteristics and Species Selection

Proper site evaluation, planning and execution can result in a more resilient urban forest. The site characteristics need to be taken into consideration before a tree species is selected. "The Right Tree in the Right Place" is a mantra for tree planting used by the Arbor Day Foundation and many utility companies nationwide. Trees come in many different shapes and sizes, and often change dramatically over their lifetimes. Some grow tall, some grow wide, and some have extensive root systems. It is necessary to visit a site location before choosing a tree species. Your planting site has unchangeable characteristics that will limit the type of species that can grow and thrive in that location. Important site characteristics that should be considered include:

- *Soils:* The soil will impact the type of tree that can be planted at the location. The soil pH, particle size (sand, silt, clay), soil moisture retention, and percent organic matter will all influence the survivability of the planted tree. Be sure that the soil used at planting is suitable for the chosen species.
- *Hardiness Zone:* Plant tree species that thrive in the village's hardiness zone. The zones are determined by the average annual minimum temperature for each area. The Village of Ballston Spa occurs in Zone 5a of the USDA Hardiness Zone Map, which identifies the climatic region where the average annual minimum temperature is between -20 to -15 (F). It is important to choose species that are adapted to the region's seasons. Lists of species based on this Hardiness Zone are provided in Appendix E.
- *Site Conditions:* Take note of the direction the planting site faces. North or east aspects are generally cooler, moister, and shadier than south and west aspects. Certain species can grow in full sun, while others are more shade tolerant. Another important site characteristic is irrigation and position. Certain planting locations receive more water and may have constant moisture, while others are consistently dry. It is important to plant either flood-tolerant or drought-tolerant species in those locations.
- *Site Traffic:* The level of vehicular or foot traffic should be noted. Hardier species will need to be planted in areas that experience high levels of vehicle and pedestrian use.
- *Neighborhood:* Determine if the neighborhood is industrial, residential, or landscaped.
- *Surrounding Infrastructure:* It is best to account for all possible interferences the tree may encounter over the course of its life. Any buildings, traffic lights, stop signs, surrounding trees, overhead powerlines, and underground utilities should be noted.

It is important to evaluate existing trees in the surrounding area to see which trees are doing well and which are stressed or in poor condition. While no two sites are exactly alike, it may provide some insight into the type of species that should be encouraged or avoided in that planting location. Another important consideration is to avoid over-planting a single species. Low species diversity can lead to severe losses in the event of species-specific epidemics, such as the devastating results of emerald ash borer (EAB, *Agrilus planipennis*). The ideal distribution for a tree population should follow the 10-20-30 rule for species diversity: a single species should represent no more than 10% of the population, a single genus no more than 20%, and a single family no more than 30% of the population.

In the Village of Ballston Spa, at the genus level, maple comprise 45% of the tree population, with 21% of the species being Norway maple; 10%, red maple; 5%, "Crimson King"; Norway maple, 5%; sugar maple, along with 4% of other maple species. It is recommended that the Village of Ballston Spa avoid large plantings of maple trees to avoid an overabundance of a singular genus in the future. It's specifically recommended to avoid planting Norway maple, which are both overabundant and invasive.

A list of species suitable for the climate of Ballston Spa is included in Appendix E. Trees on this prospective planting list have been selected based on their maintenance requirements, adaptability to specific planting sites, and suitability to the restrictive conditions of the urban environment. The list can be sorted by mature tree size, suitability for park versus street locations, tolerances, and native versus non-native species. The Village of Ballston Spa should use this list to help guide tree selection.

ESTABLISING A PLANTING GOAL

Stocking Potential

The potential tree population of the village's inventoried streets is 1,671 trees which includes 486 vacant sites and 58 stumps. Ballston Spa's urban forest (excluding park/public space trees) is 61% stocked. Stocking is a traditional forestry term used to measure the density and distribution of trees. This means that, of the total number of sites in the public ROW, 61% currently have a tree present. DRG generally recommends that the urban forest be at least 90% stocked so that no more than 10% of the existing planting sites remain vacant. The village should make every effort to budget for tree planting in the future so that it may reach the recommended stocking goal.

Full Stocking Potential

Full tree stocking can be an elusive goal, since mortality of young and old trees continues to make planting sites available. Nevertheless, it is worth the effort because working toward full stocking can help make other less glamorous aspects of urban forestry more palatable, especially removals.

Ballston Spa has a stocking level of 61%. With a total of 486 vacant sites, 105 tree removals over a 10-year period, and 58 stumps, Ballston Spa would reach its full stocking potential in ten years following the desired planting schedule of 49 trees per year. This goal, however, assumes that no trees are removed, no new streets are added, and all of the new plantings survive. A more accurate formula for determining the planting rate for such a goal 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 potential goal

S = expected planting survival rate

For example, Ballston Spa has 486 available planting sites scattered throughout its existing ROW. If it is known that an average of 21 trees per year will be removed (this number is based on the Ten-Year Urban Forestry Management Program budget, the average number of Removals in Years 1 through 5) and the planting survival rate over that period is 85%, the village will achieve full stocking in approximately 10 years if it follows its current planting plan of 82 trees per year:

$$N = \frac{21 + (486/10)}{0.85} = 82 \text{ trees/year}$$

PROCURING PLANT MATERIAL

Good quality trees establish more quickly, are less likely to experience significant transplant shock, and live longer in the landscape. To ensure that quality material can be procured, visit the local nursery, and inspect trees prior to purchase. The representative buyer should perform a 360-degree inspection of the stem, branches, and roots. Shade trees should have one dominant trunk and major branches should not touch. All branches should be less than 2/3" trunk diameter. The tree wrap should be removed from the stem so that the trunk can be inspected for hidden wounds. On balled and burlapped (B&B) trees, ensure the root ball is intact and the minimum root ball size for tree caliper is in accordance with the American National Standards and Standards for Nursery Stock. Adhering to these standards will help with tree survivability. The table below is the suggested height range and minimum root ball diameter by caliper size in the Standards for Nursery Stock.

Table 5. Suggested Height Range and Minimum Root Ball Diameter by Caliper Size.

Caliper Size	Average Height Range	Minimum Root Ball Diameter	Minimum Root Ball Depth
2 in.	12 to 14 ft.	24 in.	14 in.
2 12 in.	12 to 14 ft.	28 in.	17 in.
3 in.	14 to 16 ft.	32 in.	19 in.
3 12 in.	14 to 16 ft.	38 in.	23 in.
4 in.	16 to 18 ft.	42 in.	25 in.
4 12 in.	16 to 18 ft.	48 in.	29 in.
5 in.	18 ft. and up	54 in.	32 in.

The area where the topmost roots meet the trunk, referred to as the root collar or root flare, should be visible. If the root flare is buried, the topmost roots are not receiving enough oxygen. This can cause root decay, especially if the tree is planted in an area with heavy irrigation. Buried root flares can also cause stem girdling roots. If the trunk emerges from the soil like a telephone pole, remove the excess soil away from the base of the trunk to expose the root flare. If possible, it is best not to purchase trees that were planted too deeply.

The representative buyer for the Village of Ballston Spa should reject any tree with a particular defect that cannot be easily corrected, and any tree that exhibits signs of pests or pathogens. If the trees are to be delivered directly from the nursery without prior inspection, the Village of Ballston Spa should have a signed written agreement with the nursery that the trees will be inspected upon delivery with the right to reject trees with obvious defects.

THE TREE PLANTING PROCESS

Tree planting should follow the guidelines provided in the International Society of Arboriculture (ISA) *Best Management Practices - Tree Planting, Second Edition (2014)* and the associated *ANSI A300 Part 6* documents. The standards outline the most up-to-date knowledge on tree planting practices that help increase survivability in transplanted trees. For more detailed accounts on planting procedures, the documents can be purchased for $15 each on the ISA website.

Step 1. Digging the Hole

The depth of the planting hole is determined by the depth and firmness of the root ball. The depth should be measured at the base of the root flare to the bottom of the ball. The soil at the bottom of the planting site should be firm enough to prevent soil settling. Planting holes should be dug 1.5 to 2 times wider than the root ball. Ensure surrounding soil is not compacted, as this will prevent future root spread.

Step 2. Installing the Tree

or balled and burlapped material, place the tree in the hole by lifting and carrying it by the root ball so that the ball will not be loosened. A forklift with nursery jaws may be needed for larger caliper material. Set the tree straight and in the center of the planting site. Cut and remove rope or wire from at least the top 2/3 of the root ball and remove as much as the burlap and twine as possible. The more wire and burlap removed, the better. The tree shall be installed so that the trunk or root flare is flush with the finished grade after soil settling has taken place. Any obvious circling or girdling roots should be pruned at planting.

Step 3. Backfilling the Hole

In landscaped areas, with good quality soil, the hole should be backfilled with the soil originally removed from the hole. In industrial and heavily trafficked areas, soil may need to be replaced with more nutrient-rich, uncontaminated soil. If uncertain, soil testing is recommended. The hole should be backfilled in stages, watering in between filling, to help soil settle and prevent large air pockets which may cause the tree to tilt after planting. In particularly dry areas, building a berm

of soil in a circle around the planting hole can help retain water when it rains. At no point should the topsoil be touching the trunk of the tree. The root flare should remain visible after backfilling.

Step 4. Mulching

Applying a layer of mulch to the surface of all planting sites helps protect tree roots from weather extremes, ameliorates water retention, and suppresses competition from weeds. The use of a natural forest product, such as shredded bark or wood chips, also helps with a steady nutrient supply as the material decomposes over time. Be sure that the mulch is natural in color and not dyed. Mulch should be applied at a depth of three to four inches at the time of planting. The mulch should be spread on the perimeters of the planting site, with little to no mulch on top of the root ball itself. This is to ensure roots are receiving adequate water. Mulch should not be touching the base of the tree. Contact with the stem creates moisture pockets, which can harbor fungi and bacteria.

Step 5: Staking

The need to stake trees is dependent on the ability of the tree to stand up on its own and the location of the planting. Once the tree can stand on its own and the root ball is anchored, stakes should be removed. Generally, stakes should be removed after one year. Stakes should be attached to the tree with loose, flexible material such as ArborTie. Staking materials should be removed within a year of tree installation. Leaving staking materials on a tree for prolonged periods of time can result in stem girdling and poorly developed stem taper and root systems due to decreased sway in the wind. If staking materials must be left for more than a year, they should be checked biannually to ensure they are not girdling the tree.

Step 6: Watering

Consistent watering in the first growing season is crucial for successful tree establishment. Newly planted trees should receive 3 gals. per inch of trunk diameter, 2 to 3 times per week for the first growing season. As the tree becomes established, the volume should increase but the frequency can be diminished. The tree should be watered on a weekly basis in the second growing season and on a bi-monthly basis in the third growing season. By year four, the tree's root system should be adequately established. Watering bags may help provide a consistent source of water released slowly over time but must be installed correctly and checked to ensure they are releasing water.

YOUNG TREE TRAINING PROGRAM

The Village of Ballston Spa has 80 young trees that can be put on an early pruning schedule to create a strong structure and improve the overall health and appearance of the trees. Any new trees planted in the Village of Ballston Spa should be included in the YTTP. Ballston Spa is encouraged to reach out to local volunteer groups to set up a tree care program that is carried out on an annual basis. The village should coordinate with the local garden club, members of the tree board, local schools, or businesses to schedule tree training days. A certified arborist, either from parks or the tree board, or hired on a per day basis, should be present to train the volunteers and guide them as they prune the young trees.

