DAVEY Resource Group

January 2021

South Linden Tree Inventory Summary Report

City of Columbus, Ohio

Prepared for:

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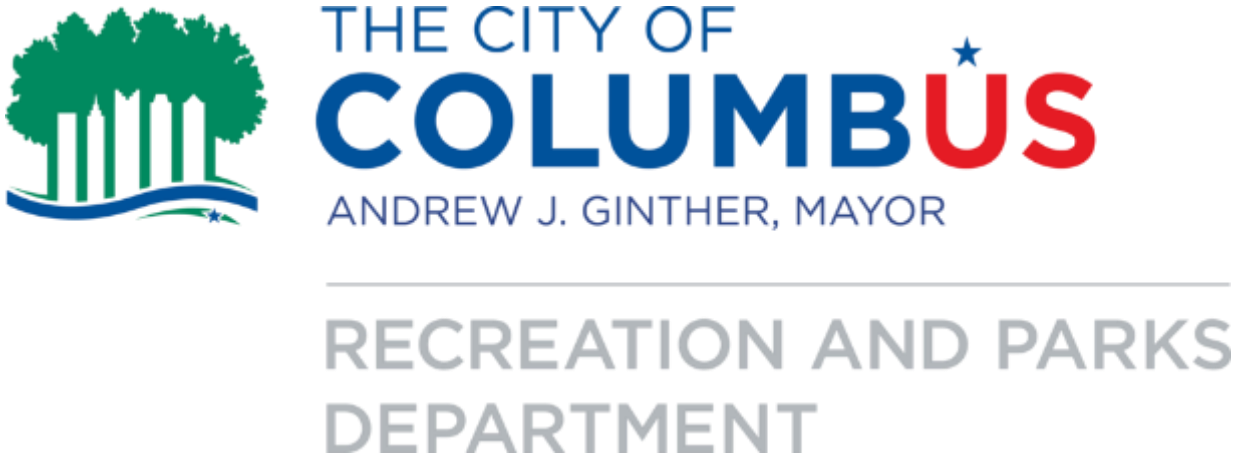
ACKNOWLEDGMENTS

This project supports the City of Columbus' vision of achieving citywide social equitability. The *South Linden Tree Inventory Summary Report* offers analytical expertise designed to aid in preserving and expanding the public tree resource within the South Linden community. The primary objective of this project is to aid city managers and community stakeholders in their efforts to maximize the environmental, economic, and social benefits provided by South Linden's trees today and into the future.

The City of Columbus recognizes the support of its Mayor and dedicated civil servants within the Recreation and Parks Department:

- Andrew J. Ginther, Mayor
- Paul Rakosky, Interim Director
- James Long, City Forester
- Troy Euton, Assistant Director
- Jim Gates, Project Manager
- Rosalie Hendon, Project Manager
- Craig Seeds, Operation and Maintenance Division Manager
- John Bowers, Forestry GIS Analyst



The South Linden 2020 Street Tree Inventory: Summary Report and Planting Plan

EXECUTIVE SUMMARY

The *South Tree Inventory Summary Report*, written by Davey Resource Group, Inc. "DRG", presents the results of an update to the city's existing street tree inventory within the South Linden neighborhood. The City of Columbus Recreation and Parks Department "CRPD" commissioned the tree inventory update and this report to achieve three primary objectives in support of the city's goal to replenish, restore, and enhance South Linden's community forest:

Objective 1 Understand the structure, composition, and maintenance needs of the existing public tree population located within South Linden's street rights-of-way (Section 1).

Objective 2 Quantify the environmental benefits and economic value provided by South Linden's inventoried trees (Section 2).

Objective 3 Develop a targeted tree planting plan for the South Linden neighborhood (Section 3).

Field data collection for the tree inventory update was completed in June 2020 by ISA Certified Arborists employed by DRG. The arborists collected data on trees, stumps, and potential future planting sites located within South Linden's public street rights-of-way. Parks and other public facilities were not included in this update. Key findings of the inventory and subsequent data analysis include:

Structure, Composition, and Maintenance

- There are 1,454 trees growing along South Linden streets comprised of 96 different species and cultivars.
- Amur maple (*Acer ginnala*) is the most frequently found tree growing along the street – accounting for nearly 11% of the population. Trees in the maple genus (*Acer*) constitute for 32% of all inventoried street trees in South Linden – which is above the industry's best management practice of the 20% genus distribution threshold.
- Most neighborhood trees were recorded in Good (59%) or Fair (32%) condition – with a low percentage of trees rated in Poor Condition (8%) or listed as Dead (2%).
- The size of South Linden's trees trend small – with 50% of the trees inventoried in the 0-8: trunk diameter size class. This small size class represents both young trees and those that have a small mature size (e.g., crabapple, Japanese tree lilac, etc.).
- DRG recommended 149 trees for removal, 17 trees for priority pruning, 383 trees for young tree training, and 923 trees for routine pruning.

Tree Benefits

South Linden's street trees provide the neighborhood with thousands of dollars in environmental benefits each year **– totaling around $3 million over the course of their lifetime** - and these are just the benefits that can be valued. The neighborhood's trees also provide important social, aesthetic, and health benefits, some of which are described below:

- **Cleans the air by annually removing over 540 lbs. of air pollutants – ozone, nitrogen dioxide, sulfur dioxide, and carbon monoxide**. This has a positive impact on human health, making it easier to breathe and by reducing respiratory issues.
- **Reduces temperatures by absorbing 18,000 lbs. of carbon dioxide each year.** Trees absorb carbon dioxide, which is a greenhouse gas that traps heat causing temperatures to rise in Columbus. The shade from trees also reduces the amount of heat that reaches roads and buildings, while leaves release water vapor (transpiration) – cooling the surrounding environment.
- **Helps reduce flooding by absorbing and intercepting 155,000 gals. of stormwater each year.** Tree canopies and roots intercept and absorb rainfall – reducing the amount entering the city's storm sewer system and helping to reduce flooding.
- **Enhances the neighborhood by strengthening ties between neighbors, encouraging children to play outdoors, reducing crime, and providing an overall sense of safety.** A 10% increase in neighborhood tree canopy cover has been associated with a 12–15% reduction in violent and property crimes (Troy 2012, Gilstad-Hayde 2015).
- **Improves the academic performance of students.** Trees near schools have been shown to increase student academic performance (Sivarajah 2018). Middle school students with more trees around their school have better test scores in reading and math (Kuo 2021).

Future Tree Planting

During the 2020 inventory update, 1,342 available sites were located along South Linden's streets to plant new trees. Using the tree inventory data and industry best management practices, CRPD worked in conjunction with DRG arborists to develop a targeted tree planting plan for South Linden designed to replenish and restore the neighborhood's stock of street trees. The plan considers the "right tree, right place" mantra and includes suggested tree species which will enhance the diversity and overall resiliency of the community forest. **Beginning in Fall 2020, the City of Columbus Recreation and Parks Department will begin implementation of the planting plan with the installation of over 460 new street trees throughout the South Linden neighborhood.** The newly installed trees will provide an immediate aesthetic impact and boost to the benefits provided by the community's street trees.

INTRODUCTION

The City of Columbus is home to 898,000 residents[1] who benefit from the city's public trees. The city has been a Tree City USA community for 41 years, annually meeting the requirements of recognition by maintaining a tree committee (Columbus Tree Sub-commission), a tree ordinance (Chapter 912), spending more than $2 per capita on tree maintenance, and celebrating Arbor Day. For over a century, staff within the Recreation and Parks Department's Forestry Division have demonstrated a commitment to the development of a thriving public tree resource throughout the City of Columbus.

The city's forestry program has ten International Society of Arboriculture Certified Arborists and is tasked with managing the health and safety of the city's trees, which includes the planting, pruning, and removal of trees in city parks and on city rights-of-way, addressing storm damage requests, as well as maintaining the Park of Roses. The Forestry Program is funded through the Recreation and Parks Operations Extension Fund (General Fund) for street tree maintenance and the Recreation and Parks Capital Improvement budget for street tree planting.

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. Past and current urban forestry projects, including the current in-progress effort to develop an Urban Forestry Master Plan, demonstrate Columbus' alignment with this approach and dedicated commitment to sustaining the public tree resource with higher levels of tree care. The city will utilize this report to plan and prioritize maintenance activities within the South Linden neighborhood.

