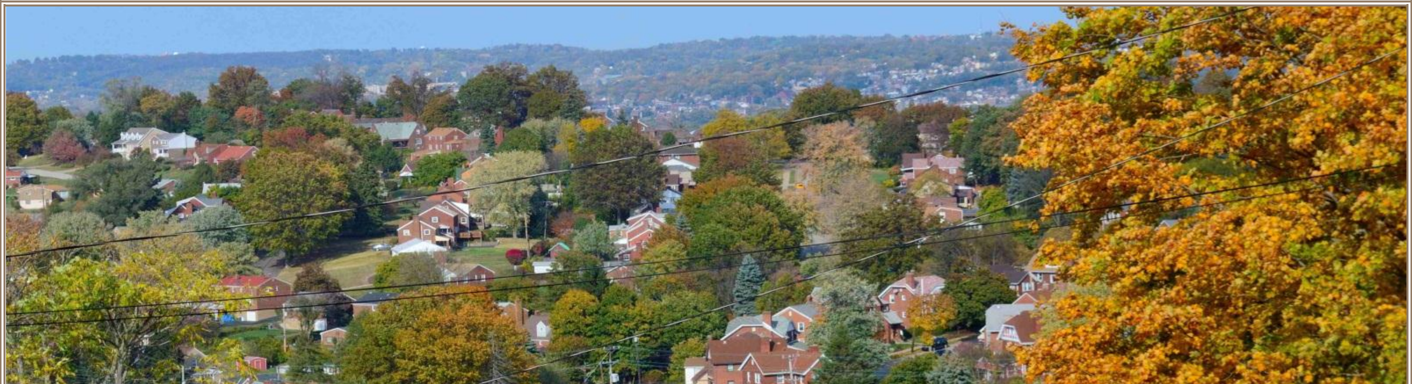


Street Tree Management Plan

City of Pittsburgh, Pennsylvania

July 2015

Prepared for:

City of Pittsburgh
Department of Public Works, Forestry Division
6520 Stanton Avenue
Pittsburgh, Pennsylvania 15206-2251

Pittsburgh Shade Tree Commission
The Office of Mayor William Peduto
512 City County Building
414 Grant Street, Pittsburgh, Pennsylvania 15219

The Western Pennsylvania Conservancy
800 Waterfront Drive
Pittsburgh, Pennsylvania 15222

Prepared by:

Davey Resource Group
A Division of The Davey Tree Expert Company
1500 North Mantua Street
Kent, Ohio 44240
800-828-8312

DAVEY RESOURCE GROUP
A Division of The Davey Tree Expert Company

Acknowledgments

The City of Pittsburgh's vision to promote and preserve the urban forest and improve the management of public trees was a fundamental inspiration for this project. One of the keystones of the Pittsburgh Urban Forest Master Plan is "Manage", which outlines goals for developing a proactive management regime for public trees through a sustainable planting program. This includes proactive risk management and a commitment to ensuring tree benefits for future generations. The 2014 street tree inventory and this management plan aim to guide and inform the city and its partners in the achievement of those goals.

The City of Pittsburgh is thankful for the funding and expertise it received from the City of Pittsburgh Shade Tree Commission, The Pennsylvania Department of Conservation and Natural Resources, Tree Pittsburgh, and the Western Pennsylvania Conservancy.

Notice of Disclaimer: Inventory data provided by Davey Resource Group, a division of The Davey Tree Expert Company, 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. Davey Resource Group 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. Davey Resource Group 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 Davey Resource Group'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.

Executive Summary

Davey Resource Group developed this plan for the City of Pittsburgh, Pittsburgh Shade Tree Commission, and the Western Pennsylvania Conservancy. The plan was created with a focus on addressing short- and long-term maintenance needs for inventoried street trees. Davey Resource Group completed a street tree inventory to gain an understanding of the needs of the existing urban forest and to project a recommended maintenance schedule for tree care. Analysis of inventory data and information about the city's existing program and vision for the urban forest was utilized to develop this management plan. A general description of the economic, environmental, and social benefits that trees provide to Pittsburgh is presented as justification for investment in this resource.

Photograph 1. Pittsburgh's urban forest is comprised of public street trees, such as **Zelkova serrata** ***(Japanese zelkova) on the left, and private trees such as the*** **Betula nigra** ***(river birch) on the right. This management plan covers the street tree portion of Pittsburgh's urban forest.***

State of the Existing Street Tree Population

The summer and fall 2014 inventory included trees, stumps, and planting sites along public street rights-of-way (ROW). A total of 38,228 sites were recorded during the inventory: 33,498 individual trees, 1,180 stumps, and 3,550 planting sites. Analysis of the tree inventory data found:

- The overall condition of the inventoried tree population is rated Good. Since the last street tree inventory in 2005, which found the majority of trees to be in Fair condition, the health of the street tree population has improved thanks to action taken by the city and its partners.
- Two species, *Acer platanoides* (Norway maple) at 11% of the population, and *Acer rubrum* (red maple) at 10% of the population, comprise the largest percentage of the street ROW and are beginning to threaten biodiversity. The city and its partners have already taken steps to ensure that these species' proportion of the population will shrink over time through a moratorium on use of Norway maple.
- The *Acer* (maple) genus was found in abundance on the street ROW (29%), which is a biodiversity concern for the city's streetscape. Since the last inventory in 2005, the abundance of maple has declined thanks to limited use of maples and implementation of diversity goals, such as those set in the *Pittsburgh Urban Forest Master Plan*.
- Overall, the diameter size class distribution of the inventoried tree population trended towards the ideal, with a greater number of young trees than established, maturing, and mature trees. The TreeVitalize Pittsburgh program has provided the framework and funding for over 23,000 trees since 2008, helping contribute towards a more sustainable urban tree age distribution.

Quantifiable Benefits

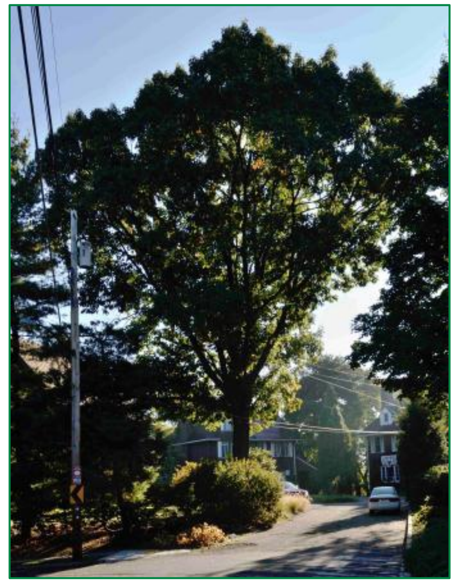
- The appraised value of Pittsburgh's street tree population is estimated to be over $51 million.
- Trees provide approximately $2.24 million in the following environmental and social benefits:
  - *Air quality*: valued at $417,700 per year.
  - *Carbon sequestration & avoidance:* net 5,808 tons tons valued at $38,335 per year.
  - *Energy*: Cooling and heating savings valued at $96,501 per year.
  - *Stormwater peak flow reductions:* 15 million gallons valued at $134,848 per year.
  - *Aesthetic benefits related to property value increases*: valued at $1,556,747 per year.

Photograph 2. The* Acer rubrum *(red maple) on the left and* Acer platanoides *(Norway maple) on the right are beautiful examples of their species. However, an abundance in past planting of both species has challenged diversity goals today. Steps have been taken to ensure that these populations will be reduced over time.

Tree Maintenance and Planting Needs

Maintenance needs recommended during the inventory include pruning (79%), tree removal (8%), stump removal (3%), and planting (9%).

Trees provide many environmental and economic benefits that justify the time and money for planting and maintenance. Maintenance should be prioritized by addressing trees with the highest risk first. The inventory noted many Severe and High Risk trees (8%) that should be removed or pruned immediately to promote public safety. Low and Moderate Risk trees should be addressed after all Severe and High Risk tree maintenance has been completed. Trees should be planted to mitigate removals and create canopy.



Photograph 3. Well-maintained trees such as this* Quercus palustris *(pin oak) located on the east side provide maximum benefits while posing low levels of risk.

Tree Removal	• Severe Risk = 14 trees • High Risk = 1,486 trees • Moderate Risk = 1,303 trees • Low Risk = 294 trees
Pruning	• Severe Risk = 3 trees • High Risk = 1,173 trees
RP Cycle	• Total trees per cycle = 19,360 • Number of trees in cycle each year = approximately 2,420
YTT Cycle	• Total trees per cycle = 9,873 • Number of trees in cycle each year = at least 3,949
Tree Planting	• Number of trees each year = at least 715
Stump Removal	Total stumps = 1,180

Pittsburgh's urban forest will benefit greatly from a twice-in-five-years young tree training cycle (YTT), and a once-in-eight-years routine pruning (RP) cycle. Based on inventory data, at least 3,949 young trees should be structurally pruned each year during the young tree training cycle, and approximately 2,420 trees should be cleaned during the routine pruning cycle each year.

In these proactive pruning cycles, all established trees are visited at least once every eight years, and all young trees receive a training prune twice every five years. Proactive pruning cycles improve the overall health of the tree population and may eventually reduce program costs. In most cases, pruning cycles will correct defects in trees before they worsen, which will avoid costly problems.

Planting trees is necessary to maintain canopy cover and to replace trees that have been removed or lost to natural mortality (expected to be 1%–3% per year) or other threats (for example, construction, invasive pests, or impacts from weather events such as drought, flooding, ice, snow, storms, and wind). We recommend planting at least 715 trees of a variety of species each year to offset these losses, maintain canopy, and maximize benefits.

Citywide tree planting should focus on creating canopy in areas that promote economic growth (such as business districts), in parking lots and near buildings with insufficient shade, and where there are gaps in the existing canopy. Trees of varied species should be planted. The city's existing planting list offers smart choices for species selection, and past performance can provide further guidance for species selection. Appendix D of the *Pittsburgh Urban Forest Master Plan* (Davey Resource Group 2012) offers strategies for increasing species diversity. Under this plan, city planting of Norway maple is banned, and planting of maple is limited to 5% of any planting project.