Guidelines on Young Tree Training

Equipment needed:

- Hand pruners for branches up to 3/4 inch wide.
- Hand saw for branches up to several inches wide.
- Pole pruner or reach pruner for branches higher in the canopy.
- Gloves and safety glasses.

It is important that the tools are sharp and clean before pruning begins.

Training Schedule

Suggested Minimum Pruning Cycle
At planting
Year 2 or 3
Year 5 or 6
Year 8 to 10

The Young Tree Training Program should be put on a three-year cycle. One third of Ballston Spa's young trees can be trained each year. In years 8 or 10, the tree will likely require minimal pruning.

Time of Pruning

Pruning in the winter months while the tree is dormant is recommended. Pruning in the winter and early spring, prior to bud break, encourages new growth, while summer pruning slows growth.

Location of Pruning Cut

At the base of each branch, where the branch meets the stem of the tree, you will find overlapping branch and trunk wood. This swollen section is referred to as the branch collar. If the tree is less than 2 inches in diameter, the branch collar may not yet be visible.

Right above the branch collar, where the branch and trunk connect (usually making a V shape), is the branch bark ridge. This area is a unique barrier, known as the branch protection zone. This section holds chemical properties that help seal off the wound to reduce the spread of decay into the trunk.

When removing a branch, it is important to make the cut just to the outside of the branch collar. Leaving the branch collar intact will ensure the tree is equipped to defend itself against potential pests invading the open wound.

Reduction cuts, which reduces the size of the branch, should always be made at the nodes of the branch.

How to Prune Young Trees

Step 1. Perform a 360-degree inspection around the tree and assess the overall form and structure of the tree.

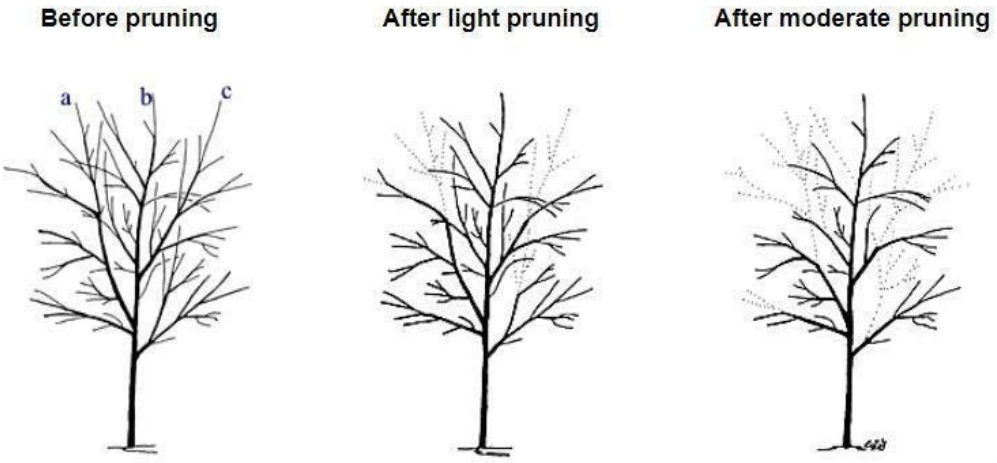
Step 2. Remove all broken, dying, diseased, and dead branches.

Step 3. Select a leader and cut back or subordinate any competing leaders. The leader is the central stem of the tree, follow the stem from bottom to top and carefully identify the leader. The most upright, vertical branch is a good candidate.

Step 4. Select the lowest permanent branch and loosely tie with flagging tape. Branches don't grow up the tree as the tree matures; therefore, any branch on a young tree will remain at the same height years later. The village should determine an acceptable clearance height and select the lowest branch at that height. The lowest branch should be healthy, well attached and not more than half the size of the stem.

Step 5. Select scaffold branches and remove or reduce competing branches. Ensure the scaffold branches are well attached, less than half the diameter of the main stem, and well-spaced, both vertically and radially. Walk around the tree and determine which are good candidates for scaffold branches. Tie loose flagging tape around selected branches to help gain a visual of the tree after pruning. Prune any branches with included bark, crossing branches or branches too close to the chosen scaffold branch. Small branches should remain between the larger scaffold branches if present.

Step 6. Select temporary branches below the lowest permanent branch. Temporary branches will eventually be removed as the tree grows but are important to retain when the tree is young. Vigorous temporary branches can be reduced, or pruned back, to slow the grow. The temporary branches can be removed in year 4, when the tree has fully established.



Proper Young Tree Pruning Technique. Reference E. Gilman (2007)

Young Tree Training Program Budget

Table 6. Young Tree Training Budget for First 5 Years of the 10 Year Program.

Activity Cost		Year 1		Year 2		Year 3		Year 4		Year 5	
Activity Cost	Cost/tree	Count	Cost	Count	Cost	Count	Cost	Count	Cost	Count	Cost
Young Tree Training Program (3-year Cycle)	$5	27	$135	27	$135	27	$135	27	$135	27	$135

The cost per tree is estimated based on volunteer groups participating in the training program. The cost assumes the hiring of a certified arborist to train and guide volunteers, as well as the equipment cost associated with the program, divided by the number of trees trained per year.

10-Year Planting Budget

The inventory has indicated vacant planting sites are suitable for new trees. Planting sites have been identified specifically by address number, street, side, and site number in the inventory. By setting a goal to plant trees in all of these sites, the village will be headed toward the full stocking of its street tree population. Table 9 represents the costs associated with a planting program over the course of ten years. The planting cost includes purchasing, planting, watering, and maintaining the tree. The price per year assumes a 2% inflation rate. At the rate of estimation of plantings per year, it will take the village ten years to plant all identified vacant sites.

Table 7. Planting Cost over a Ten-Year Period.

Year	Planting Cost	Number of Trees	Total Cost
1	$235	82	$19,270
2	$235	82	$19,270
3	$235	82	$19,270
4	$235	82	$19,270
5	$235	82	$19,270
6	$235	82	$19,270
7	$235	82	$19,270
8	$235	82	$19,270
9	$235	82	$19,270
10	$235	82	$19,270

Section 5:

Trees and Sidewalk Plan

of the Public Tree Resource

SECTION 5: TREES AND SIDEWALKS PLAN

INTRODUCTION

Trees located on sidewalks provide important ecological services to Ballston Spa's residents. However, in an urban environment, with limited growing space, conflicts between trees and sidewalks often arise. There are generally two types of tree related sidewalk conflicts: 1) sidewalk damage from the trunk or root flare, where the actual trunk or root flare is lifting the sidewalk, and 2) sidewalk damage from the lateral roots, where root growth causes the sidewalk to lift and/or crack.

When cracks or lifting is excessive, the sidewalk can become a tripping hazard to pedestrians.

This plan offers an overview of design strategies and construction techniques to improve the relationship and longevity of trees growing near sidewalks. Each repair strategy seeks to improve or eliminate sidewalk-tree conflict while minimizing damage to tree roots.

SCOPE OF WORK

As part of the larger Tree Inventory project, Davey Resource Group (DRG) conducted a Sidewalk Infrastructure Condition Assessment for the Village of Ballston Spa using a list of priority sites provided to DRG by the Village. The assessment identified and classified sidewalk infrastructure damage relating to street trees and provided onsite recommendations to address the issue.

METHODOLOGY

At each location, the arborist recorded the tree causing the greatest damage (lift or cracks) and the scope of the area to be inspected (area damaged by the tree). A Level 2 inspection was completed for each tree involved in the tree-sidewalk conflict (see Appendix F).

The arborist assigned a score to each of the six pre-determined categories, which included:

- *Location:* The number of observed parks, playgrounds, schools, places of worship, businesses, hospitals, bus stops, and other areas of high pedestrian use were recorded. Sites with higher pedestrian traffic resulted in higher ratings.
- *Clearance:* The width of walkable space within the inspection area which was not obstructed by lifting or cracking. Narrow pathways that were more difficult to navigate resulted in a higher rating.
- *Degree of Vertical Lift and Damage:* Measured as the difference in height between two pieces of concrete lifted or cracked by the tree roots. Sidewalks that were cracked but not lifted rated lower, as they don't pose as great a tripping hazard as a lifted sidewalk.
- *Number of Damaged Flags:* The number of sidewalk flags (sidewalk square) damaged by tree roots. The more flags impacted, the higher the rating.
- *Tree condition:* The size and health of the tree, rated as Good, Fair, Poor, Critical. The healthier the tree, the higher the rating.

- *Total Trees:* The number of trees impacting the sidewalk. The more trees impacted, the higher the rating.

Each category was assigned a weighted designation which was used to calculate a priority-based score. The score was between 0–100, with priority placed on the highest rating. The measurements with their assigned scores and weights are described below.

Table 8. Metric and scoring system for rating tree-sidewalk conflicts.

Metric/Parameter	Measurement Method	Score	Weight
1. **Location:** Based on observed parks, playgrounds, schools, places of worship, businesses, hospitals, bus stops, etc.; blocks include cul-de-sacs and dead ends.	No observations on block	1	15
	1 observation on block	2	
	2 observations on block	3	
	3 or more observations on block	4	
2. **Clearance:** Width of walkable space within inspection area not obstructed by lift ½ inch or greater and/or cracks ½ inch or greater in diameter	Less than 1-foot clearance	4	20
	1- to 3-foot clearance	3	
	3- to 5-foot clearance	2	
	Greater than 5-foot clearance	1	
3. **Lift:** Find the greatest lift caused by tree. If the greatest lift is at the curb and the curb is missing, damaged, or sunken, measure the lift to the presumed normal curb height. If sidewalk or curb has been "patched" or ground down, measure lift as if this work has not been completed.	½-inch to 1-inch lift	1	25
	>1-inch to 2-inch lift	2	
	>2-inch to 3-inch lift	3	
	>3-inch to 4-inch lift	4	
	Greater than 4-inch lift	5	
4. **Flags:** Count the number of sidewalk flags damaged (lifted or cracked) by the tree. Sidewalk flags are typically 5′ x 5′ or 4′ x 4′. Flags are counted around tree receiving the inspection only.	Less than 1-foot clearance	1–5	10
5. **Tree Condition:** To evaluate cost/benefit of sidewalk work based on tree longevity. Look for obvious defects such as, but not limited to, dead trees, large cavity openings, large dead or broken branches, fungal structures, large cracks, and severe leans.	Excellent or Good	4	20
	Fair	3	
	Poor	2	
	Critical, or Dead, or Stump	1	
6. **Total Trees:** Count the number of village trees/stumps abutting the address.	1 tree or stump	1	10
	2 trees and/or stumps	2	
	3 trees and/or stumps	3	
	4 trees and/or stumps	4	

The arborist then assigned a recommendation based on the most suitable remedial action for each identified site. The recommendations included: Ramping, Curving, Strengthening, Expanding, and Removal.

RECOMMENDED REMEDIAL ACTIONS

All tree-sidewalk repair techniques must maintain compliance with the Village Ordinances, Department of Transportation (DOT) and the Americans with Disabilities Act (ADA). The ADA is a civil rights law that prohibits discrimination based on disability. The standards for access are required for commercial and public properties and are strongly encouraged for residential properties as much as feasibly possible. For more detailed information on ADA guidelines, please visit 2010 ADA Standards for Accessible Design (ADA.gov).

Ramping the Sidewalk

Sidewalk ramping involves gradually raising the grade of the sidewalk to create a bridge between the sidewalk and large roots.

Damaged sidewalk slabs are removed and replaced, and 4–6 inches of sand or coarse gravel can be installed under the new sidewalk to provide a buffer for root growth. The sidewalk sections can be finished with concrete or asphalt to ensure a smooth, even surface. For minor sidewalk lifting of one inch or less, it is cost-effective to bevel down the edges to remove the tripping hazard.