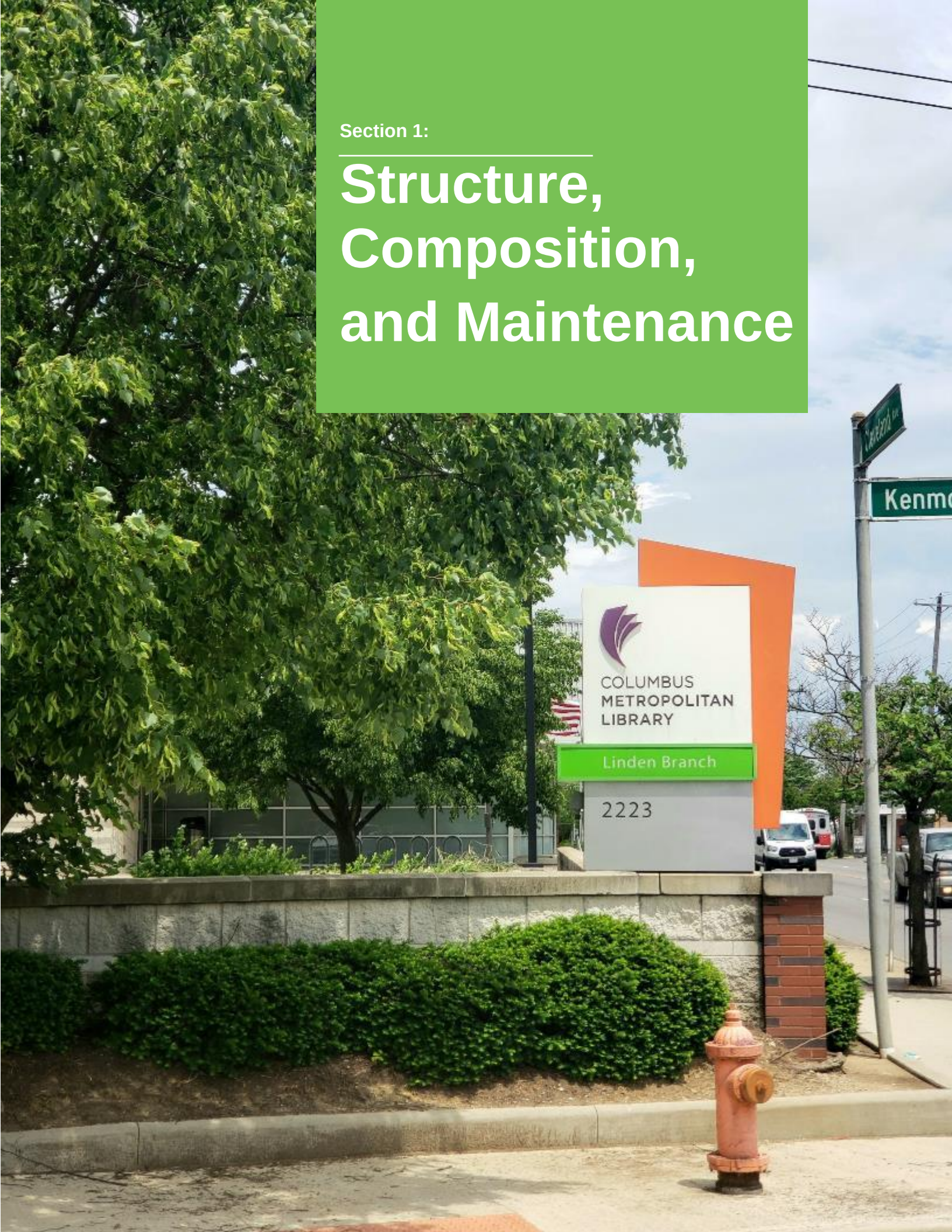
The city's urban forestry program is well on its way to creating a sustainable and resilient urban forest. In support of the public tree resource enjoyed by the residents of South Linden, the City of Columbus and the Columbus Recreation and Parks Department worked with DRG to inventory the neighborhood's street trees and develop *The South Linden Tree Inventory Summary Report*, consisting of three sections:

- **Section 1: Structure, Composition, & Maintenance** summarizes the inventory data with trends describing the current state of South Linden's inventoried trees and reports on recommended maintenance activities catalogued.
- **Section 2: Functions and Benefits** quantifies the environmental benefits and economic value of the inventoried trees and the benefits they provide for the community.
- **Section 3: Tree Planting Plan** presents a multi-year GIS-based plan for planting new trees within the rights-of-way of South Linden's streets.

[1] U.S. Census Bureau V2019, retrieved from: https://www.census.gov/quickfacts/columbuscityohio

Section 1:

Structure, Composition, and Maintenance



SECTION 1: STRUCTURE, COMPOSITION, AND MAINTENANCE

The Recreation and Parks Department designated the street rights-of-way (ROW) within the South Linden neighborhood as the project area for the tree inventory update. In June 2020, DRG arborists completed the update, which catalogued new data on existing trees, stumps, and vacant potential planting sites within the South Linden street ROW.

TOTAL SITES INVENTORIED

Of the total **3,192 inventoried sites**:

46% = Existing trees

42% = Planting sites

9% = Vacant sites unsuitable for planting

3% = Stumps

Figure 1 breaks down the total sites inventoried by type. Most vacant sites that are unsuitable for planting are locations where a tree existed at the time of the original inventory; that tree has since been removed, and the site is no longer viable for new plantings. Reasons for this include the proximity of utilities or the lack of sufficient growing space. See Appendix A for additional details about DRG's data collection methodology.

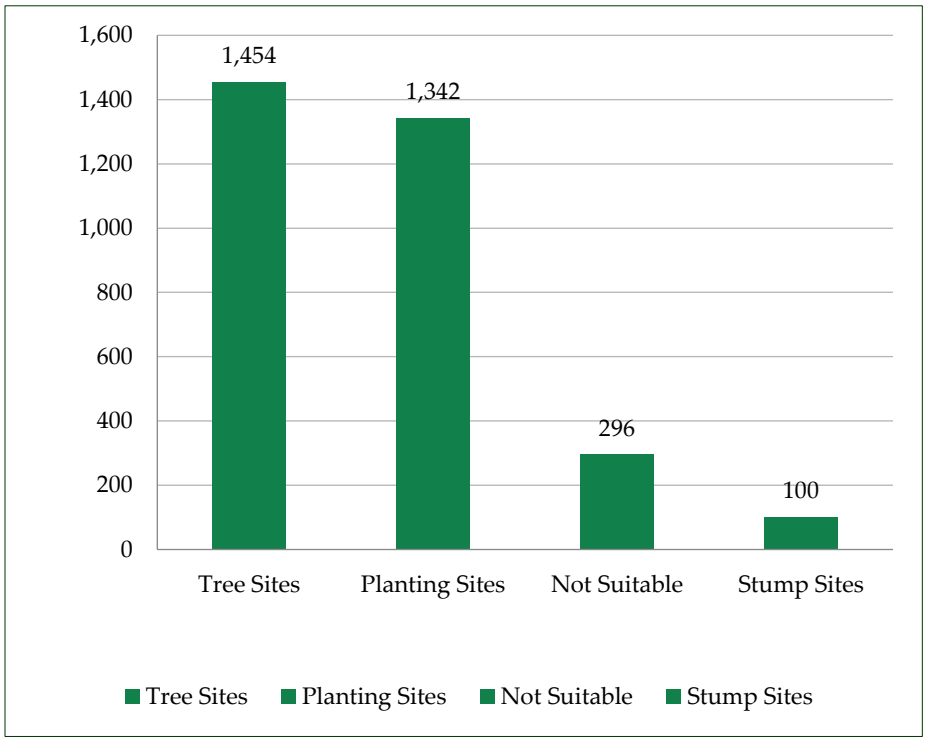


Figure 1. Number of inventoried sites by location and type.

TREE POPULATION DIVERSITY

The 10-20-30 rule is a common standard for assessing the diversity distribution of a given tree population (Santamour 1990). According to the rule, the composition of an urban tree population should have no more than:

- 10% of the trees from a single species.
- 20% of the trees from the same genus.
- 30% of the trees from one family.

The diversity analysis helps to measure a tree population's level of potential exposure to harmful pests and pathogens. The results of the analysis should be used to inform species selection in future tree planting initiatives.