Street Tree Program Needs

Adequate funding will be needed for the City of Pittsburgh and its non-profit partners to implement an effective management program that provides short- and long-term public benefits, ensures that priority maintenance is expediently performed, and establishes proactive maintenance cycles. The estimated total cost for the first year of this Ten-Year Program is about $1,962,000. By reducing the backlog of removals and priority maintenance through Years 1 through 7 of the program, the annual costs are estimated to decrease to approximately $1,347,000 per year (starting in Year 7) to carry out a proactive, cyclical maintenance program. High-priority removal and pruning is costly; most of this work is scheduled during the first two years of the program, which is why the budget is higher for those years.

Photograph 4. The shade provided by these Brookline neighborhood trees saves residents money on air conditioning costs and likely contributes to property values.

Over the long term, supporting a path towards proactive management of trees through funding upfront, short-term increases in tree maintenance will reduce municipal tree liabilities and management costs, and possibly facilitate the allocation of resources to other municipal needs.

Pittsburgh has many opportunities to improve its urban forest. Planned tree planting and a systematic approach to tree maintenance will transform an on-demand, priority-based operation into a cost-effective, proactive program. Investing in this tree management program will promote public safety, improve tree care efficiency, and increase the economic and environmental benefits the community receives from its trees. Estimated Costs for the Ten-Year Management Program are discussed in Chapter 3 and detailed in Appendix B.

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Introduction

The City of Pittsburgh is home to more than 305,000 full-time residents who enjoy the beauty and benefits of their urban forest. The city's forestry program manages trees on public property—along the street public right-of-way (ROW), in some parks, and in other public spaces. The city's Department of Public Works Forestry Division has 17 dedicated staff positions, of which 13 are currently filled, to manage urban forestry needs.

Photograph 5. A street that is well stocked with trees, such as this segment of Bigelow Boulevard, provides economic, environmental, and social benefits, including temperature moderation, reduction of air pollutants, energy conservation, and increased property values.

Funding for Pittsburgh's urban forestry program comes from the Public Works Department's operations budget. The City of Pittsburgh has a tree care ordinance and, with the assistance of community partners, is able to coordinate more than $2 per capita for tree-related expenses. The city officially celebrates Arbor Day and has been a Tree City USA member for nine years. Past urban forestry projects have demonstrated a desire to improve the environment through higher levels of tree care and have earned the city two Tree City USA Growth Awards.

Approach to Tree Management

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

Photograph 6. This well-stocked street in Squirrel Hill benefits from proactive planting decisions made over a half century ago. Strong planning today will ensure that streets are lined with similarly heathy trees in the future.

In summer and fall 2014, the Pittsburgh City Forester, the Pittsburgh Shade Tree Commission, Tree Pittsburgh, and the Western Pennsylvania Conservancy, worked with Davey Resource Group to inventory trees and develop a management plan. This plan considers the general condition, diversity, and distribution of the inventoried trees and provides a prioritized system for managing street ROW and park trees. The following tasks were completed:

- Inventory of trees, stumps, and planting sites within the street ROW
- Analysis of tree inventory data
- Development of a plan that prioritizes the recommended tree maintenance

This plan is divided into three sections:

- Section 1 (*Tree Inventory Analysis*) summarizes the tree inventory data and presents trends, results, and observations.
- Section 2 (*Benefits of the Urban Forest*) summarizes the economic, environmental, and social/health benefits that trees provide to Pittsburgh.
- Section 3 (*Tree Management Program*) utilizes the inventory data to develop a prioritized maintenance schedule and projected budget for the implementation of the recommended tree maintenance over a 10-year period.

Section 1: Tree Inventory Analysis

In the summer and fall 2014, Davey Resource Group arborists assessed and inventoried trees, stumps, and planting sites along the street ROW. A total of 38,228 sites were collected during the inventory: 33,498 trees, 1,180 stumps, and 3,550 vacant planting sites. Figure 1 provides a detailed breakdown of the number and type of sites inventoried.

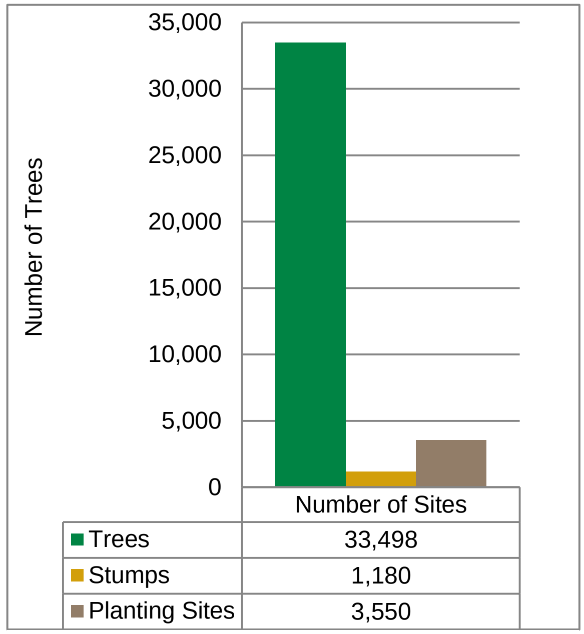


Figure 1. Sites recorded during the 2014 inventory.

Data Collection Methods

Tree inventory data were collected using a system developed by Davey Resource Group that utilizes a customized ArcPad® program loaded onto pen-based field computers equipped with geographic information system (GIS) and global positioning system (GPS) receivers. The knowledge and professional judgment of Davey Resource Group's arborists ensure the high quality of inventory data.

At each site, the following data fields were collected:

- aboveground utilities
- block side
- canopy dimension
- clearance requirements
- condition
- grow space size
- grow space type
- further inspection
- hardscape damage
- location
- mapping coordinate
- notes
- observations
- primary maintenance needs
- risk rating
- species
- stems
- tree height
- tree size*
- percent crown missing
- crown light exposure
- crown dieback
- field land use
- tree status

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

Data fields were derived for compatibility with the i-Tree software suite of forestry analysis tools developed by the U.S. Forest Service (v6.07) Eco (v5.1.6). Primary maintenance recommendations are based on *ANSI A300 (Part 1)* (2008), which outlines industry standards for tree pruning objectives and methods. Risk assessment and risk rating are based on *Urban Tree Risk Management* (Pokorny et al. 1992).

The data collected were provided in shapefile, Microsoft Excel™, and Access™ formats on a CD-ROM that accompanies this plan. Updated data will also be uploaded into Pittsburgh's existing Treekeeper® system.

Project Area

All street ROWs within Pittsburgh city limits were surveyed for trees, vacant planting sites, and stumps. Since the inventory tree work based on the recorded data has already taken place, all analyses and recommendations are based on the originally collected data. Current conditions on the ground may be different due to natural occurrences and human activity.

Assessment of Tree Inventory Data

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

Photograph 7. Davey Resource Group's ISA Certified Arborists inventoried trees along street ROW and in community parks to collect information about trees that could be used to assess the state of the urban forest.

- *Species Diversity*: The variety of species in a specific population; affects the population's ability to withstand threats from invasive pests and diseases; impacts tree maintenance needs and costs, tree planting goals, and canopy continuity.
- *Diameter Size Class Distribution*: Statistical distribution of a given tree population's trunk-size class; affects the valuation of tree-related benefits as well as the estimation of maintenance needs and costs, planting goals, and canopy continuity; the diameter size class distribution can be used to indicate the relative age of a tree population.
- *Condition*: The general health of a tree population; indicates how well trees are performing given their site-specific conditions; general health affects both short- and long-term maintenance needs and costs as well as canopy continuity.
- *Street ROW Stocking Level*: The portion of existing street ROW trees compared to the total number of potential street ROW trees (number of inventoried trees plus the number of potential planting spaces); stocking level can help determine tree planting needs and budgets.
- *Other Observations*: Inventory data analysis that provides insight into past maintenance practices and growing conditions; discusses observations that may affect future management decisions.
- *Infrastructure Conflicts*: Inventory data analysis that provides insight into how well the tree population has been integrated with other city infrastructure and suggestions for how to improve that integration in the future.

Species Diversity

Species diversity affects canopy continuity, maintenance costs, planting goals, and the forestry program's ability to respond to threats from invasive pests or diseases. Low species diversity (large number of trees of the same species) can lead to severe losses in the event of species-specific epidemics such as the devastating results of *Ophiostoma novo-ulmi* (Dutch elm disease) throughout New England and the Midwest. Because of the introduction and spread of Dutch elm disease (DED) in the 1930s, combined with its prevalence today, massive numbers of *Ulmus americana* (American elm), a popular street tree in Midwestern cities and towns, have perished (Karnosky 1979). Many Midwestern communities were stripped of most of their mature shade trees, creating a drastic void in canopy cover. Many communities replanted to replace the lost elm trees. Ash and maple trees were popular replacements for American elm in the wake of Dutch elm disease. Unfortunately, some of the replacement species for American elm trees are now overabundant, which is a concern for biodiversity. *Agrillus planipennis* (emerald ash borer, EAB) and *Anoplophora glabripennis* (Asian longhorned beetle, ALB) are non-native insect pests that attack some of the most prevalent urban shade trees and some agricultural trees throughout the country.

The composition of a tree population should follow the standard 10-20-30 Rule for species diversity in an urban tree population: a single species should represent no more than 10% of the urban forest, a single genera no more than 20%, and a single family no more than 30%. This composition breakdown and other pertinent species diversity guidelines are discussed in Appendix D of the *Pittsburgh Urban Forest Master Plan*.

Findings

Analysis of Pittsburgh's tree inventory data indicates that the street tree population has relatively good diversity, with 81 genera and 189 species represented.

Figure 2 compares the percentages of the most common species identified during the inventory to the 10% Rule. Both Norway maple (11%) and red maple (10%) exceed the recommended 10% maximum for a single species in a population.