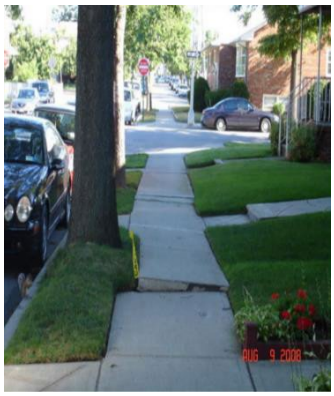
NYC Parks Trees and Sidewalks Construction Manual

Sidewalk ramping allows existing roots to remain intact and should be considered when root removal would compromise the stability of the tree. While ramping is a less expensive solution, as it doesn't require redoing the sidewalk, future lifting and cracking may occur if the tree is relatively young.

Ramping must follow the ADA guidelines, which states that the running slope must not exceed 5% and the cross slope does not exceed 2% (Please see Appendix A for more detail).

Sidewalk Curving

Sidewalk curving or meandering involves realigning the sidewalk's direction of travel to allow for more growing space. This can be done by narrowing the sidewalk or rerouting it around the tree. Increasing the distance from the sidewalk to the trunk will provide more space for the larger, structural roots, responsible for tree stability. This option avoids damaging tree roots and provides a larger, unobstructed growing space.



NYC Parks Trees and Sidewalks Construction Manual

Sidewalk curving often requires permission from the abutting property owner to dedicate more of their property to the public right-of-way. The reconstructed sidewalk must meet the ADA minimum width requirements (see Appendix A).

Sidewalk Strengthening

Reinforcing the sidewalk with rebar or wire mesh helps protect the sidewalk from tree roots. Mesh should be installed in the middle of the concrete layer. The structural reinforcement can resist cracking from soil settlement, soil heaving, or root expansion. As roots grow under the slab, they are less likely to lift the slab due to the added weight.

Expanding the Tree Bed

When space allows, a larger tree bed should be installed. This is accomplished by removing any damaged sidewalk flags from the area and expanding the soil surface area around the tree. Increased soil volume is one of the best ways to enable larger and healthier trees in urbanized areas. This technique can help prevent further damage to the surrounding sidewalk. The new sidewalk clearance must always meet accessibility standards (see Appendix A).

Removal

Removal should be reserved for stumps or trees in poor or critical condition. All other remedial actions should be considered prior to removal of a tree in Good or Fair condition.

Findings

DRG identified 59 tree-sidewalk conflicts in the Village of Ballston Spa. There were 18 locations where ramping was identified as the most suitable repair technique, 19 sites for curving the sidewalk, one site with sidewalk strengthening, 4 sites for tree bed expansions and 4 recommended removals. There were 15 sites where multiple repair techniques were applicable.

The locations of the tree-sidewalk conflicts, along with their designated score and recommended remedial actions are outlined in Appendix F. The scores are listed from highest to lowest priority, with the higher scoring sites posing a greater tripping hazard to pedestrians. The two highest priority sites in Ballston were given a rating of 3.85. The sidewalk's lift was recorded as being greater than 4 inches, with one foot of clearance for pedestrian use. The DRG arborist recommended ramping as a suitable remedial action for the sidewalk-tree conflict (Appendix F).

Materials-Based Strategy

The choice of material is critical when designing sidewalks near trees. Concrete is the most used building material for sidewalks due to it being durable, affordable, and easily molded. However, the material's rigidity and impermeability is not conducive to trees growing in close proximity to concrete slabs. The material's rigidness gives way to lifting and/or cracking as tree roots grow into the slabs. Below are alternatives that may be used instead of concrete. All materials can be ADA compliant.

Alternatives to Concrete

Pervious Cement Concrete: Pervious concrete is a structural concrete made from a mixture of cement, coarse aggregates, and water, which results in a porous open-cell structure. Pervious concrete can absorb stormwater at a rate of 3 to 5 gallons per minute per square foot surface area. The material allows the passage of air and water, which improves moisture and oxygen relations relative to standard impervious paving.

In a study conducted by Morgenroth (2011), pervious concrete increased the height, DBH, and root biomass of *Platanus orientalis* trees, when compared with its impervious concrete counterpart. In areas where there is limited space for both the sidewalk and tree pit, impervious concrete can be used to pave closer to the dripline without significantly compromising the health of the tree.

It is important to note that the effectiveness of pervious cement is dependent on the depth and substrate of the base layer. Mullaney et al. (2015) found that moisture levels were increased in drier sandy soils but decreased in wetter clay soils after rainfall, with the stabilizing effect being related to the depth of the underlying base layer.

The upfront cost of installing pervious concrete can be slightly more expensive than traditional concrete; however, the total cost can be lower. Pervious concrete has a longer lifespan than traditional concrete, lasting up to 20 to 40 years.

Asphalt: Asphalt is durable, flexible, low-cost, and easily paved, shaped, and repaired. It can also be coated with a cement dust to give it a grayer color, reducing heat absorption. Asphalt doesn't require a thick base when used for a walking surface and can be placed over tree roots. Tree roots can remain in the base layer if they do not contact the asphalt layer.

Due to the material's flexibility, tree roots can grow right through asphalt or cause bumps, which are less hazardous than lifts typically experienced in concrete slabs. Impacted sidewalks can also be repaired in smaller sections by simply patching the obstructed area with more asphalt, as opposed to complete slab replacement. Asphalt, however, can heat up in the sun and become soft. It also tends to have a shorter lifespan than concrete. While the material is more suitable to use around trees, the appearance is not always desirable.

Flexi-Pave: Flexi-pave is a heavy-duty, porous material made from recycled passenger tires, rock aggregates, and a binding agent. The material is capable of handling 4,000 inches of water per hour, is slip-resistant, and resistant to freeze-thaw. Flexi-pave's flexible nature helps prevent sidewalk cracking, reducing long-term maintenance costs.

Structural Soil Cells: Soil cells are columns and beams made of plastic or fiberglass that sit under the pavement to support un-compacted planting soil. The structure provides void space filled with soil that supports root growth and relevant pavement loads. Soil cells can be designed with pervious pavements to retain and filter significant volumes of water. The structural element of Soil Cells allows large tree roots to grow within the soil layer while directing roots away from the upper hard surface. Cracking and lifting are significantly less likely to occur.

Tree and Root Zone-Based Strategies

Species Selection

Selecting the appropriate species for a given site is critical in minimizing future sidewalk conflicts. Before planting begins, the site should be surveyed for overhead wires, underground utilities, planter dimensions, required clearances, and surrounding infrastructure.

In addition to the size of the tree at maturity, species selection should also account for trunk flare and root buttress characteristics. Trunk diameter at Ground Level (DGL) varies by species. Species with larger DGL and larger forms should be planted in larger planting pits (see Planting Plan for more information on tree pit sizing).

Root Pruning

Root pruning is a common occurrence when tree roots are lifting or cracking sidewalk flags. It should always be considered carefully and be done by a qualified professional.

It is important to understand the function of roots to grasp the impact root pruning can have on the health of the tree. Large roots are termed structural roots. These roots provide anchorage, ensuring the tree's stability.

Hiring a certified arborist for root pruning is recommended. If done incorrectly, root pruning can lead to severe tree decline or tree death. Improper root pruning may also increase the chances of whole tree failure.

Before cutting roots, it is crucial to assess the health of the tree to better determine the amount of root pruning a tree can handle. A tree in poor condition may not have the energy reserves available to compensate for lost roots.

How big of a tree root can you cut?

As a rule of thumb, avoid cutting roots more than 2 inches in diameter. Anything larger than 2 inches should be done by a professional arborist. Removing a large root may compromise the stability of the tree. Also, avoid removing roots closer to or fused to the base of the tree, as doing so will negatively impact the tree's structural integrity.

Air spading should be performed before any extensive root pruning takes place. An arborist should use an air spade to remove soil around the tree's critical root zone to gain a better understanding of the extent and health of the root system. There are times when a large tree may have structural roots that are only 2 to 3 inches in diameter. Cutting these roots may severely compromise the stability of the tree.

When it comes to root pruning, the further away you are from the tree trunk, the better. When space is available, a tree's root system occupies an area roughly four to seven times the surface area of the tree crown. Therefore, when a single root is cut, the tree often loses an extensive root network. Generally, you can safely remove roots that are 3–5 times the diameter away from the trunk of the tree.

When to root prune

Roots should be cut during late winter, when the tree is dormant, or early spring before bud break, when the risk of dehydration is lowest. Be sure that the soil remains moist after root pruning is performed to prevent the root from drying.

Tree care before and after root pruning

A health assessment of the tree should be completed before root pruning begins. Trees that are exhibiting signs of stress, including crown dieback, chlorosis (leaf yellowing), or leaf desiccation are poor candidates for root pruning. Removing roots from trees in poor health will further exacerbate tree decline. Root pruning should not be performed on trees that are leaning; doing so increases the likelihood of tree failure.

Soil should be kept moist prior to and after root pruning. Removing roots makes water uptake more difficult for the tree, be sure to apply irrigation after root pruning to facilitate access to water.

After root pruning, monitor the tree for secondary pests. The tree will be more susceptible to invading pests and pathogens. If you notice a higher presence of pests, an arborist may be needed to apply protective treatments on the open wound.

Fertilizers and soil amendments are recommended to promote root regeneration. However, a soil nutrient analysis should be performed prior to fertilizer application.

Root Barriers

Roots barriers are solid barriers installed to protect sidewalks from lifting or cracking by redirecting tree roots down and away from hardscapes. The barrier, made from corrosion-resistant metal, fiberglass, or plastic, creates an impenetrable wall that roots cannot get through. Permeable root barriers, made of a mesh screen, can also be used. Permeable barriers allow water and small roots to pass through but prevents potential damage to structures from large roots.

Root barriers can be used for mature trees, after root pruning, or as a prior condition to new plantings. The installation of a root barrier should be carefully considered and undertaken by a qualified tree expert.

BEST PRACTICES FOR NEW SIDEWALK CONSTRUCTION AND REPAIRS

Best management practices differ depending on whether the situation is creating new sidewalks and spaces for trees or remediating existing tree-sidewalk conflicts.

Common best practices when creating new spaces for trees and sidewalks include:

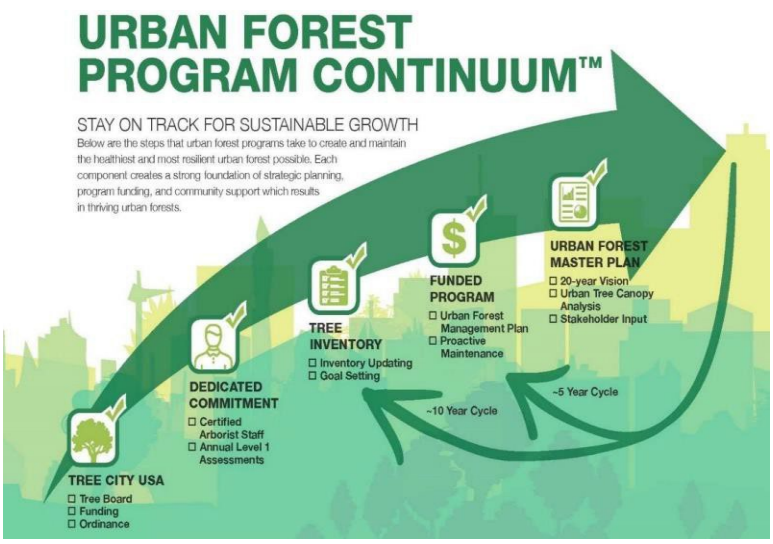
- Maximize soil volume.
- Plant appropriately sized tree species for tree pit dimensions.
- Install root barriers where appropriate.
- Increase distance between tree and hardscape (create a larger tree lawn or pit).
- Place sidewalk adjacent to curb and plant on other side of sidewalk (on excess right-of-way or private property).
- Use an alternate sub-base material that discourages surface rooting.
- Use an alternate sub-base that encourages deeper rooting under the sidewalk (i.e., soil cells).