Species Distribution

Figure 2 compares the top five most abundant tree species catalogued during the 2020 inventory to the 10% threshold. **Amur maple (*Acer ginnala*) is the only species above the recommended limit, accounting for 10.5% of all trees inventoried in South Linden.**

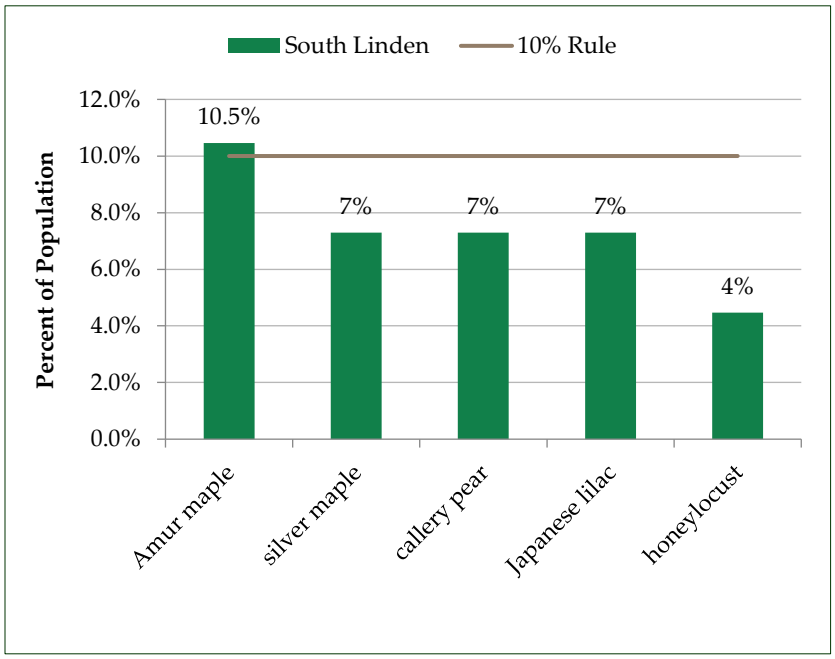


Figure 2. Species distribution of inventoried trees.

RESILIENCE THROUGH DIVERSITY

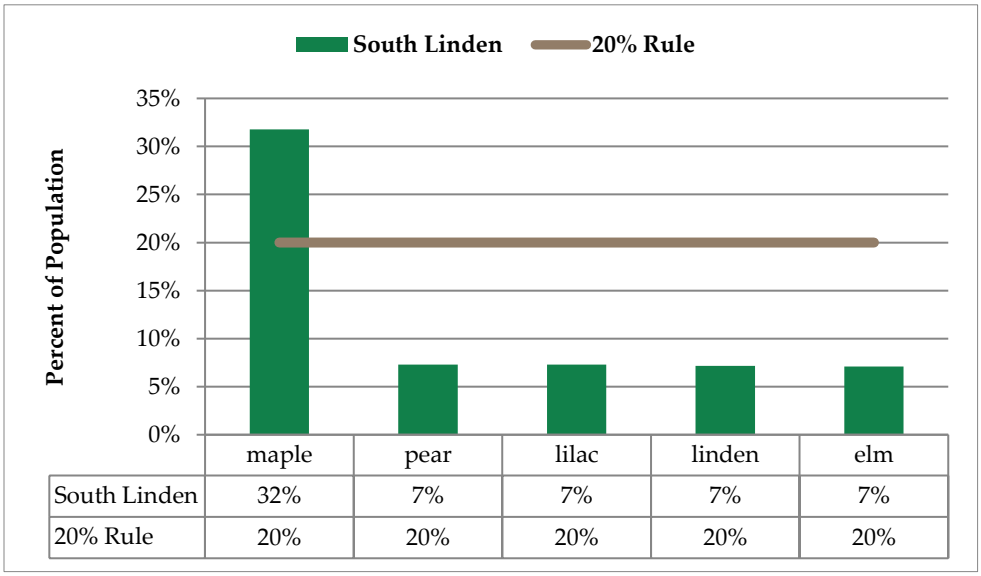
The Dutch elm disease epidemic of the 1930s provides a key historical lesson on the importance of diversity within a community forest. The disease killed millions of American elm trees, leaving behind enormous gaps in the urban canopy of many Midwestern and Northeastern communities. In the aftermath, 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 continue to threaten our urban forests, so it is 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. PHOTO CREDIT: USDA Forest Service (2017)

Genus Distribution

Some pathogens and pests, such as emerald ash borer (EAB, *Agrilus planipennis*), target an entire genus as its host. The genus diversity distribution offers a critical measure of a given population's resiliency to such attacks and helps managers to identify and remedy potential areas of overexposure.

Figure 3 compares the South Linden neighborhood's distribution of the most abundant inventoried tree genera compared to the ideal 20% threshold. **The data reveal that maple trees account for 32% of the entire inventoried population, which is significantly higher than the ideal threshold.**



	maple	pear	lilac	linden	elm
South Linden	32%	7%	7%	7%	7%
20% Rule	20%	20%	20%	20%	20%

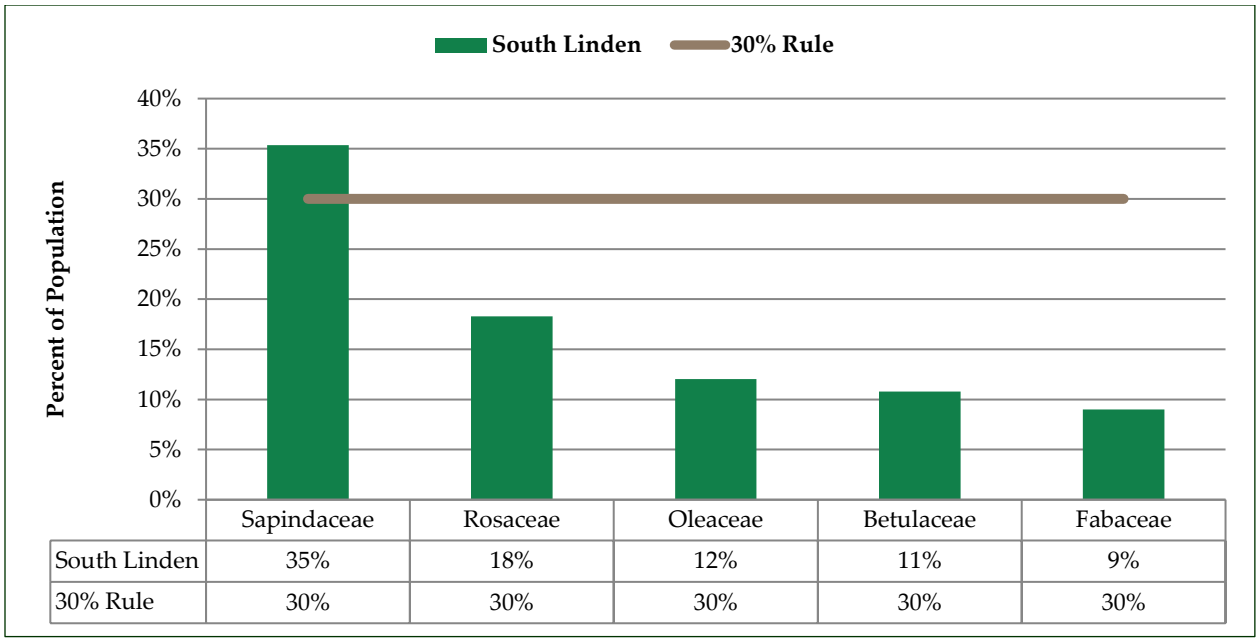
Figure 3. Genus distribution of inventoried trees.

Family Distribution

Just as some pests target specific genera, other pests target an entire family. For example, the bacterium *Erwinia amylovora*, commonly known as fireblight, affects plants in the rose family (Rosaceae), which includes serviceberry, hawthorn, apple, crabapple, cherry, plum, and pear. **Figure 4 compares the most abundant inventoried tree families in South Linden to the ideal 30% threshold and finds the most prevalent family, Sapindaceae, is above the recommended threshold, comprising 35% of the overall population.**

Tree Planting Recommendations

Based on the results of the 10-20-30 analysis, **DRG recommends limiting the installation of maple trees within the South Linden neighborhood until the species, genus, and family distributions normalize.** It should be noted that the results and recommendations of this report pertain only to the area of study—the South Linden neighborhood. Maple trees may be suitable for planting within the ROW elsewhere in the city, pending a 10-20-30 analysis of tree populations within those areas.



	Sapindaceae	Rosaceae	Oleaceae	Betulaceae	Fabaceae
South Linden	35%	18%	12%	11%	9%
30% Rule	30%	30%	30%	30%	30%

Figure 4. Family distribution of inventoried trees.