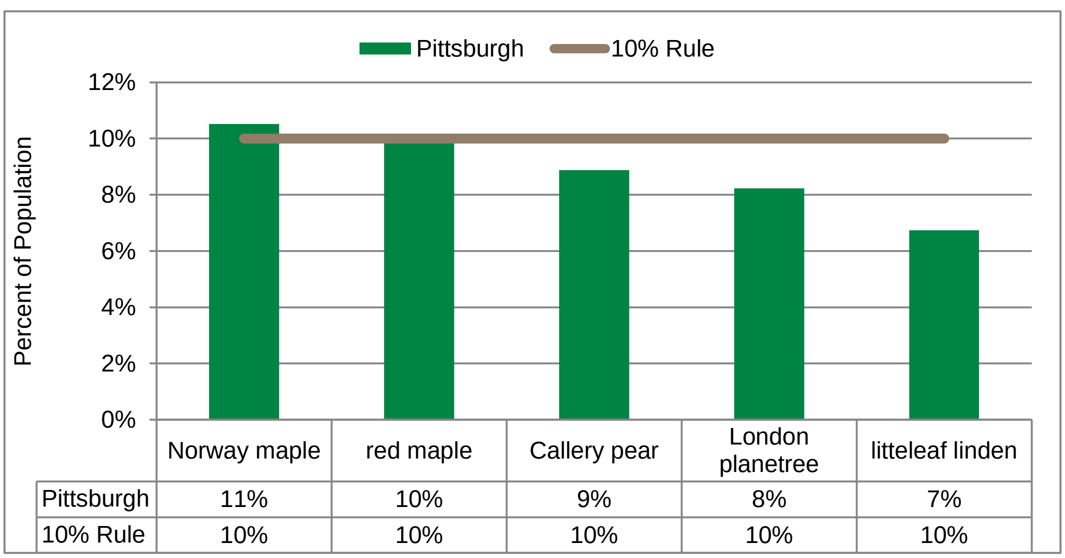
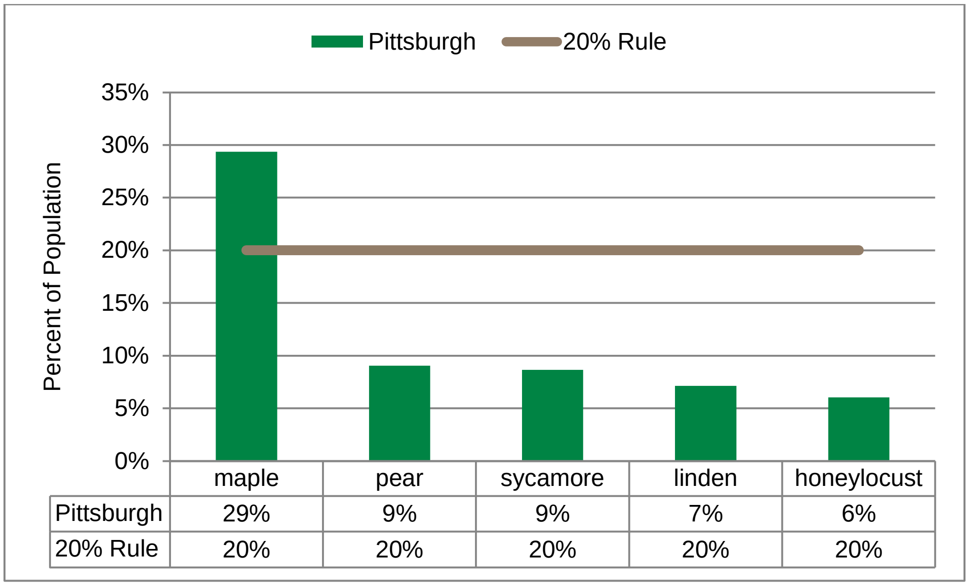


Figure 2. Five most abundant species of street ROW trees during the 2014 inventory.

Figure 3 compares the percentages of the most common genera on the street ROW to the 20% Rule. Maple comprises 29% of the inventoried tree population, which far exceeds the recommended 20% maximum for a single genus in a population.



	maple	pear	sycamore	linden	honeylocust
Pittsburgh	29%	9%	9%	7%	6%
20% Rule	20%	20%	20%	20%	20%

Figure 3. Five most abundant genera of street ROW trees during the 2014 inventory.

Discussion/Recommendations

Considering the large quantity of maple already present in the population, combined with its susceptibility to ALB, the planting of maple should be limited to minimize the potential for loss should any exotic pests or diseases threaten Pittsburgh's urban tree population. This is especially true for both Norway maple and red maple, which are highly prevalent on the species level. The city has already taken steps to reduce the proportion of these species present on the streets. Of the five most abundant species, *Acer platanoides* (Norway maple), *Pyrus calleryana* (Callery pear), and *Tilia cordata* (little-leaf linden) are restricted species and shall not be planted according to the diversity guidelines in Appendix D of the *Pittsburgh Urban Forest Master Plan*. Furthermore, the master plan also reduces the proportion of maple to 5% or less for any new planting project.

Photograph 8. Heavy past planting of* Acer rubrum *(red maple) has led to overabundance of the species on Pittsburgh's streets. Moratorium of this species should be in effect until its proportion falls well below 10%.

Diameter Size Class Distribution

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

The inventoried trees were categorized into the following diameter size classes: young (0–8 inches DBH), established (9–17 inches DBH), maturing (18–24 inches DBH), and mature trees (>24 inches DBH). These categories were chosen so that the population could be analyzed following Richards' ideal distribution (1983). Richards proposed an ideal diameter size class distribution for street trees based on observations of well-adapted trees in Syracuse, New York. Richards' ideal distribution suggests that the largest fraction of trees (approximately 40% of the population) should be young (<8 inches DBH), while a smaller fraction of trees (approximately 10%) should be in the mature size class (>24 inches DBH). A tree population with an ideal distribution would have an abundance of newly planted and young trees, and lower numbers of established, maturing, and mature trees.

Photograph 9. The diversity of tree age in this part of downtown bodes well for the future of Pittsburgh's urban forest.

Findings

Figure 4 compares Pittsburgh's tree diameter class distribution of the inventoried tree population to the ideal proposed by Richards (1983). Pittsburgh's distribution skews to young trees. The 0–8 inches (young) diameter classes exceed the ideal distribution by 7%. Trees greater than 24" (mature) slightly exceed the ideal proportion, while the 18–24 inches (maturing) diameter class falls short of the ideal by 8%.

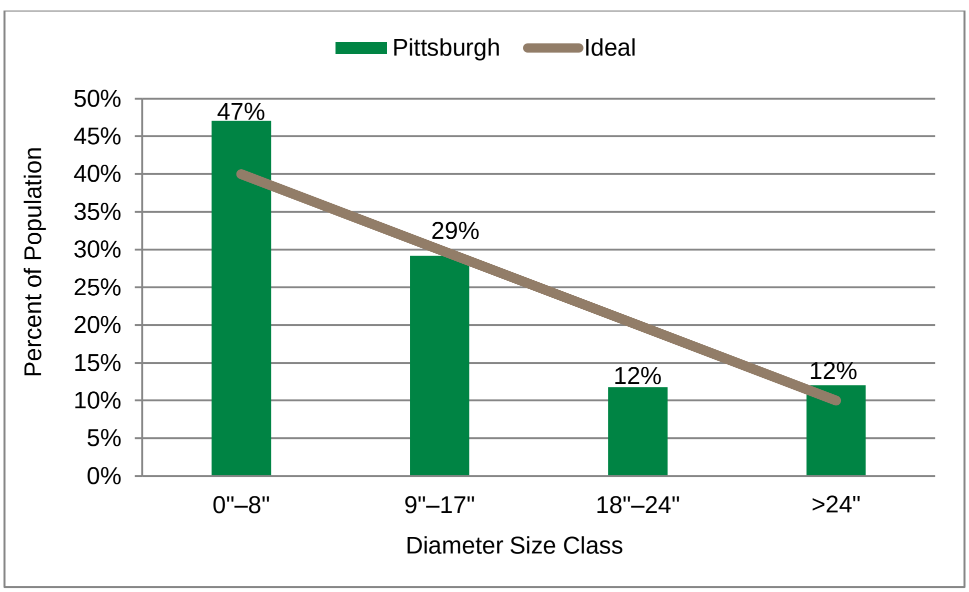


Figure 4. Comparison of diameter class distribution for inventoried trees to an ideal distribution.

Discussion/Recommendations

Even though it may appear that Pittsburgh has too many young trees, this is not the case. Pittsburgh actually has too few maturing (18–24 inches DBH) trees and, thus, the distribution is skewed. The high proportion of young trees is reflective of an extremely strong planting program over the past decade, particularly through the TreeVitalize Pittsburgh project partnership led by the Pennsylvania Department of Conservation and Natural Resources. Since 2008, this partnership that includes Allegheny County Parks, the City of Pittsburgh, the Pennsylvania Department of Conservation and Natural Resources, Tree Pittsburgh, and the Western Pennsylvania Conservancy, has planted over 23,000 trees throughout the City of Pittsburgh and Allegheny County.

The low proportion of maturing trees is reflective of a time when either little planting was done or when a high proportion of trees experienced mortality. It is also important to note that the population of large mature trees will decline over a relatively short period of time because of their age.

One of Pittsburgh's objectives is to establish age diversity in the street tree population. Davey Resource Group recommends that the partners of the TreeVitalize Pittsburgh program continue their collaboration on street tree planting and ongoing maintenance efforts to ensure that young, healthy trees are in place to fill in gaps in tree canopy and provide for gradual succession of older trees. The city must continue to promote tree preservation, enforce existing tree protection and planting codes, and develop and implement a proactive tree care system to ensure the long-term survival of older trees. Tree planting and tree care will allow the distribution to normalize over time.

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

Condition

Davey Resource Group assessed the condition of individual trees based on methods defined by the International Society of Arboriculture (ISA). Several factors were considered for each tree, including root characteristics, branch structure, trunk, canopy, foliage condition, and the presence of pests. The condition of each inventoried tree was rated Excellent, Very Good, Good, Fair, Poor, Critical, or Dead.