Common best practices when dealing with existing trees and sidewalks:

- Remove heaved slabs of concrete and pour new slabs in place with minimal excavation or impact of roots. Possibly use steel to reinforce slabs if news slabs are less than 5″ thickness.
- Ramp or bridge sidewalk blocks, or place new blocks on pier.
- Grind or shave the blocks if displacement is less than 1 inch.
- Perform appropriate root pruning following industry standards for tree health and stability.
- Install root barriers (after proper root pruning).
- Reroute the sidewalk around the trees.
- Use an alternate sub-base, such as gravel, crushed granite, rubber chips, styrofoam to provide a few more years of service from the sidewalk without removing the tree.

- Reinforce the new sidewalk slabs using steel reinforcing bars.
- Perform "slab jacking" (drilling holes in panels that are not raised, and injecting caulk to raise it to meet the other).
- Remove tree only if no alternative is feasible, and other actions would create a public safety issue.

CONCLUSIONS



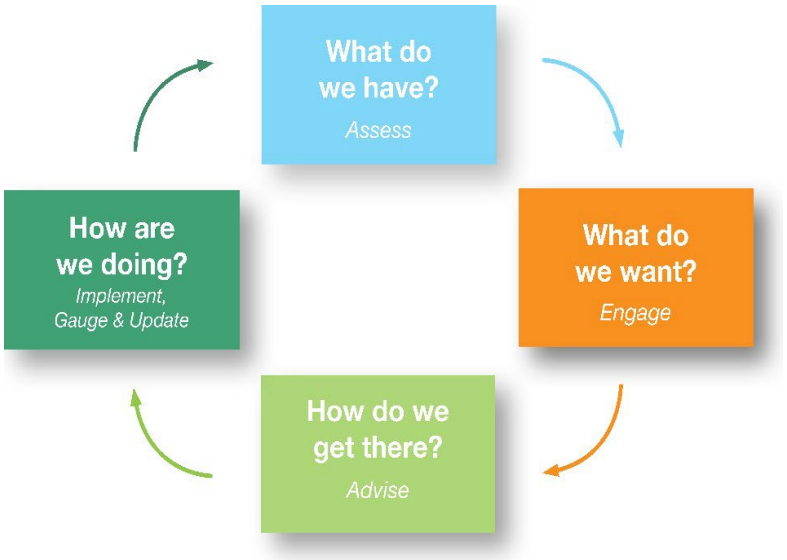
When properly maintained, the valuable benefits trees provide over their lifetime can far exceed the time and money invested in planting, pruning, and inevitably removing them. The 1,127 public trees inventoried provide nearly $5,000 in estimated annual economic value across three specific functions: pollution removal, runoff reduction, and carbon sequestration. These trees store 914 tons of carbon valued at nearly $156,000 and have a replacement value of over $2 million. Implementing the components of the ten-year maintenance plan laid out in this document will help to further grow the benefits provided by Ballston Spa's tree resource over time while shrinking the costs associated with managing the tree resource.

The maintenance program laid out here is ambitious and may be a challenge to complete in years, ten although the work becomes easier after all high priority tree maintenance is completed. This *Community Forest Management Plan* could potentially help advocate for an increased urban forestry budget to fund the recommended maintenance activities. Getting started is the most difficult part because of the expensive maintenance in the first several years, which represents the transition from reactive maintenance to proactive maintenance. However, significant investment early on can reduce tree maintenance costs over time.

As the urban forest grows, the benefits enjoyed by the Village of Ballston Spa and its residents will increase as well. Inventoried trees are only a fraction of the total trees in Ballston Spa when including private property, which is why it is important to also incentivize private landowners to care for their trees and to plant new ones. The village's urban forestry program is well on its way to creating a sustainable and resilient public tree resource, and can stay on track by setting goals, updating inventory data to check progress, and setting more ambitious goals once initial goals are complete.

EVALUATING AND UPDATING THIS PLAN

This *Standard Inventory Analysis and Management Plan* provides management priorities for the next ten years, and it is important to update the tree inventory using TreeKeeper® as work is completed, so the software can provide updated species distribution and benefit estimates. This empowers Ballston Spa to self-assess the village's progress over time and set goals to strive toward by following the adaptive management cycle (depicted to the right).



GOALS AND ACTION ITEMS

A summary of goals, timeframes, and action items to complete each goal is provided here for the convenience of Ballston Spa's tree care experts. Many of these goals are interrelated, and work on one may help to accomplish others. Ballston Spa has many diverse tree-care-related goals and completing all of them within a 10-year timeframe may not be possible. If any goals must be worked on over a longer period, the timeframe may be changed accordingly. Similarly, if different or additional action items are needed to complete a goal, they should also be changed. Finally, Ballston Spa may identify additional goals as they work toward growing their urban forestry program, and this list should be updated regularly to reflect new goals, timeframes, and action items.

Table 9. Goals, timeframe, and action items for Ballston Spa's urban forestry program.

Goal	Timeframe	Action Items
Complete priority tree maintenance tasks	1-2 years	• secure funding to remove or prune elevated risk trees
		• remove elevated risk trees recommended for removal
		• prune elevated risk trees recommended for pruning
Reduce risk associated with town trees	ongoing	• routinely inspect town trees for defects which may elevate risk
		• continue routine pruning program
		• train young trees to prevent structural problems which may elevate risk
Establish young tree training program	1–3 years	• secure or set aside necessary funding
		• hire contractors or train staff on structural pruning techniques
		• divide town into thirds and prune young trees in 1/3 of town each year
Update tree inventory	ongoing	• edit inventoried trees as work is completed
		• add new trees as they are planted
		• remove or edit trees to stumps or vacant sites as they are removed
		• remove or edit stumps to vacant sites as they are removed
		• plan to conduct a full re-inventory within the next 5-10 years
Establish planting program	2-4 years	• apply for planting grants
		• secure or set aside necessary funding
		• identify high priority locations for planting
		• identify suitable planting sites in high priority locations
		• hire contractors or train staff on tree planting
		• coordinate with volunteer groups to provide watering services during tree establishment
		• set goals for annual planting (i.e., replace removed trees, x trees annually, x trees by set date, etc.)

Goal	Timeframe	Action Items
Continue Arbor Day celebrations	ongoing	• coordinate between departments
		• provide public education on tree planting, care, and benefits
		• source seedlings to hand out to citizens
		• plant trees on town properties
Educate citizens about trees	ongoing	• provide free presentations or classes during Arbor Day celebrations
		• post urban forestry updates to town websites
		• provide approved tree planting lists and do-not-plant lists
		• table or provide educational fliers at Welcome Center
Reduce conflicts with utilities and infrastructure	ongoing	• plant only small stature trees (15-30 feet tall at maturity) below utility lines
		• plant medium stature trees (30-40 feet tall at maturity) at least 20 feet from utility lines
		• plant large stature trees (40+ feet fall at maturity) at least 40 feet from utility lines
		• routinely prune town trees to minimize conflicts with utilities, signs, and buildings
		• locate trees to avoid blocking important road signage
		• plant trees at least:
		• 5 feet from underground utilities
		• 10 feet from driveways
		• 15 feet from utility poles
		• 15 feet from buildings
		• 20 feet from stop signs
		• 20 feet from fire hydrants
		• 30 feet from intersections
Improve tree cover in parks and on public properties	ongoing	• identify parks and public properties with greatest occupancy rates and greatest need of trees
		• identify suitable planting sites in these high priority areas
		• select tree species well suited to site conditions
		• install trees using best practices
		• maintain young trees on a regular basis

Goal	Timeframe	Action Items
Increase tree species and genus diversity	ongoing	• routinely analyze species and genus composition of the urban forest
		• identify species and genera which are overabundant
		• update approved planting list and do not plant list to correspond to species and genus data
		• plant a greater variety of tree species and genera
Prepare for future invasive species threats	1–3 years	• draft an invasive species management plan using guidance from Appendix B Invasive Species.
		• identify likely areas for invasive species establishment
		• routinely monitor high-priority areas to identify new invasions early
		• manage new invasive species in ways which are cost-efficient, environmentally sound, and socially acceptable
		• routinely check with organizations like the United States Department of Agriculture (USDA) and the western New York Partnership for Regional Invasive Species Management (Capitol Region PRISM) for updates on invasive species in your area
Beautify town center	3–5 years	• determine which organizations or entities own land within the town center
		• coordinate with identified organizations or entities to develop plan
		• incorporate tree planting, native plant landscaping, and other green infrastructure to create an inviting and walkable town center
Make gateways to village more inviting	5-8 years	• identify key entrances from through routes into the village proper
		• strategically redevelop these areas for ease of use for pedestrians and vehicle traffic
		• incorporate tree planting, native plant landscaping, and other green infrastructure to create an inviting entry to the town
Select "Right Tree for the Right Place"	ongoing	• analyze site conditions before planting and select trees well suited to the site
		• select trees which will not outgrow available space at maturity
		• select trees which will not outgrow available space at maturity

Goal	Timeframe	Action Items
Create an approved tree species planting list	1–3 years	• modify DRG provided potential planting list using town information
		• distribute list on town websites
		• use list to guide tree planting decisions
Create and enforce a do not plant list	1–3 years	• identify tree species and genera which are overabundant in town
		• identify tree species which are susceptible to current or future invasive species threats
		• identify tree species which are known to be invasive in the area
		• create a list of these undesirable species
		• distribute list on town websites
		• use list to guide tree planting decisions
		• update list as needed when species and genus distribution shift or as new information on invasive species is available

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GLOSSARY

address (data field): The address number was recorded based on parcel data within the GIS data collection program and confirmed with visual observation 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 the suffix field (assigned address field) was set to "X".

air pollution removal: In i-Tree Eco, air pollution removal refers to the removal of ozone (O_3), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), and particulate matter less than 2.5 microns ($PM_{2.5}$).

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.

assigned address (data field): see **suffix**

avoided runoff: In i-Tree Eco, avoided runoff measures the amount of surface runoff avoided when trees intercept rainfall during precipitation events.

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.

carbon monoxide (CO): A colorless, odorless, highly toxic gas formed as a result of the incomplete combustion of a carbon or carbon compound.

carbon sequestration: The capture and storage of carbon from the Earth's atmosphere. In i-Tree Eco, carbon sequestration is calculated as an annual functional benefit of trees.

carbon storage: Storage of carbon in plant tissue. In i-Tree Eco, carbon storage is calculated as a structural benefit over the lifetime of the tree.

clean (secondary maintenance required): The tree has dead or diseased parts greater than 2 inches in diameter which should be removed to improve tree health, appearance, and to reduce associated risk.

comments (data field): Additional comments on the state of the inventoried site. Comments may include additional defects that were significant but not the primary defect, explanations for why further inspection is needed, and other general information considered important by the inventory arborist.

commercial (land use): Land used for the buying and selling of commercial goods. This land use type includes stores, restaurants, hospitals, and other businesses which provide goods or services for a fee. Although churches do not necessarily fall under this category, they were included under the umbrella of commercial land.

community forest: see **urban forest**.

condition (data field): The general condition of each tree rated during the inventory according to categories adapted from the International Society of Arboriculture's rating system.

cycle: Planned length of time between vegetation maintenance activities.

dead (condition rating): A dead tree shows no signs of life.

defect: See **structural defect**.

defect (data field): The primary defect noted by the inventory arborist. Defects include missing or decayed wood, dead or dying parts, broken or hanging branches, weakly attached branches and codominant stems, cracks, root problem, tree architecture, other, and none.

diameter: See **tree size**.

diameter at breast height (DBH): See **tree size**.