PEST SUSCEPTIBILITY

Early diagnosis of disease and pest infestation is essential to ensuring the health and continuity of a managed tree population. Figure 5 shows the percent of inventoried trees susceptible to some of the known pests in and around Ohio. **Spotted lantern fly (SLF, *Lycorma delicatula*) and Asian longhorned beetle (ALB, *Anoplophora glabripennis*) are known threats to a significant portion of South Linden's inventoried tree resource, with potential exposure at 42% and 40% of the entire population, respectively.**

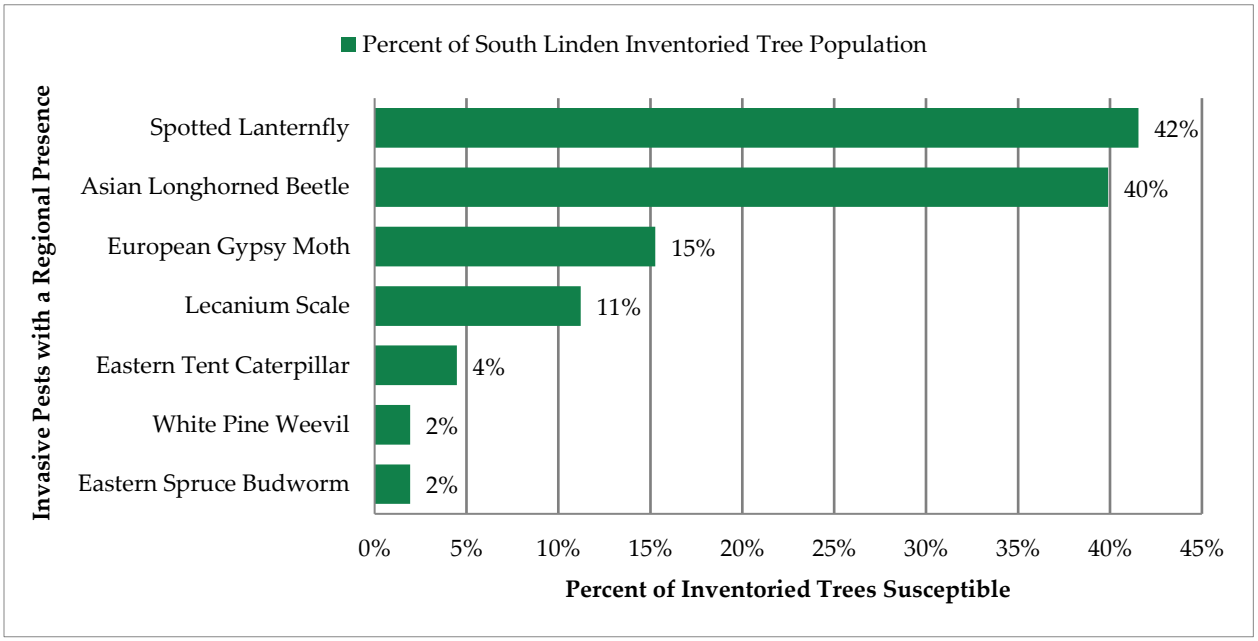


Figure 5. Tree resource susceptibility to invasive pests that have a regional presence.

Pest Susceptibility Recommendations

The overabundance of maple is a potential management concern. In the event of an outbreak of a pathogen or pest where maple are susceptible hostx, this overabundance represents more than just a potential significant resource loss; it also represents an extensive amount of viable habitat for the invading pests, making it easier for them to proliferate and spread. **Improving species diversity is a critical goal that will boost the resiliency of South Linden's tree resource in the event of future pest invasions and pathogen outbreaks.**

Columbus should inspect trees in the *Acer* genus for signs of SLF and ALB infestation on a routine basis to identify affected trees. Early detection and eradication will help prevent a widespread outbreak.

RELATIVE AGE DISTRIBUTION

Tree size can be used to analyze the relative age of given tree population and offer insight into the population's future maintenance needs. The analysis utilizes tree size as an approximation of tree age. South Linden's inventoried trees are 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 allow for comparison with an "ideal" relative age distribution (Richards 1983). Figure 6 compares South Linden's relative age distribution of the inventoried tree population to Richard's "ideal" age distribution. The analysis shows Young trees are overrepresented, while Maturing trees are underrepresented.

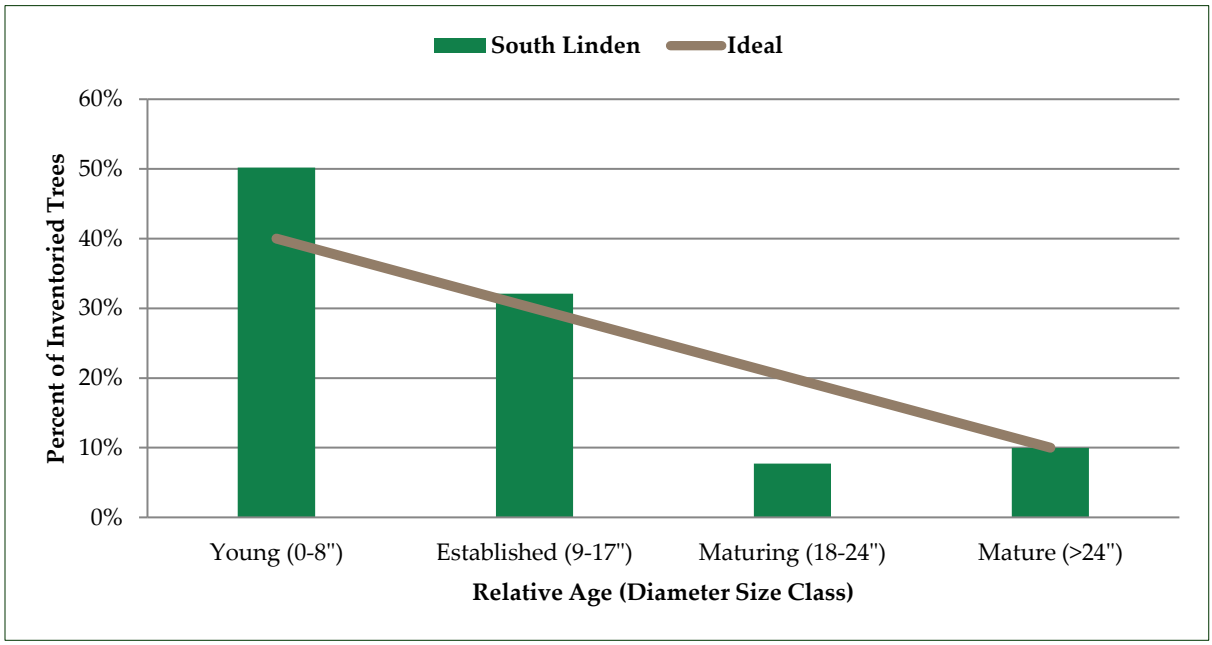


Figure 6. Relative age distribution of inventoried trees grouped by size class.

Figure 7 shows the relative age distribution and condition rating within each size classification. providing insight into the inventoried population's stability. Established trees have the lowest percentage of their age class represented by Poor and Dead trees (6% of the Established total). This is both positive and important, as these trees will age into Maturing, which is now an underrepresented category. However, 14% of the mature trees are in Poor and Dead condition, while 13% of the maturing trees are in Poor and Dead condition. This highlights the importance of proactive tree care over the next several years to mitigate against potential future underrepresentation of mature trees among the South Linden inventoried tree resource. The healthier South Linden's trees remain, the easier it will be for South Linden to return to the ideal distribution.