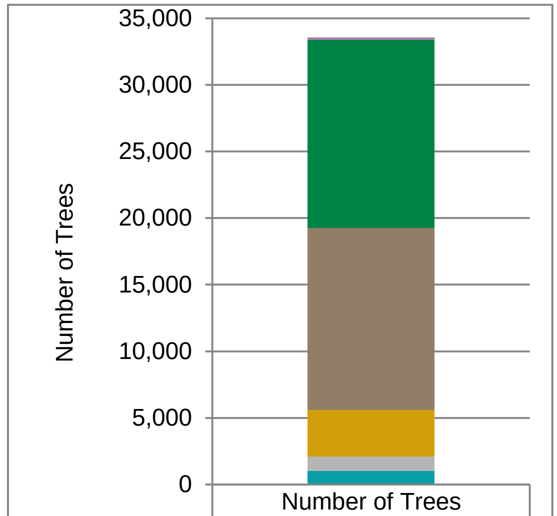
In this plan, the general health of the inventoried tree population was characterized by the most commonly assigned condition during the inventory.

Comparing the condition of the inventoried tree population with relative tree age can provide insight into the stability of the population. In this plan, relative age was based on DBH. Since tree species have different lifespans and mature at different diameters, heights, and crown spreads; actual tree age cannot be determined from diameter size class alone. However, general classifications of size can be extrapolated into relative age classes. The following categories are used to describe the relative age of a tree: young (0–8 inches DBH), established (9–17 inches DBH), maturing (18–24 inches DBH), and mature (>24 inches DBH).

Figures 5 and 6 illustrate the general health and percent of young, established, maturing, and mature trees relative to their condition.

Findings

Most of the inventoried trees were found to be in Good or Fair condition, 42% and 41%, respectively (Figure 5). Based on these data, the general health of the overall inventoried tree population is rated Good. Figure 6 illustrates that most of the young trees were rated to be in Good condition, while most of the established, maturing, and mature trees were rated to be in Fair condition.



	Number of Trees
Excellent	2
Very Good	110
Good	14,131
Fair	13,652
Poor	3,483
Critical	1,098
Dead	1,022

Figure 5. Tree condition of all inventoried trees.

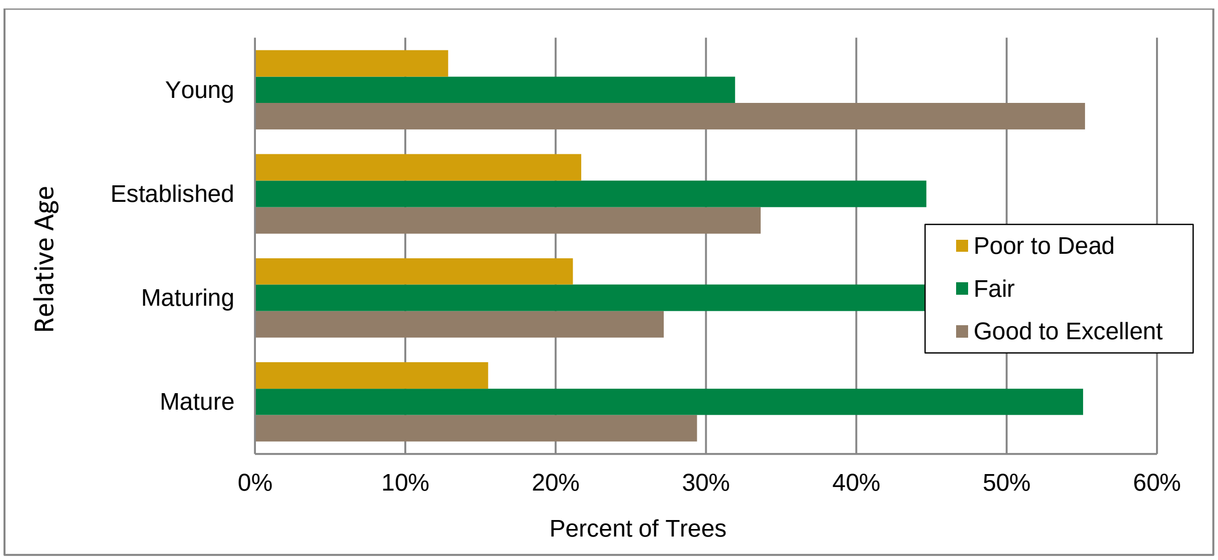


Figure 6. Tree condition by relative age during the 2014 inventory.

Discussion/Recommendations

Even though the condition of Pittsburgh's inventoried tree population is typical, data analysis has provided the following insight into historical maintenance practices and future maintenance needs:

Photograph 10. This* Quercus alba *(white oak) in the Hays neighborhood is an example of a tree in Good condition.

- Dead trees and trees in Critical condition should be removed as soon as possible. Due to their condition status, these trees most likely will not recover, even with increased care.
- Younger trees rated in Fair or Poor condition may benefit from improvements in structure, which may improve the health of these trees over time. Pruning should follow *ANSI A300 (Part 1)* (ANSI 2008).
- Poor condition ratings assigned to mature trees were generally due to visible signs of decline and stress, including decay, dead limbs, sparse branching, and/or poor structure. These trees will require corrective pruning, regular inspections, and possible intensive plant health care to improve their health.

Street ROW Stocking Level

Stocking is a traditional forestry term used to measure the density and distribution of trees. In urban forestry, stocking level can be used to describe how close a street tree population is to achieving its full potential in regards to street tree density. A well-stocked street tree population will have trees growing in the most appropriate streetscape locations. Municipalities should aim to increase stocking level whenever possible to increase the benefits accrued by the street tree portion of the urban forest.

Stocking potential is a unique measurement, as there are many municipality-specific factors that affect how many street trees can be supported. Stocking level is the ratio of street ROW spaces occupied by trees to the total street ROW spaces suitable for trees. For example, a street ROW tree inventory of 1,000 total sites with 750 existing trees and 250 vacant planting sites would have a stocking level of 75%.

For an urban area, Davey Resource Group recommends that the street ROW stocking level be at least 90% so that no more than 10% of the potential planting sites along the street ROW are vacant.

When vacant site data are not complete, stocking level can be more difficult to estimate. There are two basic ways of determining a theoretical stocking level. One is by comparing the number of street miles in a municipality to the number of existing trees. For example, 10 linear miles of street ROW with spaces for trees to grow at 50-foot intervals along each side of the street would have a potential for 2,110 trees. If the inventory found that 1,055 trees were present, the stocking level would be 50%. The advantage of determining stocking level in this capacity is that it does not require the collection of vacant planting sites during the inventory; also, it does not take into account natural and infrastructure barriers to tree planting, nor does it consider municipal codes and planting specifications.

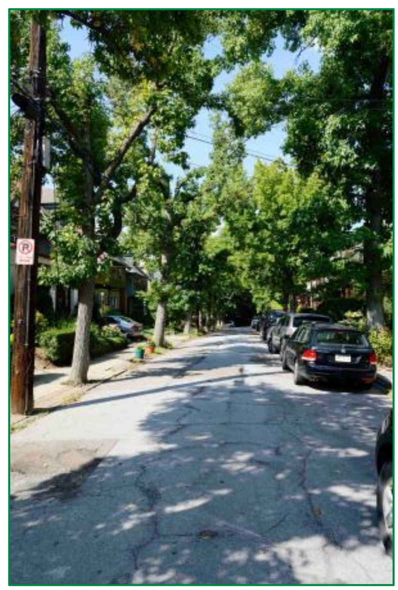
Another way to determine stocking is by comparing the number of street trees growing in a city to the number of people inhabiting that city. This can give an idea of what priority the municipality and its residents are putting on street trees. This approach allows for easy measurement and use of tree inventory data and U.S. Census data. This approach also does not directly account for natural and infrastructure barriers to tree planting.

Pittsburgh's 2014 inventory data included planting sites in existing tree pits and tree lawns. However, the data did not include potential planting sites beyond the sidewalks but still in the right-of-way. Planting spots were also not collected for sites which could support a tree if a new tree pit was cut into a sidewalk. Collecting vacant site data in this way helps identify sites that are ready for immediate planting or that only require minor improvements before planting can occur. This method will overestimate the stocking level in Pittsburgh, since it is not taking into account all potential sites.

Estimating Pittsburgh's stocking level based on street miles presents more difficulties. Pittsburgh is a very old town by American standards. The city was not planned with street trees in mind. Streets are relatively narrow, there are very few tree lawns or boulevards, and there are many conflicts with gas, water, electric, and communications infrastructure. In addition, many neighborhoods in Pittsburgh have declined in population density over past decades. For example, there are streets that exist on maps but have few or no residents living on them. Many roads traverse naturally wooded areas which were not inventoried. For these reasons, proving an estimate will grossly underestimate the stocking level in Pittsburgh.

Findings

The inventory found 3,550 vacant planting spaces. Of the inventoried sites, 44 were potential planting sites for large-sized trees (8-foot-wide and greater growing space size); 215 were potential planting sites for medium-sized trees (6- to 7-foot-wide growing space sizes); 2,440 were potential sites for small-sized trees (3- to 5-feet-wide growing space sizes); and 851 were unsuitable sites (tree pits less than 9 square feet). Based on the data gathered during this inventory, Pittsburgh's current street ROW tree stocking level is 93%.



Photograph 11. This Highland Park neighborhood street is an example of a fully stocked block.

Planting sites were only collected for tree-lawns that were 3 feet wide or greater and for existing tree pits. Large swathes of the city have tree lawns smaller than 3 feet wide, or have room for planting in a ROW that extends several feet behind the sidewalk. This means that the planting potential for Pittsburgh is much greater than that indicated by the number of planting sites collected during the inventory. Analyzing the theoretical stocking level may lend a perspective in regards to how many trees the city ROW could truly hold.

Looking at the stocking level theoretically, the city has 1,031 linear miles of street ROW (City of Pittsburgh 2014), and 33,568 trees, for an average of 32.6 trees per street mile. In theory, any given street should have growing space for 1 tree every 50 feet along each side of a street, or 211 trees per mile. The current theoretical stocking level is 18%. This suggests that there is room for an additional 184,000 street trees in Pittsburgh to reach its full theoretical stocking potential, although this goal is not likely to be achievable for reasons previously mentioned.