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.

failure size (data field): The size of the portion of a tree for which risk was assessed during the inventory.

fair (condition rating): A fair tree has minor problems that may be corrected with time or corrective action.

front (side): The side of a parcel facing the address street.

functional benefit: In i-Tree Eco, a benefit which is due to the physiological processes carried out by trees, calculated on an annual basis.

further inspection (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.

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.

good (condition rating): A tree in good condition shows no major problems.

grow space size (data field): The r root space available between hardscape features as measured parallel to the street. In parks, the longest dimension of the estimated root space.

grow space type (data field): Categorization of the type of growing space in which a site is located, including median, open space, planting strip, well/pit, or wooded space.

high risk tree: 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.

industrial (land use): Land used to produce goods. Factories, warehouses, and associated parking are included in this land use.

insect/disease monitoring (further inspection): A tree which requires additional inspection by an entomologist or tree disease specialist to determine whether or not there is an emergent pest or disease present.

invasive tree: A tree species that is out of its original biological community. 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**.

inventory date (data field): Date a site was collected.

i-Tree Eco: i-Tree Eco is a street tree management and analysis tool that uses tree inventory data to quantify the dollar value of annual environmental benefits, including runoff reduction, air pollution reduction, and carbon sequestration, as well as life-long structural benefits trees provide, including carbons storage and structural value.

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, CO_2 reduction, stormwater control, and property value increase. While i-Tree Streets was not used for the tree benefits analysis in this management plan, it is still used as the basis for the tree benefits tab in TreeKeeper®.

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.

land use (data field): Use that the land adjacent to a site is put to, including residential, commercial, industrial, park, or public grounds.

large (grow space size): Site with a minimum dimension of at least 8 feet between hardscape features. Suitable for large sized mature trees.

level 3 assessment (further inspection): A more in-depth assessment than the level 2 assessment conducted during the inventory which requires specialized equipment or training to complete.

low-risk tree: 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.

mapping coordinates (data field): Helps to locate a tree; X and Y coordinates were generated for each tree using GPS.

median (grow space type): Strip of landscaped area which divides lanes of traffic. The center of traffic circles is included in this grow space type.

median (side): Site located between lanes of traffic, between parking spaces, or within roundabouts or cul-de-sacs.

medium (grow space size): Site with a minimum dimension of at least 6 feet and a maximum dimension below 8 feet between hardscape features. Suitable for medium sized mature trees.

moderate risk tree: 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.

multi-stem tree (data field): Indicates whether a tree has multiple trunks splitting less than 1 foot above ground level. For this inventory, multi-stem trees were measured below the trunk split or at ground level in cases where multiple stems originated from a branching point below grade.

multi-year annual (further inspection): Designates a tree which should be inspected annually or biannually to monitor a defect for improvement or degradation.

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 (risk rating): Equal to zero. It is used only for planting sites and stumps, or as a residual risk rating when a tree is recommended for removal.

open space (grow space type): Unrestricted, maintained growing space located behind the sidewalk, if sidewalk is present, or behind the curb of a street if sidewalk is not present. Most sites within privately owned lawns fall into this grow space type.

ordinance: See **tree ordinance**.

overhead utilities (data field): Designates the presence of any overhead utility lines including primary and secondary electrical distribution lines, telecommunication lines, service drops, streetlight supply lines, etc. within the airspace around or in a tree's crown.

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 (land use): Open land set aside for public recreation.

park name (data field): The park or public grounds on which a site was located. If a site was within the street ROW, the park name field was set to N/A.

particulate matter ($PM_{2.5}$): A major class of air pollutants consisting of tiny solid or liquid particles of soot, dust, smoke, fumes, and mists.

planting strip (grow space type): Also known as a **tree lawn**, a strip of landscaped area located between the sidewalk and the road.

plant tree (primary maintenance required): Used only for sites which do not currently host a tree, but which could be viable planting sites. Indicates the need to plant a tree.

poor (condition rating): A tree in poor condition has major problems that are irrecoverable.

primary maintenance required (data field): The type of tree work recommended to reduce immediate risk or fulfill other goals.

prune (primary maintenance required): The tree needs priority pruning to remove dead limbs, provide clearance, remove an obstruction, or thin or restore the canopy.

pruning: The selective removal of plant parts to meet specific goals and objectives.

public grounds (land use): Public land used for purposes other than public recreation (see **park**). Includes City offices or publicly owned lots.

raise (secondary maintenance required): The tree has limbs which are obstructing pedestrian or vehicle traffic or obscuring streetlights, signs, or signals. These limbs should be raised to provide appropriate clearance and reduce associated risk.

rear (side): The side of the parcel opposite of the address street.

reduce (secondary maintenance required): The tree has limbs which are interfering with overhead utilities or nearby buildings. These limbs should be reduced to provide appropriate clearance and reduce associated risk.

remove (primary maintenance need): 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 crown.

replacement value: In i-Tree Eco, the compensatory value calculated based on the local cost of having to replace a tree with a similar tree.

residential (land use): Privately owned land used to house people. Includes apartments, condos, and single-family homes.

residual risk (data field): The risk rating of a tree after the recommended primary maintenance has been carried out. Residual risk may be equal to but never greater than the original risk rating.

resilience: The ability of a community to absorb disturbance and reorganize while undergoing change to retain essentially the same function, structure, identity, and feedbacks as prior to the disturbance.

resistance: The ability of a community to remain unchanged when challenged by a disturbance such as pests, severe weather, or climate change.

restore (secondary maintenance required): A tree which needs special pruning to restore the crown and improve tree health, generally due to dieback or damage in the crown.

right-of-way (ROW): See **street right-of-way**.

risk: Combination of the probability of an event occurring and its consequence.

risk assessment complete (data field): Indicates whether the arborist was able to complete a Level 2 qualitative risk assessment. Arborists may not be able to fully assess tree risk due to embankments, homeowner conflicts, fences, or other obstacles to getting a 360 degree view of the tree.

risk rating (data fields): Level 2 qualitative risk assessment will be performed on the ANSI A300 (Part 9) 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 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.

routine prune (primary maintenance required): The tree requires no immediate pruning but should be included in a routine pruning cycle to maintain condition over time.

secondary maintenance required (data field): A further description of the work needed to reduce immediate risk when the primary maintenance need is prune.

side (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 assigned address.

side (side): Site is located on either side of the lot that is between the front and rear.

site: Any point for which data was recorded during the inventory, including trees, vacant sites, and stumps.

small (grow space size): Site with a minimum dimension of less than 6 feet between hardscape features. Potential suitable for small-sized mature trees.

species (data field): Fundamental category of taxonomic classification, ranking below a genus or subgenus, and consisting of related organisms capable of interbreeding.

stem: A woody structure bearing buds and foliage and giving rise to other stems.

structural benefit: In i-Tree Eco, a benefit which is produced by the physical arrangement and composition of trees and tree parts and which is calculated as an aggregate over the lifetime of a tree.

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 value: See **replacement value**.

stump removal (primary maintenance required): Indicates a stump that should be removed.

suffix (data field): Data field indicating whether the address was assigned by the arborist.

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.

thin (secondary maintenance required): The tree has very densely spaced limbs in the crown which should be thinned to improve tree health, provide appropriate air flow within the crown, and improve tree aesthetics.

topping: Characterized by reducing tree size using internodal cuts without regard to tree health or structural integrity; this is not an acceptable pruning practice.

train (primary maintenance required): A young or small size tree that requires routine structural pruning to ensure good form as it grows.

TRAQ-risk rating (data fields): see **risk rating**

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 inventory: Comprehensive database containing information or records about individual trees typically collected by an arborist.

tree lawn: see **planting strip**.

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.

tree pit: see **well/pit**.

tree size (data field): A tree's diameter measured to the nearest inch in 1-inch size classes at 4.5 feet above ground, also known as diameter at breast height (DBH) or diameter.

tree well: see **well/pit**.

urban forest: All 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.

volunteer: A tree that was not intentionally planted, but rather grew naturally in a location and has been allowed to remain as part of the maintained landscaping.

ward (data field): The Albany Ward within which a site falls.

well/pit (grow space type): A growing space completely surrounded by hardscape, typically sidewalk, and generally constrained in area in all dimensions.

wooded space (grow space type): An unmaintained area typically located behind the curb or sidewalk and usually hosting volunteer trees.

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APPENDIX A
DATA COLLECTION AND SITE LOCATION METHODS

DATA COLLECTION METHODS

DRG collects tree inventory data using their proprietary GIS software, called Rover, loaded onto pen-based field computers. At each site, the following data fields were collected:

- Address
- Comments
- Condition
- Defect
- Further Inspection Required
- Inventory Date
- Overhead Utilities
- Park Name
- Primary Maintenance
- Residual Risk
- Risk Assessment Complete
- Side
- Species
- Suffix
- TRAQ-Risk Rating
- Tree Size*

* measured in inches in diameter at 4.5 feet above ground or diameter at breast height (DBH]).

The knowledge, experience, and professional judgment of DRG's arborists ensure the high quality of inventory data.

SITE LOCATION METHODS

Equipment and Base Maps

Inventory arborists use FZ-G1 Panasonic Toughpad® units with internal GPS receivers. Geographic information system (GIS) map layers are loaded onto these units to help locate sites during the inventory. The table, below, lists these base map layers, along with each layer's source and format information.

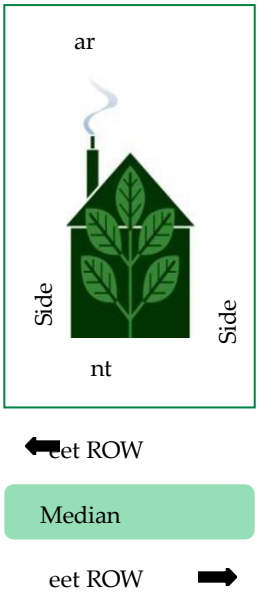
Data Source	Data Year	Projection
Shapefile Avineon, Inc.	2020	NAD 1983 2011 StatePlane Michigan Central, International Feet
Aerial Imagery Avineon, Inc.	2016	NAD 1983 2011 StatePlane Michigan Central, International Feet

STREET ROW SITE LOCATION

Individual street ROW sites were located using a methodology that identifies sites by *address number*, *street name*, *side*, and *on street*. This methodology was used to help ensure consistent assignment of location.

Address, Suffix, Street, and On Street

Sites were assigned an *address* based on the parcel nearest to the site location. Where there was no GIS parcel addressing data available for sites located adjacent to a vacant lot, or adjacent to an occupied lot without a posted address number, the arborist used their best judgment to assign an address number based on nearby addresses. An "X" was then added to the *suffix* or *assigned address* field in the data to indicate that the address for the site was filled manually.



Sites in medians were assigned an address number by the arborist in Rover using parcel and streets geographical data. Each segment was numbered with an assigned address that was interpolated from addresses facing that median and addressed on that same street as the median. If there were multiple medians between cross streets, each segment was assigned its own address.