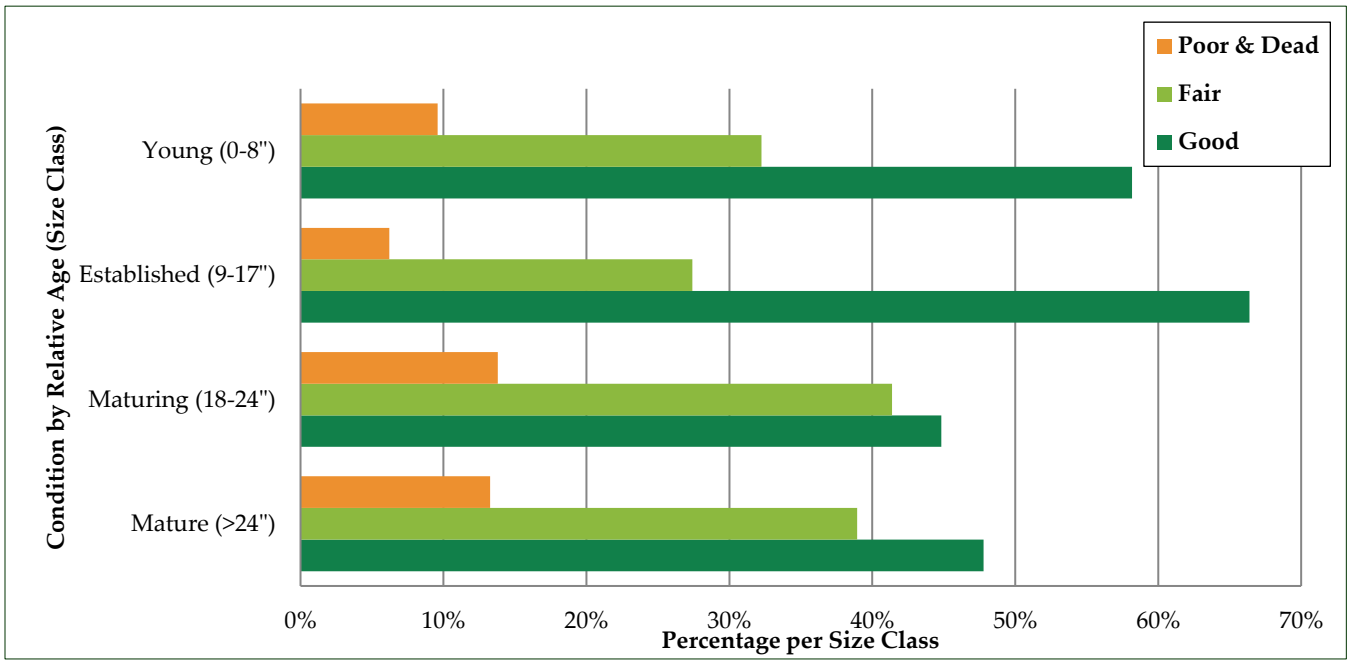


Figure 7. Condition of inventoried trees by relative age class.

Relative Age Recommendations

While South Linden has an excess of young trees and a shortage of maturing trees, the neighborhood has a low overall percentage of trees in Poor condition, indicating that young trees have strong potential of reaching maturity if they are well maintained. DRG recommends that Columbus implement a robust maintenance program within South Linden to conserve and enhance the condition of young trees as they age so they successfully replace removed trees and fill canopy gaps in maturity. The city should also focus on tree preservation and proactive care to protect mature and maturing trees from unnecessary or premature removal and to prevent them from succumbing to treatable defects. In the short term, prioritizing proactive maintenance above tree planting will help achieve a shift in the relative age distribution back towards the ideal over the long term.

OVERALL CONDITION IS GOOD

The condition of each inventoried tree was recorded and rated by an arborist as Good, Fair, Poor, or Dead. Several factors affecting condition were considered for each tree, including root characteristics, branch structure, trunk, canopy, foliage condition, and the presence of pests. Figure 8 presents the breakdown of condition rating for South Linden's inventoried trees.

The general health of the inventoried tree population is characterized by the most prevalent condition assigned during the inventory. **In South Linden, the general health of the inventoried population is rated as Good**.

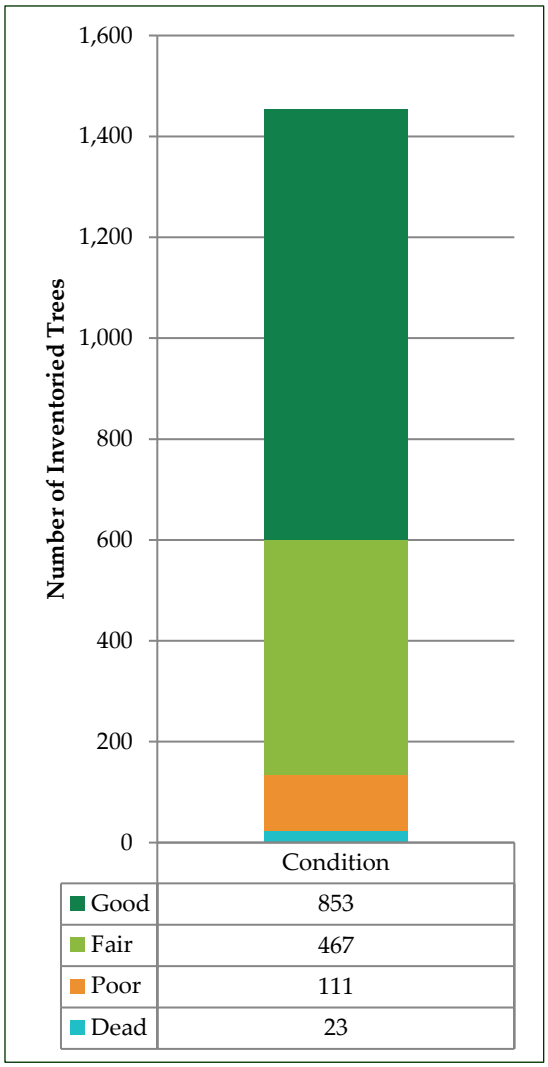


Figure 8. Condition of inventoried trees.

Condition Recommendations

Dead trees and most trees in Poor condition should be removed as soon as possible; the health of these trees is unlikely to recover even with increased care, and their existence presents potential risk.

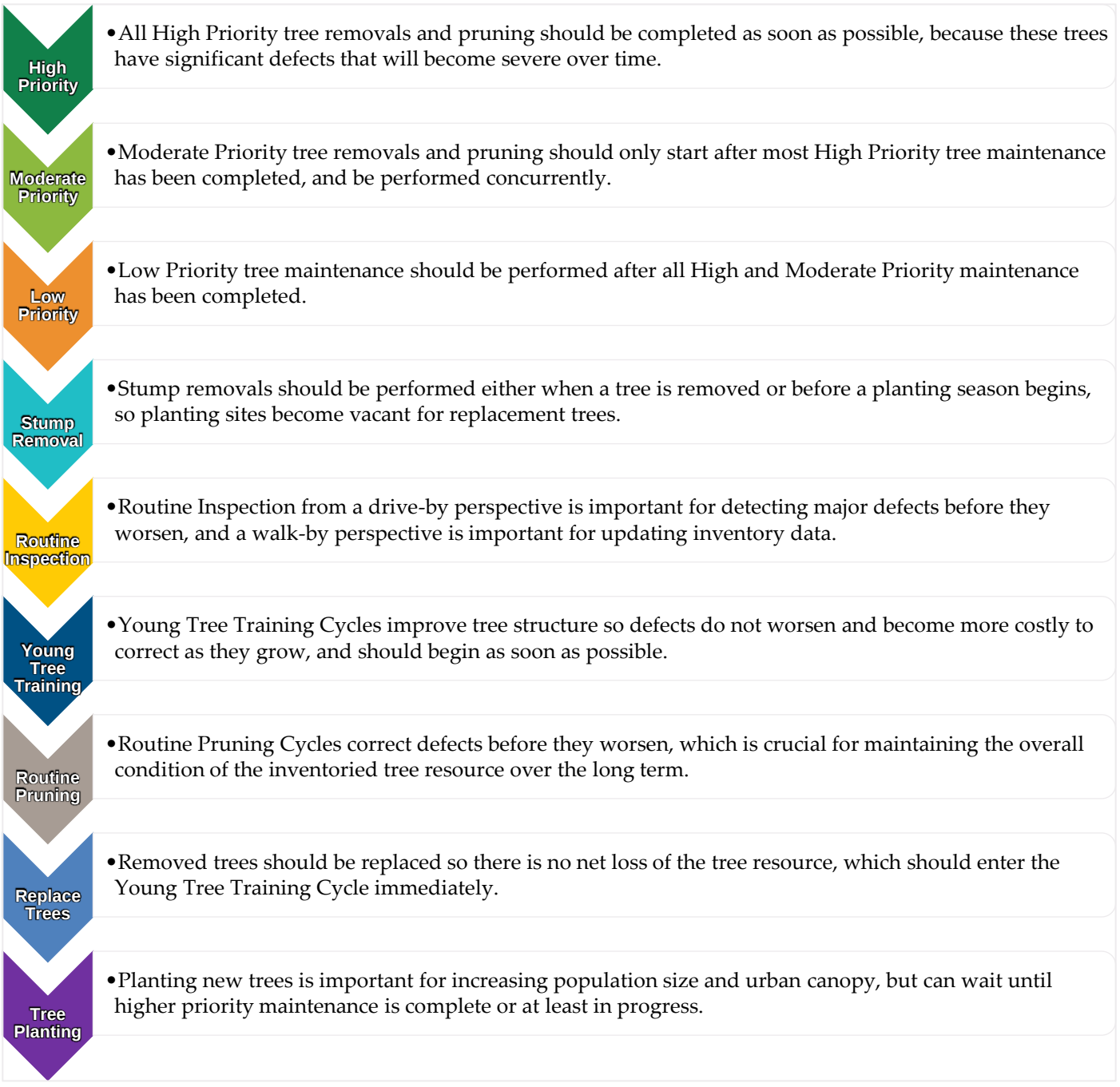
Younger trees rated in Fair or Poor condition may benefit from structural pruning to improve their health over time. Pruning should follow ANSI A300 (Part 1) guidelines.