Stocking level can also be analyzed using the number of trees per capita. There is 1 tree for every 9.1 residents. Pittsburgh's ratio of street trees per capita is 0.11—which is well below the mean ratio of 0.37 reported for 22 U.S. cities (McPherson and Rowntree 1989). If Pittsburgh aims to achieve a tree ratio of 0.37, then 80,000 additional trees must be planted. For the sake of comparison, in this same study, Newark, New Jersey was shown to have 0.09 tree per person, Los Angeles had 0.20 tree per person, and Syracuse, New York had a ratio of 0.23 tree per person (McPherson and Rowntree 1989).

Discussion/Recommendation

While stocking level measurements can be a yardstick for determining the potential and progress of street tree planting, planting should ultimately continue until the costs of planting outweigh the benefits provided over a tree's lifetime. Davey Resource Group recommends that Pittsburgh plant 715 new trees per year over the next 10 years. Planting at this level will fill all identified vacant sites and replace all tree removals. In addition, planting 50 "canopy investment" trees (see canopy investment planting) to increase canopy and improve canopy distribution will help improve stocking levels. Since most of these sites were identified as suitable during the 2014 inventory, or already have an existing tree slated for removal, these sites are very likely to be high quality and conducive to supporting urban trees.

Other Observations

Observations were recorded during the inventory to further describe a tree's health, structure, or location when more detail was needed. Data were also collected on High Risk trees that are likely to negatively impact the street ROW if they fail. Inventory findings for Other Observations is accounted for separately from Infrastructure Conflicts.

Photograph 12. The cavity in this Squirrel Hill* Acer saccharum *(sugar maple) is not yet severe enough to warrant removal. However, this tree should be regularly inspected so that it can be removed when the risk of failure exceeds the benefits it provides.

Findings

Table 1. Sites for Which Observations Were Noted

Observations	Occurrences
Grate or Guard	966
Cavity or Decay	763
Serious Decline	663
Mechanical Damage	395
Poor Root System	347
Poor Location	305
Remove Hardware	273
Poor Structure	264
Signs of Stress	133
Improperly Pruned	108
Pest Problem	50
Improperly Mulched	24
Improperly Installed	19
Nutrient Deficiency	11
Grand Total	4,321

Grates or guards were installed in 3% of all tree sites. Of these 966 trees, 111 were recommended for removal, 8 of which were rated to be High Risk trees.

Significant cavity or decay was noted in 2% of tree sites. Of these 763 trees, 357 were marked as removals, 229 of which were Severe or High Risk trees.

Serious decline was noted in 2% of tree sites. All 663 of these trees were marked as removals, 332 of which were Severe or High Risk trees.

Discussion/Recommendations

If possible, the grates and guards should be removed from standing trees. Since trees often do not grow straight, they can potentially grow into the guards, which damages tree health and impedes tree maintenance. The grates used in Pittsburgh are not constructed with the capability of expanding as trees grow. This greatly limits the growth potential of trees.

Trees noted as having poor structure (264 trees) or cavity or decay (763 trees) should be regularly inspected. Corrective actions should be taken when warranted. If trees that are not already marked for removal continue to decline, removal may be required.

Infrastructure Conflicts

In an urban setting, space is limited both above and below ground. Trees in this environment may conflict with infrastructure such as buildings, sidewalks, and utility wires and pipes, which may create risks to public health and safety. Existing or possible conflicts between trees and infrastructure recorded during the inventory include:

Photograph 13. The beauty of these* Acer rubrum *(red maple) is undeniable. However, their lowest branches are impinging on the roadway. This can lead to vehicle damage and can negatively affect tree health, since limbs are likely to be torn off. Road-side branches should be no lower than 14 feet.

- *Clearance Requirements*—The inventory noted trees blocking the visibility of safety devices, streetlights, or traffic signs or signals. This information should be used to schedule pruning activities.
- *Overhead Utilities*—The presence of overhead utility lines above a tree or vacant planting site was noted; it is important to consider these data when planning pruning activities and selecting tree species for planting.
- *Hardscape Damage*—Trees can adversely impact hardscape, which affects tree root and trunk systems. The inventory recorded damage related to trees causing curbs, hardscape features, and sidewalks to lift. These data should be used to schedule pruning and plan repairs to damaged infrastructure. To limit hardscape damage caused by trees, trees should be planted only in growing spaces where adequate aboveground and belowground space is provided. If Pittsburgh city specifications for a minimum planting site of 30’ square feet with a minimum side dimension of 3’ are followed, trees should have enough room to thrive, meaning hardscape damage will be less likely.

Findings

Table 2 shows there were 3,848 trees recorded with some type of clearance issue. Most of these trees were related to conflicts with vehicles (59%). When the bottom of a tree's canopy over the road was less than 14 feet or rubbing from vehicles was noted, this clearance was recorded. The second most common clearance issue affects pedestrians (27%). In these cases, part of the tree was impinging into the pedestrian walkway.

Table 2. Trees Noted to Have Clearance Issues

Clearance Need	Occurrences
Vehicle	2,251
Pedestrian	1,037
Building	288
Sign or Signal	182
Light	90
Total	3,848

Table 3 shows there were 13,786 trees with utilities over their site; 2,190 of those trees were conflicting with the overhead utilities. There were 11,000 medium- and large-sized species planted under overhead utilities. This is 38% of all inventoried medium- and large-sized tree species. Furthermore, there were 3,222 trees (10% of all trees) noted as having been negatively affected (health problems or possible failure) by utility pruning.

Table 3. The Status of Overhead Utilities for All Tree Sites

Tree Size Class	Overhead Utilities		No Overhead Utilities	Percent of Tree Size Class Under Utilities
	Conflicting	Not Conflicting		
Medium and Large Trees	2,041	8,959	17,755	38%
Small Trees	149	2,637	1,947	59%
All Trees	2,190	11,596	19,712	41%


Photographs 14 and 15. The* Platanus × acerifolia *(London planetree*) *shown here is an example of a large-statured tree species that has been planted directly underneath utility wires. The drastic pruning required can often lead to health problems, as evidenced by the decay and heavy sprouting in one of its remaining limbs.

Table 4 shows that hardscape damage was moderate: 18% of the sites showed evidence of raised sidewalk slabs or curbs.

Table 4. Trees with Associated Hardscape Damage

Hardscape Damage	Occurrences
No	32,211
Yes	6,017

Photograph 16. Large tree species planted in small spaces, such as this pin oak, can lead to sidewalk damage.

Discussion/Recommendations

Tree canopy should not interfere with vehicular or pedestrian traffic; rest on buildings; or block signs, signals, or lights. Pruning to avoid clearance issues and to raise tree crowns should be completed in accordance with *ANSI A300 (Part 9)* (2011). Davey Resource Group's clearance guidelines are: 14 feet over streets; 8 feet over sidewalks; and 5 feet from buildings, signs, signals, or lights.

Before the TreeVitalize Pittsburgh project launched in 2008, Pittsburgh foresters gave little attention to the future height of trees that were being planted under wires. This has resulted in a large number of trees that have been negatively affected by utility pruning to ensure the uninterrupted delivery of electricity.

The City of Pittsburgh, Tree Pittsburgh, and Western Pennsylvania Conservancy urban foresters only assign suitable sites for planting according to the "right tree in the right place" concept. Through TreeVitalize Pittsburgh, only small-statured trees are considered for planting under overhead electrical utilities. We recommend the continued practice of planting only small-growing trees within 20 feet of overhead utilities, medium-sized trees within 20–40 feet, and large-growing trees over 40 feet to help minimize future conflicts, improve future tree conditions, and reduce the costs of maintaining trees under utility lines.

Growing Space

Information about the type and size of the growing space was recorded. Growing space size was recorded as the minimum width of the growing space needed for root development. Growing space types are categorized as follows:

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

Findings

Table 5 shows that 36% of sites identified were tree pits and 32% were in tree lawns.

Pittsburgh's standard size tree pit planting sites are at least 30 square feet in area with a minimum of 3 feet per side. Table 6 shows that only 22% of tree pits are standard size or better.

Pittsburgh's policy is that trees should be planted in tree lawns only if they are 3 feet wide or greater. Table 7 shows that 78% of trees planted in tree lawns are in tree lawns which meet this standard.

Table 5. Description of Sites Identified on Pittsburgh's Street ROW

Site Type	Occurrences
Well or Pit	13,828
Tree Lawn or Parkway	12,425
Open and Unrestricted	9,743
Open and Restricted	1,428
Median	725
Raised Planter	43
Island	36

Table 6. Growing Area Associated with Trees Growing in Tree Pits on Pittsburgh Streets

Well or Pit Size	Occurrences
Less than 9 square feet	3,073
Greater than 9 square feet, but non-standard size	7,741
Standard size or better	3,014

Table 7. Width of Tree Lawns in Which Trees Are Growing on Pittsburgh Streets

Tree Lawn Width	Occurrences
2 foot or less	2,704
3 to 5 feet	8,789
5 to 7 feet	550
Wider than 7 feet	382

Photograph 17. These* Prunus serrulata (*Kwanzan cherry*) *are the proper-sized trees to plant in this 3-foot tree-lawn with electric wires overhead.

Photographs 18 and 19. The* Syringa reticulata (*Japanese lilac tree*) *pictured on the left is planted in a standard 3'×10' tree pit. This tree has plenty of room for full development. The* Acer platanoides (*Norway maple*) *shown on the right were planted in spaces that were much too small. They were never given the opportunity to properly grow.

Discussion/Recommendations

Over the years many trees have been planted in sites which are much too small. This has had a negative effect on general tree health and has made hardscape damage much more likely to occur. If the city continues to abide by its standard sizes for tree pits and tree lawns when new planting occurs, over time the number of trees growing in very constricted spaces will decline. It will also facilitate the spread of a tree's trunk taper, root collar, and immediate large structural roots.