The *street* assigned to a site was determined by parcel addressing information as the *address* was. *On street* was assigned to each site based on the nearest street centerline.

Side

Each site was assigned a *side*, including *front*, *side*, *median*, or *rear* based on the site's location in relation to the lot's street frontage. The *front* is the side facing the address street. *Side* is either side of the lot that is between the front and rear. *Median* indicates a median or island surrounded by pavement. The *rear* is the side of the lot opposite of the address street. The *on street* and *street* generally do not match for sites with a *side* of *side* or *rear*.

PARK AND PUBLIC SPACE SITE LOCATION

Park and/or public space site locations were collected using the same methodology as street ROW sites, however nearly all of them have the "Assigned Address" field set to 'X' and have the "Park Name" data field filled. All sites within a park were assigned the *side* value of *front*.

Site Location Example

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.

I-TREE ECO METHODOLOGY

Replacement value (also called structural value) is a compensatory value calculated based on the local cost of having to replace a tree with a similar tree. In other words, it is a measurement of the value of the resource itself. The structural value of an urban forest is the sum of the structural values of all the individual trees contained within. Monetary values are assigned based on valuation procedures of the Council of Tree and Landscape Appraisers using information on species, diameter, condition, and location (McPherson 2007) and (Nowak et al. 2008).

Carbon sequestration refers to the capture and storage of carbon from the earth's atmosphere. i-Tree Eco analysis reports on the gross annual amount of carbon sequestered as well as the total amount of carbon stored over the lifetime of the tree. For this analysis, carbon storage and sequestration values are calculated at a rate of $170.55 per ton.

Air pollution removal refers to the removal of ozone (O_3), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), and particulate matter less than 2.5 microns ($PM_{2.5}$). For this analysis, the pollution removal value is calculated based on the prices of $0.42 per pound of ozone, $0.01 per pound of sulfur dioxide, $0.06 per pound of nitrogen dioxide, $0.66 per pound carbon monoxide, and $18.07 per pound of particulate matter less than 2.5 microns.

Avoided runoff measures the amount of surface runoff avoided when trees intercept rainfall during precipitation events. Surface runoff from rainfall contributes to the contamination of streams, rivers, lakes, and wetlands by washing oils, pesticides, and other pollutants, either directly into waterways or into drainage infrastructure that ultimately empties into waterways. For this analysis, annual avoided runoff is calculated based on the estimated amount of intercepted rainfall and the local weather station at the Niagara Falls International Airport, where annual precipitation in 2016 equaled 26.2 inches. The monetary value of avoided runoff is based on the U.S. Forest Service's Community Tree Guide Series at a rate of $0.067 per cubic foot.

APPENDIX B
INVASIVE PESTS AND 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 cleanup costs. Keeping these pests and diseases out of the country is the number one priority of the USDA's 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, invasive pests may 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 native species to extinction. The following appendix includes key pests and diseases that adversely affect trees in New York, or which are emergent threats for New York at the time of this plan's development. This list is not comprehensive and may not include all threats.

It is critical to the management of public trees to routinely check APHIS, USDA Forest Service, and other websites for updates about invasive species and diseases in your area so that you can be prepared to combat their attack. Updated pest range maps can be found at: https://www.nrs.fs.fed.us/tools/afpe/maps/ and updated pest information can be found at: https://www.aphis.usda.gov/aphis/resources/pests-diseases/hungry-pests.

ASIAN LONGHORNED BEETLE

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 arrived in the United States in wood pallets and other wood-packing material accompanying cargo shipments from Asia. ALB is a serious threat to America's hardwood tree species.

Adult Asian longhorned beetle.

Photograph courtesy of New Bedford Guide (2011)

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: box elder (*Acer negundo*); Norway maple (*A. platanoides*); red maple (*A. rubrum*); silver maple (*A. saccharinum*); sugar maple (*A. saccharum*); buckeye (*Aesculus glabra*); horsechestnut (*A. hippocastanum*); birch (*Betula*); London planetree (*Platanus* × *acerifolia*); willow (*Salix*); and elm (*Ulmus*).

BEECH BARK DISEASE

Beech bark disease is the result of an insect-fugus complex which begins when a non-native beech scale insect, *Cryptococcus fagisuga*, feeds on the bark of beech trees, creating lesions through which a native canker fungi, *Neonectria* spp., can enter the tree. The scale insect, which is native to Europe, was first introduced to Nova Scotia in the 1890s and has since spread west and south across Canada and the United States.

Perennial nectria cankers caused by beech bark disease on an American beech.

Photograph courtesy of Linda Haugen, USDA Forest Service, Bugwood.org

Cryptococcus fagisuga is a soft-bodied scale insect which secretes a white wooly wax during the nymph stage which can make infested trees appear to be covered in wool. The insects feed on the bark, leaving punctures through which the nectria canker fungi can enter. 50–85% of infect beech trees will die within 10 years of infestation. Even trees that do not succumb to the disease may be significantly structurally weakened by the nectria cankers and are prone to "beech snap", or trunk failure. Such trees pose a safety hazard within the urban environment.

The beech scale and resulting beech bark disease is found on both American beech (*Fagus grandiflora*) and on European beech (*Fagus sylvatica*).

BEECH LEAF DISEASE

Beech leaf disease (BLD) was first identified in Ohio in 2012. Since then, it has been found in Pennsylvania, New York, Rhode Island, Connecticut, and Massachusetts.

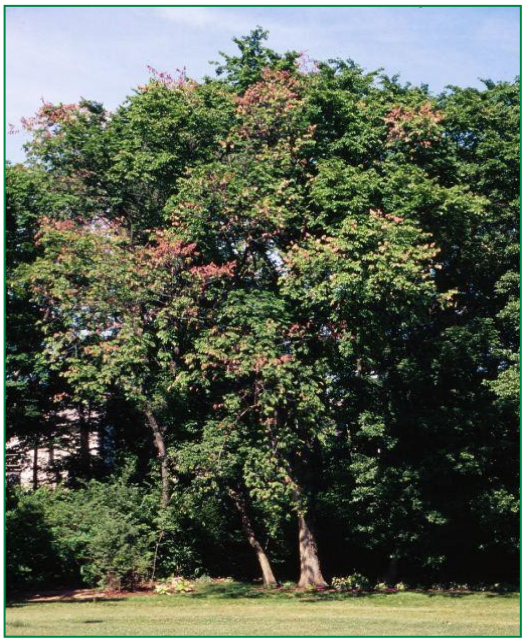
Dark stripes between leaf veins are an early symptom of BLD.

Photograph courtesy of Tom Macy, Ohio DNR Division of Forestry (2019)

The disease complex is associated with a nematode, *Litylenchas crenatae*, and impacts American beech (*Fagus grandifolia*), European beech (*F. sylvatica*), and Oriental beech (*F. orientalis*). Early signs of the disease include dark stripes between the veins of leaves, most noticeable when looking up through the canopy on sunny days. As the disease progresses, leaves become withered, curled, or develop a leathery texture and sections of canopy may die back. Infected trees often appear to have a thin canopy, and the disease can lead to tree mortality. Research into this disease is ongoing, and the method of spread and infection, as well as potential treatments, are not yet known.

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 and by 1959 it had killed thousands of elms. Today, DED is present in about two-thirds of the eastern United States and kills many of the remaining and newly planted elms annually. The disease is caused by a fungus that attacks the vascular system of elm trees, blocking the flow of water and nutrients and resulting in rapid leaf yellowing, tree decline, and death. The species most affected by DED is *Ulmus americana* (American elm).



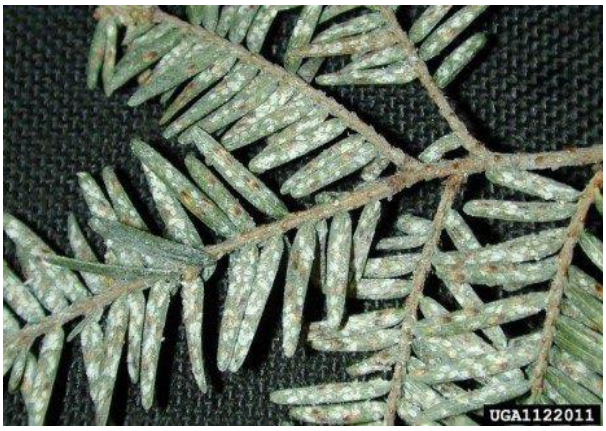
Branch death, or flagging, at multiple locations in the crown of a diseased elm.

Photograph courtesy of Steven Katovich, USDA Forest Service, Bugwod.org (2011)

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 elm by elm bark beetles. Two species of beetle carry the fungus: native elm bark beetle (*Hylurgopinus rufipes*) and European elm bark beetle (*Scolytus multistriatus)*.

ELONGATE HEMLOCK SCALE

The elongate hemlock scale (EHS, *Fiorina externa*) was introduced from Japan and was first observed in Queens, NY as early as 1908. It was not considered a major pest until the 2000s when its range and prevalence increased dramatically. This invasive scale insect has been found in 16 states to date, including Connecticut, Delaware, Maine, Maryland, Massachusetts, Michigan, New Hampshire, New Jersey, Nevada, New York, North Carolina, Ohio, Pennsylvania, Rhode Island, Tennessee, and Virginia as well as the District of Colombia. The insect is thought to have been spread widely on infested conifer products, including holiday wreaths and Christmas trees.



EHS covering the undersides of hemlock needles.

Photograph courtesy of Eric R. Day, Virginia Polytechnic Institute and State University, bugwood.org (2011)

Adult female EHS are soft-bodied, amber, legless, and wingless. They are encased in a 2mm long, brown, waxy scale covered under which they feed and lay around 20 lemon-colored eggs. Males are enclosed in white, 1.5mm scales. While they have wings, they are weak fliers and travel only to mate. They do not feed. Young instars are called crawlers and are yellow and legged. They emerge from May–September and mature to later instars which feed under scales. The scales are a visible sign that a tree is infested with EHS, and needle yellowing, especially on lower branches, premature needle drop, and branch dieback are all common symptoms of EHS infestation. While these insects can kill trees outright by siphoning away nutrients and water from the tree, more commonly they weaken hosts, leaving them susceptible to other pests or environmental conditions.

EMERALD ASH BORER

Close-up of an emerald ash borer.

Photograph courtesy of USDA APHIS (2020)

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). Common signs and symptoms of EAB infestation include excessive woodpecker activity, branch dieback, and characteristic D-shaped exit holes.

HEMLOCK WOOLY ADELGID

Hemlock woolly adelgids on a branch.

Photograph courtesy of Connecticut Agricultural Experiment Station, Bugwood.org (2011)

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 hemlock trees, as they are preyed on by on natural enemies and possible tree resistance has evolved with this insect. In eastern North America and in the absence of natural control elements, HWA attacks both eastern or Canadian hemlock (*Tsuga canadensis*) and Carolina hemlock (*T. caroliniana*), often damaging and killing them within a few years of becoming infested.

HWA is now established from northeastern Georgia to southeastern Maine and as far west as eastern Kentucky and Tennessee.

SPONGY MOTH (*LYMANTRIA DISPAR*)

Lymantria dispar (LDD, formerly called European gypsy moth) 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. LDD caterpillars defoliate trees, which makes the host trees vulnerable to diseases and other pests that can eventually kill the tree.

Close-up of male (darker brown) and female (whitish color) LDD moths.

Photograph courtesy of USDA APHIS (2019)

Male LDD 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, saw-toothed patterns on their wings. Although they have wings, the female of the species cannot fly.