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. If retained, these trees will likely require corrective pruning and intensive plant health care to improve their vigor. Routine inspection is required to monitor for worsening conditions.

RECOMMENDED TREE MAINTENANCE

Proactive Approach

During the inventory, both a risk rating and a recommended maintenance activity were assigned to each tree. DRG recommends a prioritized and proactive approach to tree maintenance where items with elevated risk are given precedence. Specifically, highest priority is given to recommended tree removal and pruning activities rated as Extreme and High risk. The following flow chart illustrates the progression of a prioritized and proactive maintenance program:



Importance of Pruning Cycles

Over time, routine pruning can minimize reactive maintenance, limit instances of elevated risk, and provide the basis for a robust risk management program. DRG recommends a routine pruning cycle for the inventoried trees within South Linden. **Though the total length of the cycle can vary, it is generally recommended not to approach or exceed a length of ten years between prunings**. The ten-year mark is where research shows tree condition begin to deteriorate significantly without regular pruning (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.

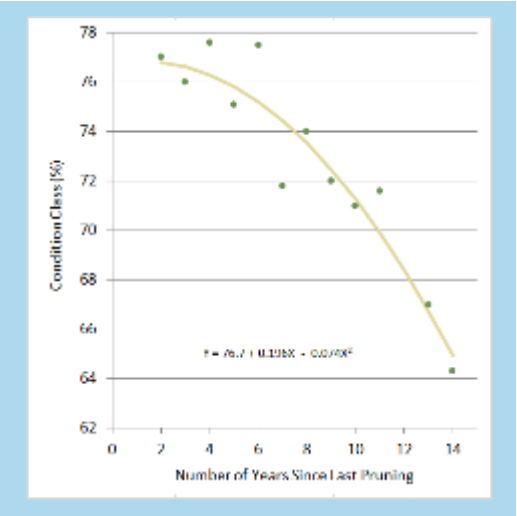


Figure 9. Relationship between tree condition and years since previous pruning (adapted from Miller and Sylvester 1981).

DRG recommends two categories of pruning cycle: Young Tree Training and Routine Pruning. Trees included in the Young Tree Training cycle are generally less than 8 inches DBH. These younger trees sometimes 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, increasing its risk rating and creating potential liability. 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.

Recommended Maintenance Activities

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 = 149 trees
High Priority = 4 trees
Moderate Priority = 13 trees

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 = 17 trees
High Priority = 0 trees
Moderate Priority = 17 trees

Routine Pruning Cycle

Over time, routine pruning minimizes the occurrence of reactive maintenance, and provides the foundation for a successful tree risk management program.

Total = 923 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 = 383 trees

Tree Planting

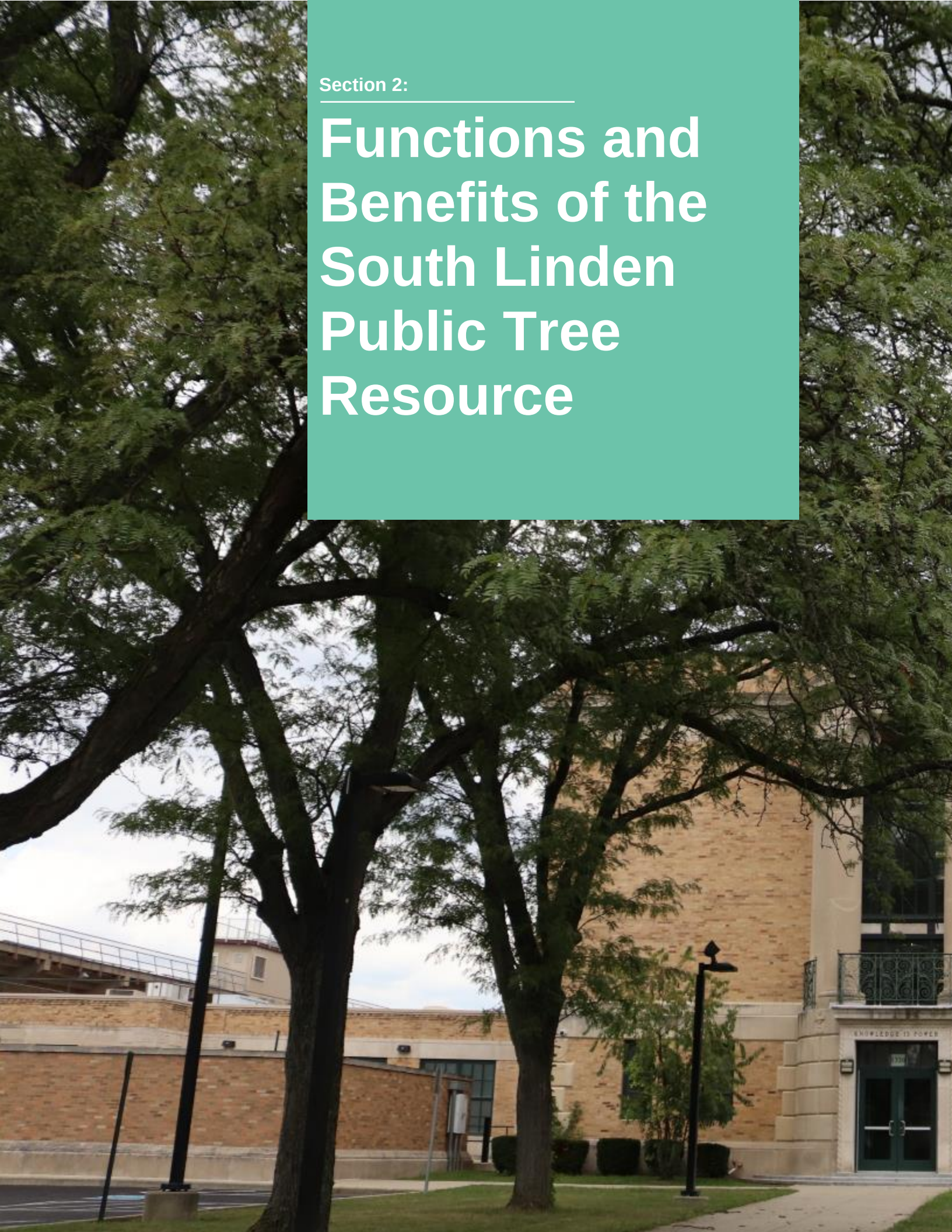
Planting new trees in areas that have poor canopy continuity is important, as is planting trees where there is sparse canopy, to ensure that tree benefits are distributed evenly across the city.

Total new plantings = 1,342

Routine Tree Inspection

Routine inspections are essential to uncovering potential tree and tree-related problems 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 assessments per year, assuming a seven-year maintenance cycle:
Drive-by assessment = at least 430 trees
Walk-by assessment = at least 185 trees



Section 2:

Functions and Benefits of the South Linden Public Tree Resource

SECTION 2: FUNCTIONS AND BENEFITS

Urban environments present unique challenges to daily life, and trees occupy a vital role in that environment by providing of a wide array of economic, environmental, and social benefits that far exceed the investments in 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. Advanced analytics, such as i-Tree Eco and the i-Tree software suite, are furthering our understanding of the importance of trees to the well-being of our communities by estimating the monetary value of the ecosystem services trees provide.

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 gals. 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).

$3 MILLION TOTAL VALUE

DRG performed an i-Tree Eco benefits analysis on the South Linden inventory. i-Tree Eco is an analytical tool that uses the unique data collected during an inventory to quantify tree benefits. In South Linden, the inventory data allowed the i-Tree eco model to quantify and monetize both structural value and functional benefits including carbon removal and storage, air pollution removal, and surface runoff avoidance (Table 1).