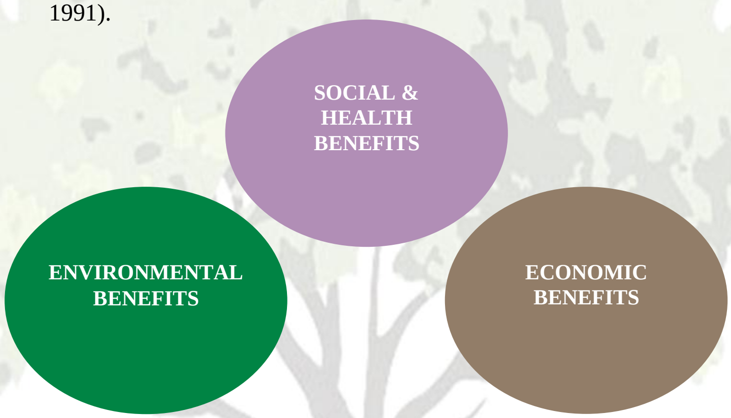
In some neighborhoods the city easement actually significantly extends beyond the sidewalk. This leaves open and unrestricted space for trees to grow. Although trees growing in such sites were collected, vacant planting sites in open and unrestricted space were not. Efforts should be made to identify more of these sites since they create very high potential for the growth of large, healthy trees.

Photograph 20. These two magnificent* Platanus × acerifolia (*London planetree*) *were grown in an open/unrestricted environment. Most of the city's largest and healthiest trees were grown in this type of site.

Section 2: Benefits of the Urban Forest

The urban forest plays an important role in supporting and improving the quality of life in urban areas. A tree's shade and beauty contributes to the community's quality of life and softens the often hard appearance of urban landscapes and streetscapes. When properly maintained, trees provide abundant environmental, economic, and social/health benefits to a community far in excess of the time and money invested in their planting, pruning, protection, and removal. A full accounting of Pittsburgh's street tree benefits is available in the 2015 Pittsburgh i-Tree Ecosystem Analysis (Davey Resource Group 2015).

- 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 2001b).
- Chicago apartment buildings with medium amounts of greenery had 42% fewer crimes than those without any trees (Kuo and Sullivan 2001a).
- Chicago apartment buildings with high levels of greenery had 52% fewer crimes than those without any trees (Kuo and Sullivan 2001a).
- Employees who see nature 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 3–4 minutes (Ulrich 1991).

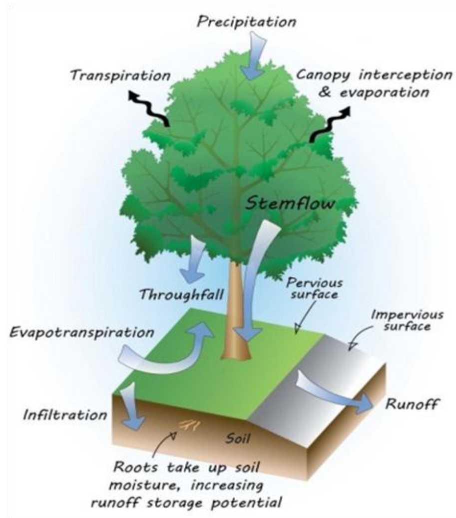


- Trees decrease energy consumption and moderate local climates by providing shade and acting as windbreaks.
- Trees act as mini-reservoirs, helping to slow and reduce the amount of stormwater runoff that reaches storm drains, rivers, and lakes. 100 mature tree crowns intercept ~100,000 gallons of rainfall 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.

- Trees increase residential property values an average of 7% when present in the yard or neighborhood. Commercial property rental rates were 7% higher when trees were on the property (Wolf 2007).
- Trees moderate temperatures in the summer and winter, saving on heating and cooling expenses (North Carolina State Univ. 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 the business district had a positive influence on consumers' perceptions of the area (Wolf 2000).

The i-Tree Eco and i-Tree Streets applications were used to assess the trees inventoried—these management and analysis tools use tree inventory data to quantify the dollar value of annual environmental and aesthetic benefits provided by trees, including energy conservation, air quality improvement, CO_2 reduction, stormwater control, and increases in property value. They estimate the costs and benefits of a street tree population and create annual benefit reports that demonstrate the value street trees provide to a community.

The Pittsburgh street tree population has recorded an annual benefit of $2.24 million in energy savings, stormwater reduction, increased property values, and overall air quality improvements.



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

Air Quality Improvements

The inventoried tree population removes 27,900 pounds of air pollutants annually. The i-Tree Streets calculation takes into account the biogenic volatile organic compounds (BVOCs) that are released from trees. The net total value of these benefits is estimated to be $417,700.

Carbon Sequestration and Avoidance

Trees absorb carbon dioxide (CO_2) as a process of photosynthesis (Nowak et al. 2013). It is estimated that Pittsburgh street trees sequester a net 4.4 million pounds of carbon dioxide every year, valued at $14,368 annually, while accounting for CO_2 released during decomposition and maintenance activities. They also reduce the amount of emissions by reducing heating and cooling demands. It is estimated that trees prevent the emission of 7.3 million pounds of carbon annually, which values at $23,967 per year. Both services reduce the total amount of CO_2 in the atmosphere at any given time.

Energy Use

The contribution of public trees towards conserving energy is reflected in their ability to shade structures and surfaces, reduce electricity use for air conditioning in summer, and divert wind in the winter, which reduces natural gas use. Based on the inventoried trees, the annual electric and natural gas savings are equivalent to 278 MWh of electricity and 4,098 MBtu of natural gas. When converted into monetary values using default economic data, this accounts for a savings of $96,501 energy consumption each year. These large leafy canopies provide shade, which reduces energy usage and increases their value.

Stormwater

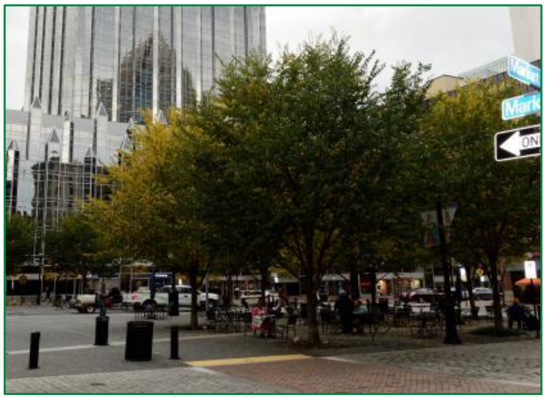
Trees intercept rainfall, which reduces costs to manage stormwater runoff. Pittsburgh's inventoried ROW trees intercept 15 million gallons of rainfall annually. The estimated average savings for the city in the management of stormwater runoff is $134,848 annually.

Aesthetic/Other

Trees provide social benefits in numerous quantifiable ways. These benefits stem, in part, from increases in property and real estate values. Pittsburgh's trees contribute $1,556,747 worth of aesthetic/other benefits.

Section 3: Tree Management Program

This tree management program was developed to uphold Pittsburgh's comprehensive vision for preserving its street trees. This 10-year program is based on the tree inventory data. This program was designed to reduce risk through prioritized tree removal and pruning, and to improve tree health and structure through proactive pruning cycles. Tree planting to mitigate removals and increase canopy cover and public outreach are important parts of the program, as well.

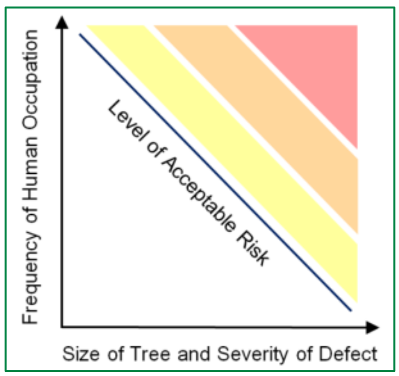


Photograph 21. These* Ulmus × *(hybrid elm) trees planted downtown are an example of trees with a low risk of failure. Inclusion in a regular pruning cycle will increase vitality and minimize chances of failure.

Implementing a tree care program is an ongoing process. Tree work must always be prioritized to reduce public safety risks. Davey Resource Group recommends completing the work identified during the inventory based on assigned risk ratings; however, it is also essential to routinely monitor the tree population to identify other Severe or High Risk trees so that they may be systematically addressed. Regular pruning cycles and tree planting is important; however, priority work (especially for trees rated as Severe or High Risk) must sometimes take precedence to ensure that risk is expediently managed.

How Risk Was Assessed during the Inventory

Every tree has an inherent risk of tree failure or defective tree part failure. During the inventory, Davey Resource Group performed a risk assessment for each tree and assigned a risk rating following protocol based on *Urban Tree Risk Management* (Pokorny et al. 1992). The probability of failure, size of defective part, probability of target impact, and other risk factors were evaluated for each tree inventoried tree. Independent point values were assigned and summed to generate the risk rating.



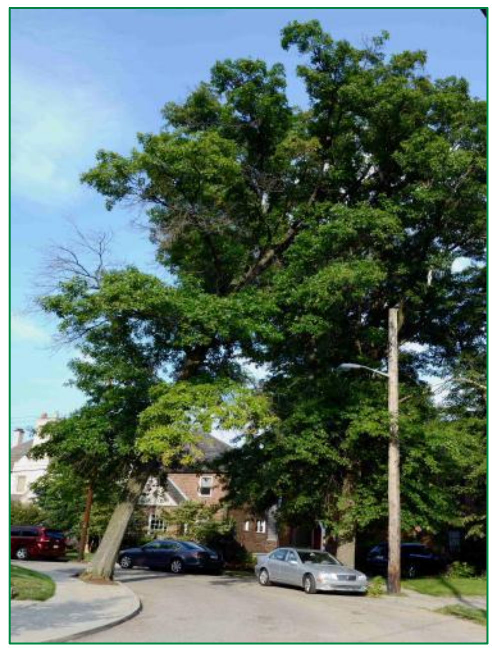
- *Probability of Failure* (1–4 points)—Identifies the most likely failure and rates the likelihood that the structural defect(s) will result in failure based on observed, current conditions.
- *Size of Defective Part* (1–3 points). Rates the size of the part most likely to fail.
- *Probability of Target Impact* (1–3 points). Rates the use and occupancy of the area that could be struck by the defective part.
- *Other Risk Factors* (0–2 points). This category is used if professional judgment suggests the need to increase the risk rating. It is especially helpful when growth characteristics become a factor in risk rating. For example, some tree species have growth patterns that make them more vulnerable to certain defects such as weak branch unions and branching shedding.

Once risk rating is calculated, a level of risk is assigned to each tree. The assigned risk rating allows for effective prioritization of tree maintenance work.