LDD prefers approximately 150 primary hosts but feeds on more than 300 species of trees and shrubs. Many preferred hosts are found in these common genera: birch (*Betula* spp.); cedar (*Juniperus* spp.); larch (*Larix* spp.); poplar (*Populus* spp.); oak (*Quercus* spp.); and willow (*Salix* spp.).

OAK WILT

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 scarlet oak (*Quercus coccinea*), shingle oak (*Q. imbricaria*), pin oak (*Q. palustris*), willow oak (*Q. phellos*), and red oak (*Q. rubra*). 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.

Oak wilt symptoms on red and white oak leaves.

Photograph courtesy of USDA Forest Service (2011a)

Just as with DED, oak wilt disease is caused by a fungus that clogs the vascular system of oak and results in decline and death of the tree. The fungus is carried from tree to tree by several borers common to oak, 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.

SOUTHERN PINE BEETLE

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 white pine including eastern white pine (*Pinus strobus*). 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 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 southern pine beetles.

Photograph courtesy of Forest Encyclopedia Network (2012)

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

The spotted lanternfly (SLF, *Lycorma delicatula*) is native to China and was first detected in Pennsylvania in September 2014. SLF feeds on a wide range of fruit, ornamental, and woody trees, with tree-of-heaven (*Ailanthus altissima*) being one of its preferred hosts. SLF is a "hitchhiker" 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.

Pinned spotted lanternfly nymph.

Photograph courtesy of PA Dept of Agriculture

Symptoms of SLF include plants oozing or weeping with a fermented odor, buildup of a sticky fluid called honeydew on the plant or on the ground underneath them, and sooty mold growing on plants. The following trees are susceptible to SLF: almond, apricot, cherry, nectarine, peach, plum (*Prunus* spp.), apple (*Malus* spp.), maple (*Acer* spp.), oak (*Quercus* spp.), pine (*Pinus* spp.), poplar (*Populus* spp.), sycamore (*Platanus* spp.), walnut (*Juglans* spp.), and willow (*Salix* spp.), as well as grape vines and hop plants.

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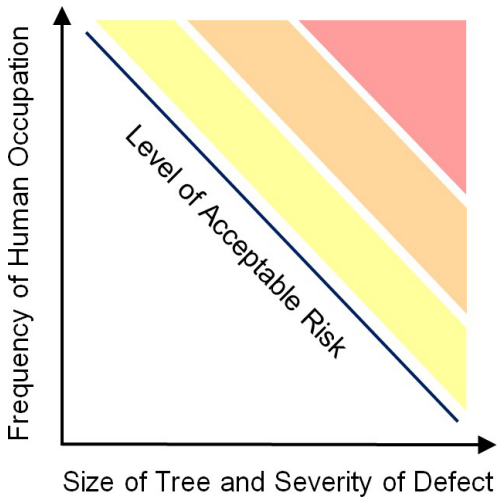
APPENDIX C
RISK ASSESSMENT & PRIORITY AND PROACTIVE MAINTENANCE

RISK ASSESSMENT

Every tree has an inherent risk of whole or partial tree failure. During the 2021 Glens Falls inventory, DRG performed a Level 2 qualitative risk assessment for each tree and assigned a risk

rating based on the ANSI A300 (Part 9), and the companion publication *Best Management Practices: Tree Risk Assessment* (ISA 2011). Trees can have multiple potential modes of failure, each with its own risk rating. However, only one risk rating per tree was assigned during the inventory - the mode of failure with the greatest associated risk. The specified time period for the risk assessment was one year.



- **Likelihood of Failure**—Identifies a mode of 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.
  - Imminent – Failure may occur at any moment under normal weather conditions.
- **Likelihood of Impacting a Target**—Considers the rate of occupancy of targets within the target zone and any factors that could affect the failed tree or tree part as it falls towards the target.
  - Very low—The chance of the failed tree or branch impacting the target is remote.
    - Common on rarely used sites, including rarely used trails or trailheads
    - May occur in instances where target areas provide protection
  - Low—It is not likely that the failed tree or branch will impact the target.
    - Occasional use areas fully exposed to the tree
    - Frequently used areas partially exposed to the tree
    - Constant use areas that are well protected from the tree

- 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 areas 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.

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 the target and the 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
    - 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 to traffic or utilities, or personal injury.
    - 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.

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

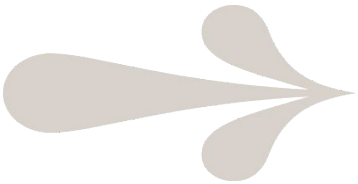
Trees have the potential to fail in more than one way and can affect multiple targets.

Tree risk assessors identified the tree failure mode having the greatest risk and reported that as the tree risk rating. Generally, trees with the highest qualitative risk ratings should receive corrective treatment first. The following risk ratings were 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 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. In special situations, such as a memorial tree or a tree in a historic area, Ballston Spa 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:

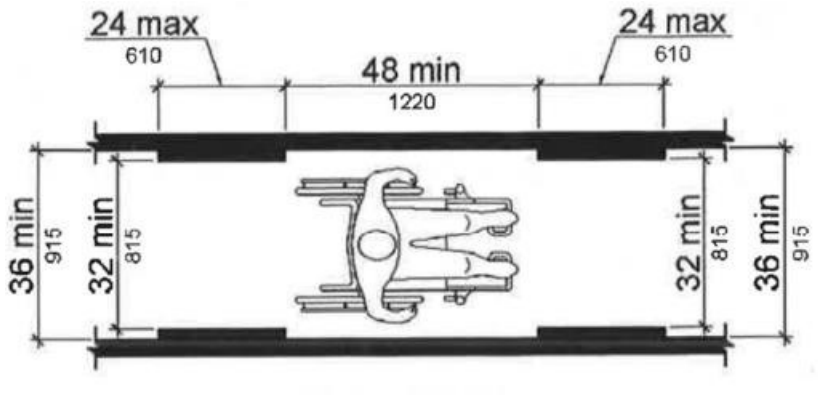
- Lower frequency and severity of accidents, damage, and injury
- Less expenditure for claims and legal expenses
- Healthier, longer-lived trees
- Fewer tree removals over time
- Lower tree maintenance costs over time

Regularly inspecting trees and establishing tree maintenance cycles generally reduce the risk of failure, as problems can be found and addressed before they become significant hazards.

APPENDIX D
DEPARTMENT OF TRANSPORTATION GUIDELINES: AMERICAN WITH DISABILITY ACT

MINIMUM WIDTH

Per 2010 ADA section 430.5.1, walking surfaces must be 36 inches wide minimum but can reduce to 32 inches wide at 'pinch points' for a run length of 24 inches. A minimum distance of 48 inches is required between any two consecutive 'pinch points'. See Diagram below, provided by the NYC Department of Transportation, Pedestrian Ramp Program.



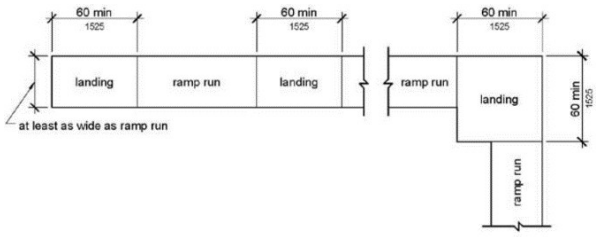
NYC Department of Transportation
Pedestrian Ramp Program
Sidewalk & Inspection Management Division
55 Water Street, 4th Floor, New York, NY 10041

SIDEWALK SLOPE

Sidewalk running slopes should follow the curb grade (roadway grade). Sidewalk running slopes exceeding 5% are not compliant with ADA standards, unless the roadway grade exceeds 5% (in which case completion of DOT's Technical Infeasibility Form is required).

STANDARD ADA RAMP SLOPE

- Running slope up to 8.3% are permitted under the following conditions:
    - Maximum rise of 5.5 inches.



    - Maximum slope is 7.5%.
    - Provide flat (maximum cross slope of 1.5%) landing area at top and bottom of the sloped area for a length of 60 inches minimum.

- Ramps with slopes greater than 8.3% are only allowed where necessary due to space limitations (as per 2010 ADA table 405.2).
- Cross slopes not to exceed 1.5%.
- Maintain positive drainage toward street.
- All grades to meet existing site features; trees, intersecting sidewalks, curbs and roads, building entrances, stoops, driveways, etc.

APPENDIX E
SUGGESTED TREE SPECIES FOR ZONE 5

Small Trees 15 ft. – 30 ft.

Genus Species	Common Name	Crown Shape	Shade	Part Sun	Full Sun	Drought Tolerance
Amelanchier arborea	common serviceberry	Upright, Vase		x	x	moderate
Amelanchier canadensis	Canadian serviceberry	Upright, Vase		x	x	moderate
Cercis canadensis	eastern redbud	Round, Vase		x	x	high
Cornus alternifolia	pagoda dogwood	round		x	x	moderate
Cornus kousa	Kousa dogwood	Round		x	x	moderate
Cornus mas	cornelian cherry dogwood	Round		x	x	moderate
Crataegus crus-galli var. inermis	hawthorn thornless	Round, Vase			x	high
Crataegus phaenopyrum	hawthorn Washington	Round, Vase			x	high
Crataegus viridis	green hawthorn	Round, Vase			x	high
Maackia amurensis	amur maackia	Round, Vase			x	high
*Magnolia × soulangiana**	saucer magnolia	Round, Upright		x	x	moderate
*Magnolia stellata**	star magnolia	oval		x	x	moderate
*Magnolia tripetala**	umbrella magnolia	spreading	x	x	x	moderate
*Magnolia virginiana**	sweetbay magnolia	Columnar, Vase		x	x	moderate
Malus spp.	flowering crabapple	Oval, Spreading			x	moderate
Oxydendrum arboreum	sourwood	Oval, Pyramidal		x	x	moderate
Prunus subhirtella	Higan cherry	upright or weeping			x	moderate
Prunus virginiana	common chokecherry	Upright, Round		x	x	moderate
Stewartia ovata	mountain stewartia	spreading	x	x	x	low
*Styrax japonicus**	Japanese snowbell	round, vase		x	x	moderate
Ilex × attenuata	Foster's holly	upright, pyramidal		x	x	moderate

Medium Species 31 ft. - 45 ft.