Table 1. Value Annually of the South Linden Inventoried Trees

South Linden Ecosystem Benefits	Benefits	
	Quantity	Value
Air: CO (carbon monoxide) removed	9 lbs.	$6
Air: NO_2 (nitrogen dioxide) removed	72 lbs.	$25
Air: O_3 (ozone) removed	451 lbs.	$859
Air: SO_2 (sulfur dioxide) removed	1 lbs.	$0
Air: PM2.5 particulate matter (dust, soot, etc.) removed	17 lbs.	$1,174
Carbon sequestered	9 tons	$1,541
Current stored carbon	696 tons	$118,634
Stormwater: reduction in runoff	155,795 g	$1,392
Structural Value		$2,947,993
Total Value		$3,071,624

STRUCTURAL VALUE

The structural value, also known as compensatory value or replacement value, represents the value of the actual trees (e.g., the cost to replace a given tree with an identical one of the same size and species). The structural value of an urban forest tends to increase with a rise in the number and size of healthy trees (Nowak et al. 2002a). The replacement value of South Linden's inventoried tree resource is estimated to be $2,947,923 annually.

CARBON REMOVAL AND STORAGE

Trees are carbon sinks, which are the opposite of carbon sources. While carbon is emitted from cars and smokestacks, carbon is absorbed into trees during photosynthesis and stored in their tissue as they grow. As the primary greenhouse gas driving climate change, carbon dioxide (CO_2) impacts people, property, and the environment. The i-Tree Eco model estimates both the carbon sequestered each year and total carbon stored.

- South Linden's inventoried trees annually sequester (i.e., remove) over 18,000 lbs. of carbon from the air.
- Over their lifetime, South Linden's inventoried trees have stored 1,391,160 lbs. of carbon valued at $118,634.
- Among the tree species found during the inventory, silver maple (*Acer saccharinum*) stores and sequesters the most carbon, averaging 3,615 lbs. of stored carbon per tree and 27 lbs. of carbon sequestration per tree annually.

STORMWATER CONTROL

Stormwater runoff can cause flooding and sewer overflow, both of which negatively impact the entire community. Trees can mitigate these negative impacts. Leaves and branches catch rainfall before it reaches the ground. Roots create more pore space in the soil which allows more stormwater to soak into the ground to be taken up by plants via transpiration. **Specific to South Linden, the i-Tree Eco analysis found that the inventoried tree resource reduces stormwater runoff by an estimated 155,795 gals. per year.**

Of all species inventoried, silver maple contribute the most annual stormwater benefits. The silver maple population, accounting for 7.3% of all inventoried trees, avoided approximately 30,803 gals. of runoff. By comparison, the most abundant species in the inventory, the Amur maple (10.5% of the population), only avoided approximately 4,445 gals. of runoff.

On a per-tree basis, larger trees with leafy canopies provide greater levels of functional benefits. For example, callery pear (*Pyrus calleryana*) and Japanese lilac tree (*Syringa reticulata*) comprised almost equal proportions of the inventoried tree resource, 7.3% and 7.2%, respectively. Despite this near equal numerical representation, as a species, the callery pear avoided greater than seven times as much runoff as the Japanese lilac tree (7,327 gals. versus 1,032 gals.).

AIR QUALITY IMPROVEMENT

Compared to rural landscapes, urban landscapes are characterized by high emissions in a relatively small area. Because trees have the natural ability to absorb and remove pollutants from the area, they play an important role in mitigating this negative side effect of urban living. **Within South Linden, it is estimated that the inventoried tree resource annually removes 549 lbs. of air pollutants, including particulate matter ($PM_{2.5}$).** Figure 10 demonstrates the importance of the removal of $PM_{2.5}$ (fine particulate matter less than 2.5 microns in size) in terms of its value to the community, as $PM_{2.5}$ is associated with significant adverse health effects which include premature mortality, pulmonary inflammation, accelerated atherosclerosis, and altered cardiac functions (Pope et al. 2004).

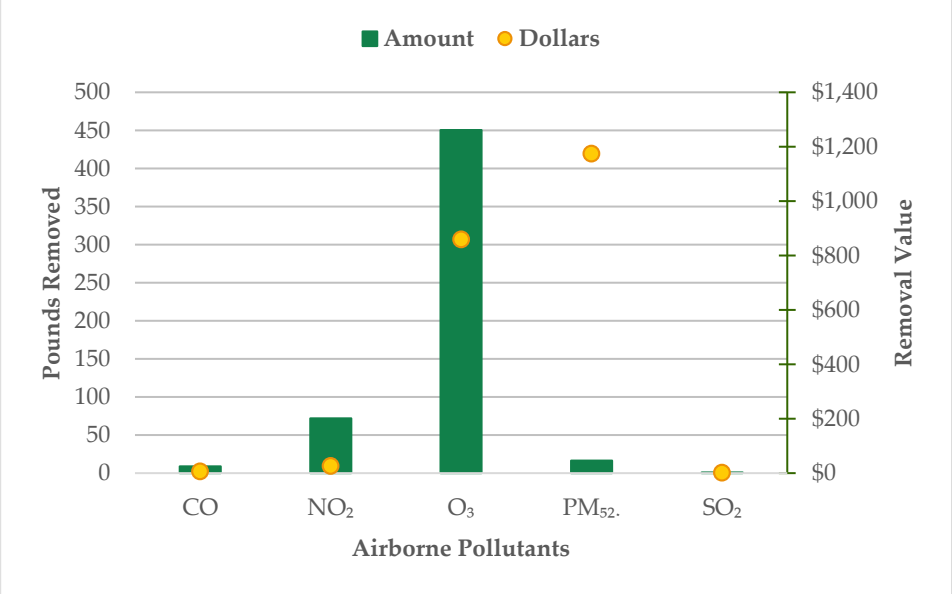


Figure 10. Estimated value of removing airborne pollution by weight and type.

Section 3:

Tree Planting Plan

SECTION 3: TREE PLANTING PLAN

PLANTING PLAN OVERVIEW

A foundational principle for prolonging the useful life of street trees rests upon the mantra of "right tree, right place". The right tree in the right place is a favorite saying used by the Arbor Day Foundation and numerous like-minded tree friendly organizations nationwide. It describes planting tree species with characteristics and environmental needs that align with the site characteristics of the location where the tree will be planted. The aim is to ultimately select a tree species that will not only survive but thrive and flourish in the chosen planting location in a way that harmonizes with the surrounding urban environment.

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.

In South Linden, DRG and the Columbus Recreation and Parks Department collaborated on a neighborhood planting plan designed around the right tree, right place philosophy (Map 1). During the inventory, DRG identified 1,342 locations along the street ROW within South Linden that were deemed suitable locations for planting new trees. For each location, information was collected on the type and size of the available growing space. Utilizing the data collected for each site, DRG made a recommendation on whether a small-maturing, medium-maturing, or large-maturing tree should be planted at each location. For each of the three size classes, DRG recommended ten species. The species recommendations were informed by South Linden's 10-20-30 diversity distribution. Finally, each vacant site was randomly assigned one of the ten recommended species appropriate for that site's recommended tree size (Map 1).

Map 1. Neighborhood Planting Plan

Tree Size Recommendations

Potential planting sites were designated for small-maturing, medium-maturing, and large-maturing trees based on the following guidelines:

Vacant site small – Minimum width of 4 to 5 feet and least 30 feet from another tree.

Vacant site medium - Minimum width of 6 to 7 feet and least 40 feet from another tree.

Vacant site large – Minimum width of 8 feet and least 50 feet from another tree.

In addition to these minimum width requirements, DRG considered the presence of existing utilities, overhead lines, and distances from intersections, stop signs, fire hydrants, driveways, etc. The inventory found 416 large planting sites, 59 medium, and 867 small sites (Table 2).