- *Severe Risk* (rating of 9 or 10)—Trees described as Severe Risk have defects that cannot be cost-effectively or practically treated. Most of the trees in this category have multiple or significant defects in the trunk, crown, or critical root zone. Defective trees and/or tree parts are generally larger than 20 inches in diameter and are found in areas of frequent occupation, such as a congested street, a main thoroughfare, and/or near a school.
- *High Risk* (rating of 7 or 8)—Trees designated as High Risk have defects that may or may not be cost-effectively or practically treated. Most of the trees in this category have multiple or significant defects that affect more than 40% of the trunk, crown, or critical root zone. Defective trees and/or tree parts are generally 4–20 inches in diameter and are found in areas of frequent occupation, such as a congested street, main thoroughfare, and/or near a school.
- *Moderate Risk* (rating of 5 or 6)—Trees described as Moderate Risk have defects that may be cost-effectively or practically treated. Most of the trees in this category exhibit several moderate defects that affect less than 40% of a tree's trunk, crown, or critical root zone. These trees may be in high-, moderate-, or low-use areas.
- *Low Risk* (rating of 3 or 4)—Trees designated as Low Risk have minor visible structural defects or wounds and are typically found in areas with moderate- to low-use areas.
- *None* (rating of 0)—Used for planting sites and stumps.

Trees with elevated (Severe or High) risk levels are usually recommended for removal or pruning. In some situations, risk may be reduced by adding support (cabling or bracing) or by moving the target away from the tree. Davey Resource Group recommends only removal or pruning for the purpose of minimizing risk. However, in special situations, such as a significant or memorial tree or a tree in a historic area, the city may decide that cabling, bracing, or moving the target may be the best option to reduce risk.

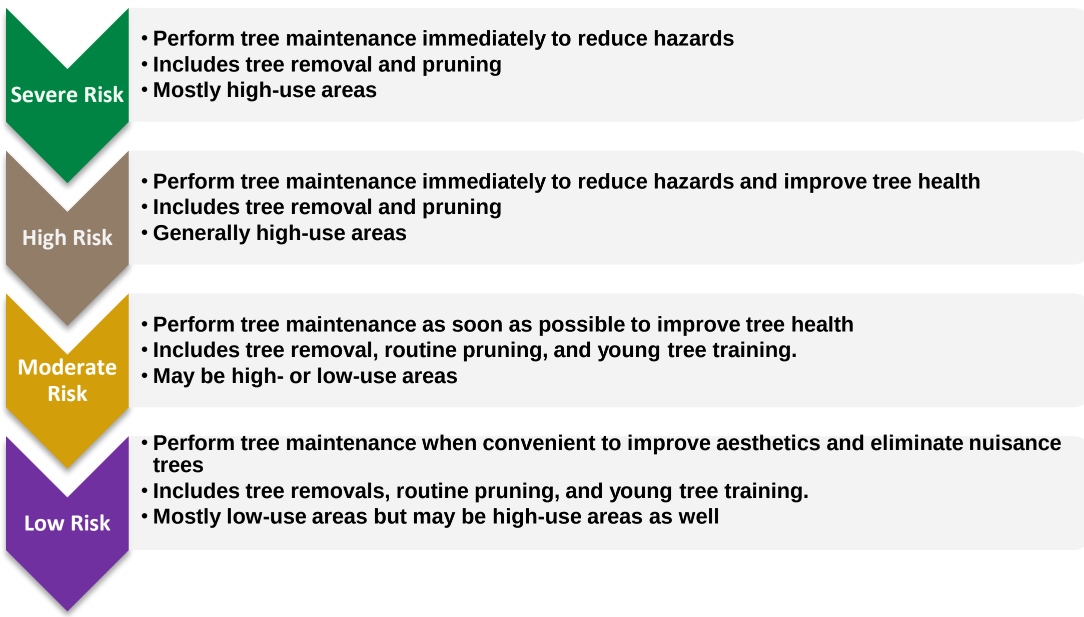
Determination of acceptable risk ultimately lies with Pittsburgh Forestry Division managers. Given that trees often have associated risks, location is an important factor in the determination and acceptability of risk for any given tree. The level of risk associated with a tree increases as the frequency 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.



Photograph 22. The heavy lean in this large* Quercus palustris *(pin oak), combined with its proximity to people and property, makes it a Severe Risk tree. The city had the tree removed as soon as the risk assessment was shared.

Tree Maintenance

In this plan, the recommended tree maintenance work was divided into either tree removals, High and Severe Risk pruning, or proactive pruning categories. Maintenance priorities are based on assigned risk; the higher the risk, the higher the priority. Proactive tree maintenance recommendations include Moderate or Low Risk prunes that are placed into an 8-year cyclical pruning program, along with young trees that are placed into a 2.5-year cyclical program. Tree planting, inspections, and community outreach are also considered proactive maintenance. Appendix B details the estimated costs and timing for all recommended maintenance addressed during the inventory.



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:

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

Regularly inspecting trees and establishing tree maintenance cycles generally reduce the risk of failure, as problems can be identified and addressed before they escalate.

In this plan, all tree removals and Severe and High Risk pruning are included in the priority maintenance program.

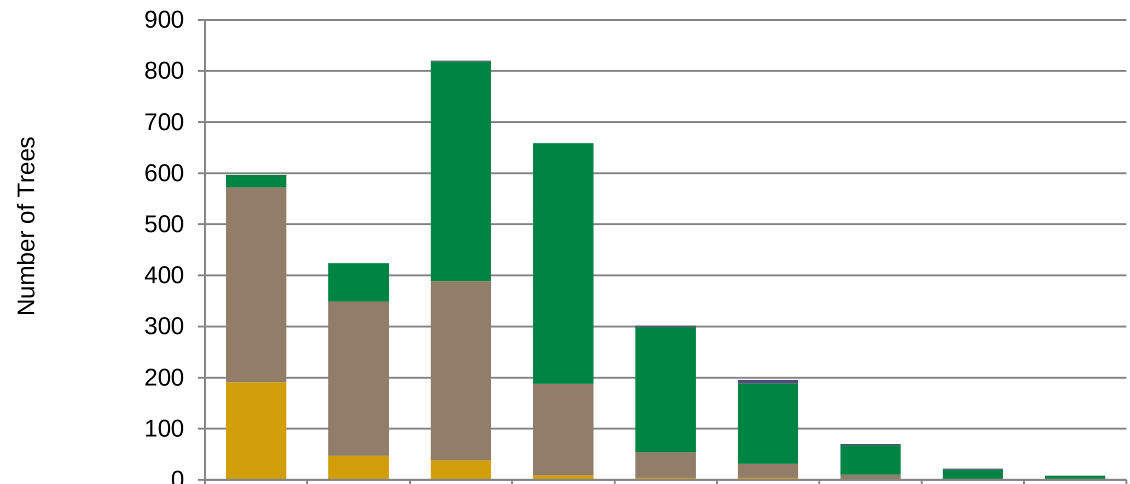
Tree Removal

Although tree removal is usually considered a last resort and may sometimes create a reaction from the community, there are circumstances when it is necessary. Trees fail from natural causes, such as age, diseases, insects, and weather conditions, and from physical injury due to vehicles, vandalism, and root disturbances. Davey Resource Group recommends that trees be removed when corrective pruning will not adequately eliminate the hazard or when it is cost-prohibitive to correct problems. Trees causing obstructions or interfering with power lines or other infrastructure should be removed when their defects cannot be corrected through pruning or other maintenance practices. Nuisance trees and diseased trees also merit removal.

Photograph 23. This* Tilia americana *(American basswood) ***is a priority removal. In its current state, this tree is providing limited benefits and is large enough to cause significant damage if it were to fail.***

Even though large short-term expenditures may be required, securing the funding required to expediently complete priority tree removals is important to reduce risk and to promote public safety.

Figure 7 presents tree removals by risk rating and diameter size class. Priority is established based on the degree of risk—higher risk calls for higher priority. The following sections briefly summarize the recommended removals based on the inventory. Appendix B details the estimated costs and timing of recommended removals.



Risk Rating	1″–3″	4″–6″	7″–12″	13″–18″	19″–24″	25″–30″	31″–36″	37″–42″	≥43″
Severe	0	0	1	0	3	6	2	2	0
High	25	75	430	471	245	158	58	18	6
Moderate	381	302	351	179	50	27	9	2	2
Low	191	47	38	9	4	4	1	0	0

Diameter Size Class

Figure 7. Tree removals by risk rating and diameter size class.

Severe Risk

The inventory identified 14 Severe Risk trees that were recommended for removal. Size of the defect, probability of failure, or location of the trees in relation to their surroundings were the basis for Severe Risk ratings. These trees are medium to large in size (12–42 inches DBH) and should be removed immediately to promote public safety. Severe Risk removals can be performed concurrently with Severe Risk pruning.

High Risk

High Risk removals have observable and sizeable defects with elevated probabilities of failure. The location of these trees in relation to their surroundings also increases their risk. The inventory identified 1,486 High Risk trees recommended for removal. The diameter size classes for these trees ranged between 1 inch DBH and 61 inches DBH. These trees should be removed immediately because of their assigned risk. Severe and High Risk removals and pruning can be performed concurrently.

Moderate Risk

Tree removals in this category still pose some risk but have a smaller size of defect and/or less potential for target impact. The inventory identified 1,303 Moderate Risk trees recommended for removal. Most Moderate Risk trees were smaller than 24 inches DBH. These trees should be removed as soon as possible, after all Severe and High Risk removals and pruning have been completed.

Low Risk

Low Risk removals pose little threat; these trees are generally small, dead, invasive, or poorly formed trees that need to be removed. Eliminating these trees will reduce breeding site locations for insects and diseases and will enhance the aesthetic value of the area. Healthy trees growing in poor locations or undesirable species are also included in this category.

The inventory identified 294 Low Risk trees recommended for removal. Almost all of these trees were smaller than 13 inches DBH. Many of these trees were invasive *Morus alba* (white mulberry) that may be in Fair or Good condition but should still be eliminated due to their negative impact on desirable vegetation. All Low Risk trees should be removed when convenient and after all Severe, High, and Moderate Risk removals and pruning have been completed.