Genus Species	Common Name	Crown Shape	Shade	Part Sun	Full Sun	Drought Tolerance
Acer sacruim	hedge maple	Rounded			x	moderate
Aesculus × carnea	red horsechestnut	Round, Pyramidal			x	moderate
*Asimina triloba**	pawpaw	Pyramidal	x	x	x	high
Chamaecyparis thyoides	Atlantic whitecedar	upright, columnnar		x	x	high
Cladrastis kentukea	American yellowwood	Round, Vase		x	x	moderate
Corylus colurna	Turkish filbert	Oval, Pyramidal		x	x	moderate
Eucommia ulmoides	hardy rubber tree	Upright, Narrow Oval			x	high
Ostrya virginiana	American hophornbeam	Oval, Round	x	x	x	low
Parrotia persica	Persian parrotia	Upright, Vase		x	x	high
Pistacia chinensis	Chinese pistache	Oval, Round, Spreading, Vase		x	x	high
Prunus maackii	amur chokecherry	Pyramidal	’ round	x	x	moderate
Prunus sargentii	Sargent cherry	Columnar, Upright, Vase			x	high
Quercus acutissima	sawtooth oak	Round, Pyramidal			x	high
Quercus cerris	European turkey oak	Round, Pyramidal		x	x	high
Sassafras albidum	sassafras	oval		x	x	moderate
Juniperus virginiana	eastern redcedar	Pyramidal		x	x	high
Pinus flexilis	limber pine	Upright, Pyramidal		x	x	high
Thuja occidentalis	eastern arborvitae	Pyramidal	x	x	x	moderate

Large Species: 45 ft and above

Genus Species	Common Name	Crown Shape	Shade	Part Sun	Full Sun	Drought Tolerance
× *Cupressocyparis leylandii*	Leyland cypress	pyramidal		x	x	high
Abies balsamea	balsam fir	pyramidal		x	x	low
Abies concolor	white fir	pyramidal		x	x	high
Aesculus flava	yellow buckeye	upright		x	x	moderate
Betula alleghaniensis	yellow birch	upright, spreading		x	x	moderate
Betula lenta	sweet birch	pyramidal		x	x	moderate
Betula nigra	river birch	Oval, Pyramidal, Upright		x	x	moderate
Betula papyrifera	paper birch	upright, spreading			x	low
Carpinus betulus	European hornbeam	Columnar, Pyramidal, Upright		x	x	high
Carya cordiformis	bitternut hickory	upright			x	high
Carya ovata	shagbark hickory	upright		x	x	high
Castanea mollissima	Chinese chestnut	round		x	x	high
Celtis occidentalis	common hackberry	Oval, Upright		x	x	high
Cercidiphyllum japonicum	katsuratree	Oval, Spreading, Pyramidal, Upright		x	x	moderate
Chamaecyparis nootkatensis	Nootka falsecypress	Pyramidal		x	x	moderate
Cryptomeria japonica	Japanese cryptomeria	Pyramidal			x	high
Diospyros virginiana	common persimmon	spreading		x	x	high
Fagus grandifolia	American beech	Oval, Pyramidal	x	x	x	moderate
Fagus sylvatica	European beech	Upright, Oval		x	x	moderate
Ginkgo biloba	ginkgo	Round, Pyramidal		x	x	high
Gleditsia triacanthos inermis	thornless honeylocust	vase		x	x	high
Gymnocladus dioicus	Kentucky coffeetree	oval		x	x	high
Ilex opaca	American holly	Pyramidal	x	x	x	high
Juglans nigra	black walnut	round			x	low
Larix decidua	European larch	round			x	high

Genus Species	Common Name	Crown Shape	Shade	Part Sun	Full Sun	Drought Tolerance
Liquidambar styraciflua	American sweetgum	oval, pyramidal		x	x	moderate
Liriodendron tulipifera	tuliptree	Oval, Upright		x	x	moderate
Magnolia acuminata	cucumbertree magnolia	pyramidal		x	x	moderate
Magnolia macrophylla	bigleaf magnolia	oval		x	x	low
Metasequoia glyptostroboides	dawn redwood	pyramidal		x	x	moderate
Nyssa sylvatica	black tupelo	Oval, Pyramidal		x	x	high
Pinus strobus	eastern white pine	Oval, Pyramidal		x	x	moderate
Pinus sylvestris	Scotch pine	Oval			x	high
Pinus taeda	loblolly pine	oval		x	x	high
Pinus virginiana	Virginia pine	round			x	high
Platanus × acerifolia	London planetree	Round, Spreading, Pyramidal			x	high
Platanus occidentalis	American sycamore	oval			x	high
Psedotsuga menziesii	Douglas-fir	upright pyramidal		x	x	high
Quercus alba	white oak	Round, Pyramidal		x	x	moderate
Quercus bicolor	swamp white oak	Oval, Round		x	x	moderate
Quercus coccinea	scarlet oak	Round			x	moderate
Quercus imbricaria	shingle oak	Oval, Round, Pyramidal			x	high
Quercus lyrata	overcup oak	Oval, Round		x	x	moderate
Quercus macrocarpa	bur oak	Round, Spreading			x	high
Quercus montana	chestnut oak	oval			x	high
Quercus muehlenbergii	chinquapin oak	Round, Spreading			x	high
Quercus palustris	pin oak	Pyramidal			x	moderate
Quercus phellos	willow oak	Round, Pyramidal			x	high
Quercus robur	English oak	Columnar, Upright			x	high
Quercus rubra	northern red oak	Round			x	high
Quercus shumardii	Shumard oak	Oval, Round			x	high
Quercus velutina	black oak	Round, Spreading			X	high

Genus Species	Common Name	Crown Shape	Shade	Part Sun	Full Sun	Drought Tolerance
Styphnolobium japonicum	Japanese pagodatree	Round			x	high
Taxodium distichum	common baldcypress	Upright, Columnar			x	high
Tilia americana	American linden	Oval, Pyramidal		x	x	moderate
Tilia cordata	littleleaf linden	Pyramidal			x	moderate
Tilia tomentosa	silver linden	Oval, Pyramidal		x	x	moderate
Tsuga canadensis	eastern hemlock	upright pyramidal	x	x	x	low
Ulmus parvifolia	Chinese elm	Vase			x	moderate

APPENDIX F
TREE-SIDEWALK CONFLICT RATINGS AND RECOMMENDATIONS

Site ID	Address	Species	DBH	Location	Clearance	Lift	Flags	Tree Condition	Total Trees	Score	Recommendation
1273	28 Eastern Ave	Maple, Red	24	2	4	5	7	3	2	3.85	Ramping
1277	28 Eastern Ave	Maple, Red	21	2	4	5	7	3	2	3.85	Ramping
1342	21 Eastern Ave	Maple, Norway	21	2	4	5	5	3	2	3.65	Ramping
1349	21 Eastern Ave	Maple, Norway	14	2	4	5	5	3	2	3.65	Ramping
1366	22 Columbia Ave	Oak, Pin	29	1	4	5	3	4	3	3.6	Ramping
510	123 Milton Ave	Honeylocust, Thornless	18	4	4	4	3	3	1	3.4	Expansion
905	92 South St	Maple, Sugar	16	2	4	4	5	3	2	3.4	Curving
1287	60 Chapman St	Maple, Norway	22	2	4	4	3	3	4	3.4	Ramping
1368	22 Columbia Ave	Honeylocust, Thornless	19	1	4	5	3	3	3	3.4	Ramping
1401	47 Malta Ave	Maple, Norway	36	3	4	5	2	3	1	3.4	Curving
411	101 Milton Ave	Honeylocust, Thornless	19	4	3	3	5	3	3	3.35	Expansion/Ramping
530	2 Front St	Honeylocust, Thornless	16	4	4	3	3	3	3	3.35	Curving/Expansion
1245	162 Malta Ave	Maple, Norway	15	2	4	4	3	3	3	3.3	Curving/S
1249	162 Malta Ave	Maple, Norway	15	2	4	4	3	3	3	3.3	Curving/S
430	93 Milton Ave	Honeylocust, Thornless	17	4	4	3	4	3	1	3.25	Expamsion/ Ramping
1326	36 Columbia Ave	Maple, Norway	42	1	4	5	3	3	1	3.2	Removal
1334	74 Chapman St	Maple, Red	14	2	4	4	4	3	1	3.2	Ramping
1512	162 Thompson St	Maple, Norway	20	2	4	3	5	2	4	3.15	Removal
1217	97 Saratoga Ave	Maple, Red	41	2	4	4	3	3	1	3.1	Ramping

Site ID	Address	Species	DBH	Location	Clearance	Lift	Flags	Tree Condition	Total Trees	Score	Recommendation
1596	95 Eastern Ave	Maple, Red	19	2	3	3	5	3	3	3.05	Curving/Ramping
1324	20 Chapman St	Maple, Norway	23	2	3	4	4	3	1	3	Curving
1575	262 Milton Ave	Ash, Green	13	4	1	4	5	3	1	3	Expansion
750	10 E North St	Maple, Red	26	1	4	4	3	3	1	2.95	Curving
1408	69 Hyde Blvd	Maple, Red	21	1	3	4	4	3	2	2.95	Curving
500	124 Milton Ave	Honeylocust, Thornless	14	4	2	3	3	4	1	2.95	Expansion
503	72 Ford St	Maple, Norway	21	2	4	2	5	3	2	2.9	Curving
1339	19 Hyde Blvd	Maple, Red	19	1	4	3	4	3	2	2.9	Curving
1265	15 Saratoga Ave	Maple, Norway	18	2	3	3	5	3	1	2.85	Ramping
1328	19 Hyde Blvd	Maple, Red	24	1	4	2	4	4	2	2.85	Curving
1355	52 Chapman St	Walnut, Black	28	2	3	3	3	3	3	2.85	Ramping
1539	90 Eastern Ave	Maple, Norway	23	2	3	5	4	1	1	2.85	Ramping
300	93 Bath St	Stump	12	1	4	3	4	3	1	2.8	Curving
343	143 Milton Ave	Maple, Norway	34	1	4	3	4	3	1	2.8	Ramping
908	16 Glen St	Ash, Green	13	1	4	3	4	3	1	2.8	Curving/ Strengthening
1329	59 Chapman St	Maple, Norway	16	2	3	4	1	3	2	2.8	Ramping
548	136 Bath St	Maple, Norway	27	1	4	2	5	3	2	2.75	Curving
1234	15 N High St	Maple, Norway	23	1	3	4	3	3	1	2.75	Ramping
864	114 South St	Vacant site small	0	2	4	2	3	3	2	2.7	Curving/ Strengthening
1318	21 Hyde Blvd	Maple, Red	23	1	3	3	4	3	2	2.7	Curving
1393	31 Malta Ave	Maple, Red	10	3	3	3	2	3	1	2.7	Curving
1543	239 Milton Ave	Ash, Green	18	4	3	2	3	3	1	2.7	Expansion/Ramping
1270	27 Chapman St	Maple, Norway	15	2	3	3	2	3	2	2.65	Ramping

Site ID	Address	Species	DBH	Location	Clearance	Lift	Flags	Tree Condition	Total Trees	Score	Recommendation
1684	9 Ballston Ave	Maple, Norway	22	1	4	2	5	3	1	2.65	Curving/ Strengthening
1565	284 Milton Ave	Ash, Green	14	4	2	3	1	3	1	2.55	Expansion/Ramping
638	60 Ballston Ave	Maple, Norway	30	1	3	2	5	3	1	2.45	Curving
1259	25 Saratoga Ave	Maple, Norway	21	2	4	2	1	3	1	2.40	Ramping
1337	34 Columbia Ave	Maple, Norway	23	1	3	3	2	3	1	2.4	Curving
1344	32 Columbia Ave	Maple, Norway	13	1	3	3	2	3	1	2.4	Curving
760	14 E North St	Stump	11	1	4	3	3	1	1	2.3	Removal
799	49 Division St	Maple, Red	21	1	3	3	1	3	1	2.3	Strenthening
1228	17 N High St	Locust, Black	1	1	2	3	3	3	1	2.3	Curving
1516	223 Milton Ave	Ash, Green	15	4	2	1	3	3	1	2.25	Expansion
1282	27 Chapman St	Maple, Norway	19	2	2	3	2	2	2	2.25	Curving
1533	233 Milton Ave	Ash, Green	16	4	2	1	2	3	2	2.25	Expansion/Ramping
769	22 E North St	Maple, Norway	18	1	4	1	3	3	1	2.2	Ramping
771	31 Glen St	Stump	46	1	4	2	3	1	1	2.05	Removal
1289	101 Saratoga Ave	Maple, Sugar	30	2	3	1	2	3	1	2.05	Curving
1549	84 Eastern Ave	Maple, Red	21	2	3	1	2	3	1	2.05	Curving/S
1343	10 Heritage Pl	Maple, Silver	31	1	3	1	1	3	1	1.8	Curving