Table 2. South Linden Planting Sites

Planting Site Type	Qty
Large	416
Medium	59
Small	867
Total	1,342

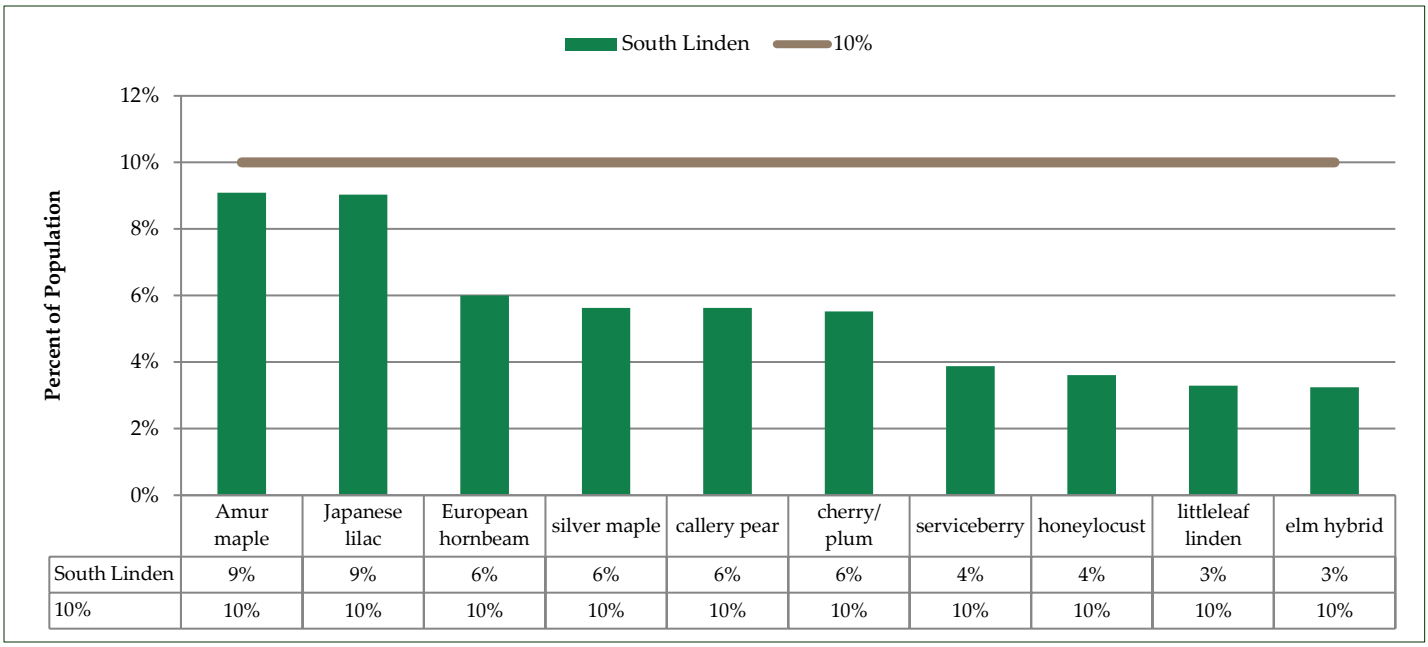
South Linden Fall 2020 Planting Initiative

In Fall 2020, the City of Columbus Recreation and Parks is conducting a large-scale planting initiative within South Linden that will see approximately 35% of the identified vacant sites filled with new trees. Table 3 shows the size and quantity breakdown of the Fall 2020 initiative.

Table 3. Fall Planting Sites

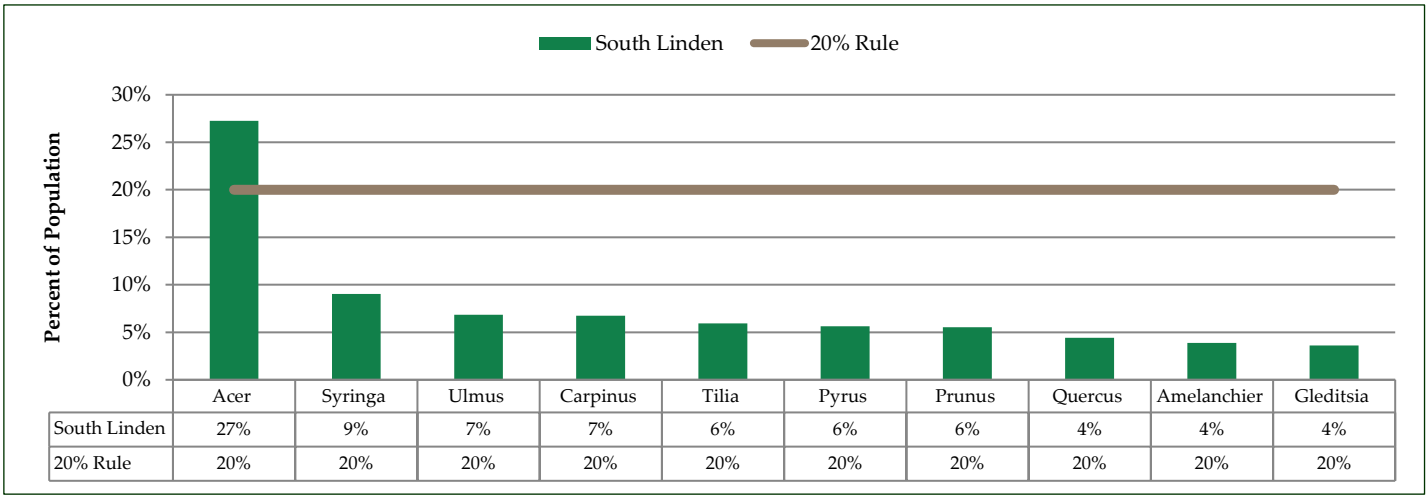
Site Type	Quantity
Large	75
Medium	5
Small	384
Total	464

The Fall 2020 planting initiative makes a strong first push at improving species diversity and helping normalize the diversity distribution within South Linden. After the Fall 2020 plantings, there are no species within the South Linden ROW which exceed the 10% threshold (Figure 11), and overrepresentation of the genus *Acer* decreases from 32% to 27% of the inventoried tree population (Figure 12).



	Amur maple	Japanese lilac	European hornbeam	silver maple	callery pear	cherry/ plum	serviceberry	honeylocust	littleleaf linden	elm hybrid
South Linden	9%	9%	6%	6%	6%	6%	4%	4%	3%	3%
10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%

Figure 11. Species diversity after the Fall 2020 planting initiative.



	Acer	Syringa	Ulmus	Carpinus	Tilia	Pyrus	Prunus	Quercus	Amelanchier	Gleditsia
South Linden	27%	9%	7%	7%	6%	6%	6%	4%	4%	4%
20% Rule	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%

Figure 12. Genus diversity after the Fall 2020 Planting initiative.

DRG Recommended Tree Species

After the Fall 2020 plantings, there will remain approximately 878 suitable vacant sites within South Linden. For each of these sites, DRG assigned one of ten tree species that was selected for each vacant site size class (Table 4). Over the coming years, these recommendations will ensure that future planting initiatives will continue to improve South Linden's diversity and improve community forest sustainability.

Table 4. Species Recommendations

Species Palettes			
#	Large Tree Planting Sites	Medium Tree Planting Sites	Small Tree Planting Sites
1	*Quercus shumardii*	*Ulmus x* 'Frontier'	*Magnolia* × 'Galaxy'
2	*Ulmus americana* 'Jefferson'	*Tilia americana* 'Redmond'	*Cornus kousa* × *chinensis* 'Kousa'
3	*Quercus macrocarpa* 'Urban Pinnacle'	*Ostrya virginiana 'Autumn Treasure'*	*Crataegus virdis* 'Winter King'
4	*Metasequoia glyptostroboides*	*Nyssa sylvatica* 'JFS-Red'	*Malus* × 'Royal Raindrops'
5	*Tilia americana* 'Boulevard'	*Gleditsia triacanthos* var. *inermis* 'Draves'	*Maackia amurensis*
6	*Tilia tomentosa* 'Sterling'	*Eucommia ulmoides*	*Carpinus betulus* 'Frans Fontaine'
7	*Corylus colurna*	*Querus robur* × *Q. bicolor* 'Nadler'	*Parrotia persica* 'Vanessa'
8	*Ulmus parvifolia* 'Emer II'	*Cladrastis kentukea*	*Syringa pekinensis* 'Morton'
9	*Gymnocladus dioicus* 'Espresso'	*Carpinus betulus* 'Emerald Avenue'	*Taxodium distichum* 'Skyward'
10	*Zelkova serrata* 'Green Vase'	*Ginkgo biloba* 'Princeton Sentry'	*Amelanchier laevis* 'Lustre'

CONCLUSION

When properly maintained, the valuable benefits trees provide over their lifetime far exceed the time and money invested in planting, pruning, and inevitably removing them. The 1,454 public trees inventoried have a combined economic and structural value worth over $3 million. Successful tree maintenance and tree planting programs will increase the value of South Linden's community forest asset, expand the quantity and quality of public benefits, enhance resiliency, and promote canopy sustainability.

It is worth noting that the inventoried trees account for only a fraction of the entire tree population within South Linden. The neighborhood has several parks and public facilities whose trees were not included in this inventory. Additionally, many trees are located on private property; it is critical to educate homeowners and other private landowners on the importance of trees and to incentivize the performance of tree care and tree planting activities.

With this plan, bolstered and supported by the Fall 2020 planting initiative and the forthcoming City of Columbus Urban Forest Master Plan, South Linden's community forest is well on its way to proliferating a sustainable and resilient public tree resource that will benefit the neighborhood residents and stakeholders for generations to come.

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