Photograph 24. This Hill District* Acer rubrum *(red maple) is an example of a tree designated for Low Risk removal. Disease progression means that this tree is no longer viable; however, the tree is unlikely to cause significant damage if it were to fail.

Stump Removal

The inventory identified 1,180 stumps recommended for removal. Most of these stumps were smaller than 25 inches DBH as shown in Figure 8.

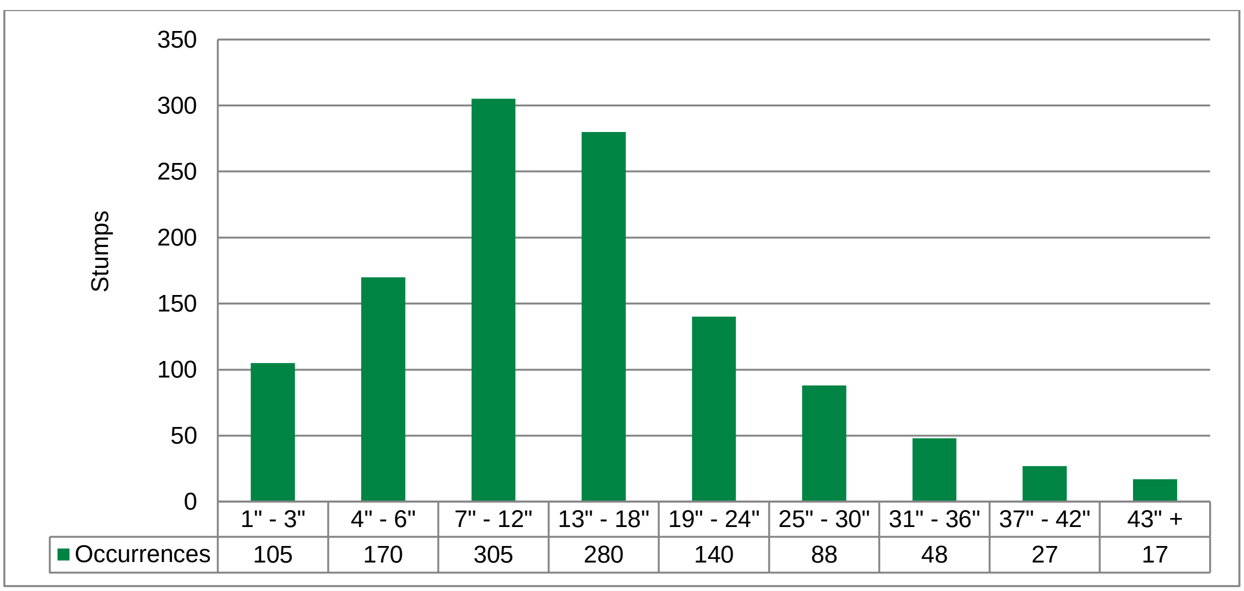


Figure 8. Stumps requiring removal by diameter class.

Discussion/Recommendations

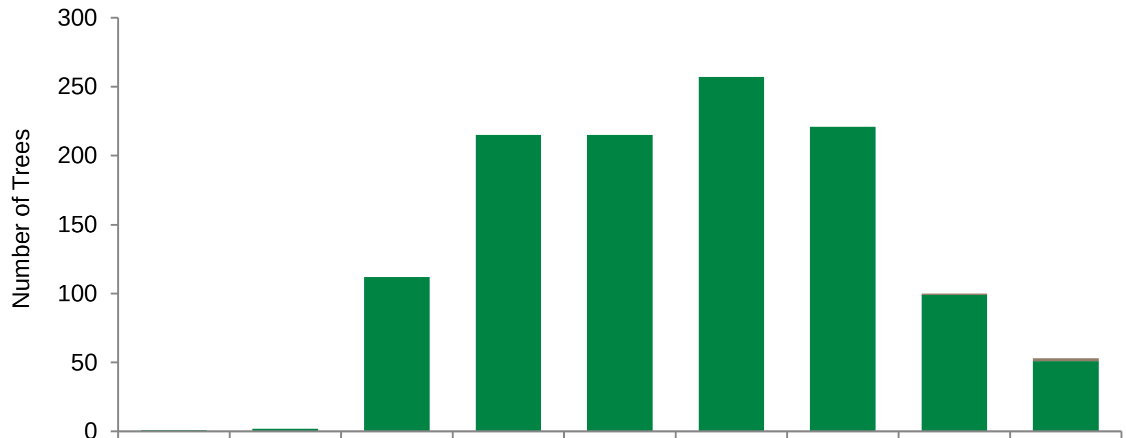
Tree removal is the most expensive management activity performed by many municipalities. In the long run, prompt removal will prevent injury to citizens and visitors, and minimize damage to property, blockage of roadways after storms, and interruption of electricity and communications delivery. Removals should be done in the first two years of the plan to minimize risk.

Priority Pruning

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

Figure 9 presents the number of trees recommended for pruning by size class. The sections that follow briefly summarize the recommendations.

Appendix B details the estimated costs and timing of recommended removals.



	1″–3″	4″–6"	7″– 12″	13″–18″	19″– 24″	25″–30″	31″– 36″	37″– 42″	≥43″
Severe	0	0	0	0	0	0	0	1	2
High	1	2	112	215	215	257	221	99	51

Figure 9. Severe and High Risk trees requiring pruning by diameter class.

Severe Risk

The inventory identified only 3 Severe Risk trees recommended for pruning. The size of the defect, probability of failure, or location of the trees in relation to their surroundings were the reasons for their elevated risk ratings. Severe Risk pruning should be performed at the same time as removal. All Severe Risk trees were between 37 inches and 49 inches DBH.

High Risk

High Risk trees recommended for pruning have observable and sizeable defects with elevated probabilities of failure. The location of these trees in relation to their surroundings also increases their risk. The inventory identified 1,173 High Risk trees recommended for pruning. The diameter size classes for these trees ranged between 3 inches to 61 inches DBH. Pruning should be performed on trees 19 inches DBH and greater, since these trees have a higher potential for causing severe damage. Once these trees are pruned, High Risk trees smaller than 19 inches should be pruned.

Discussion/Recommendations

Priority pruning is essential to limiting risk of human injury and property damage. Priority pruning also enhances the aesthetic contributions of the urban forest. It should be performed as soon as budgets allow.

Proactive Maintenance

Proactive tree maintenance requires that trees are managed and maintained under the responsibility of an individual, department, or agency. Tree work is typically performed during a cycle. Individual tree health and form are routinely addressed during the cycle. When trees are planted, they are planted selectively and with purpose. Ultimately, proactive tree maintenance should reduce crisis situations in the urban forest, as every tree in the managed population is regularly visited, assessed, and maintained. Davey Resource Group recommends proactive tree maintenance that includes pruning cycles, inspections, and planned tree planting.

Pruning Cycles

The goals of pruning cycles are to visit, assess, and prune trees on a regular schedule to improve health and reduce risk. Typically, Davey Resource Group recommends that pruning cycles begin after all Severe and High Risk trees are corrected through priority removal or pruning. However, due to the long-term benefits of pruning cycles, Davey Resource Group recommends that the cycles be implemented in Year 1, after all priority work is completed. To ensure that all trees receive the type of pruning they need to mature with better structure and fewer hazards, two pruning cycles are recommended: the young tree training cycle (YTT Cycle) and the routine pruning cycle (RP Cycle). The cycles differ in the type of pruning, the general age of the target tree, and length.

The recommended number of trees in the pruning cycles will need to be modified to reflect changes in the tree population as trees are planted, age, and die. Newly planted trees will enter the YTT Cycle once they become established. As young trees reach maturity, they will be shifted from the YTT Cycle into the RP Cycle. When a tree reaches the end of its useful life, it should be removed and eliminated from the RP Cycle. Tree Pittsburgh currently dedicates staff resources for ongoing training pruning for new trees planted in Pittsburgh as early as one year after planting. young tree training pruning with staff and volunteers can focus on trees for as long as 5 or 6 years after planting.

Photograph 25. These* Quercus palustris (*pin oak*) *in a southwest side industrial park would benefit from inclusion in a regular pruning cycle. Such proactive maintenance can lead to lower property damage liability claims for the city, while continuing to soften the visual impact of industrial areas.

For many communities, a proactive tree management program is considered unfeasible. An on-demand response to urgent situations is the norm. Research has shown that a proactive program that includes a routine pruning cycle will improve the overall health of a tree population (Miller and Sylvester 1981). Proactive tree maintenance has many advantages over on-demand maintenance, the most significant of which is reduced risk. In a proactive program, trees are regularly assessed and pruned, which generally means that most defects will be found and eliminated before they escalate to a hazardous situation with an unacceptable level of risk. Other advantages of a proactive program include: increased environmental and economic benefits from trees, more predictable budgets and projectable workloads, and reduced long-term tree maintenance costs.

Why Prune Trees on a Cycle?
Miller and Sylvester (1981) examined the frequency of pruning for 40,000 street and boulevard trees in Milwaukee, Wisconsin. They documented a decline in tree health as the length of the pruning cycle increased. When pruning was not completed for more than 10 years, average tree condition was rated 10% lower than when trees had been pruned within the last several years.
Miller and Sylvester suggested that a pruning cycle of five years is optimal for urban trees.

YTT Cycle

Trees included in the YTT 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, which increases risk and creates potential liability. Generally, conifers do not need structural pruning during their early years and are included in the regular pruning rather than YTT cycle.

YTT pruning is performed to improve tree form or structure; the recommended length of an YTT Cycle is three years because young trees tend to grow at faster rates (on average) than more mature trees.

The YTT Cycle differs from the RP Cycle in that these trees generally can be pruned from the ground with a pole pruner or pruning shear. The objective is to increase structural integrity by pruning for one dominant leader. Of course, this is species-specific, since many trees such as *Betula nigra* (river birch) may naturally have more than one leader. For these and similar trees, YTT pruning is used to develop a strong structural architecture of branches so that future growth will lead to a healthy, structurally sound tree.

Photograph 26. This young* Corylus colurna (*Turkish filbert*) *will benefit from inclusion in the young tree training cycle. Pruning at an early age improves tree structure, enhances the benefits a tree provides, and lengthens the useful life of a tree.

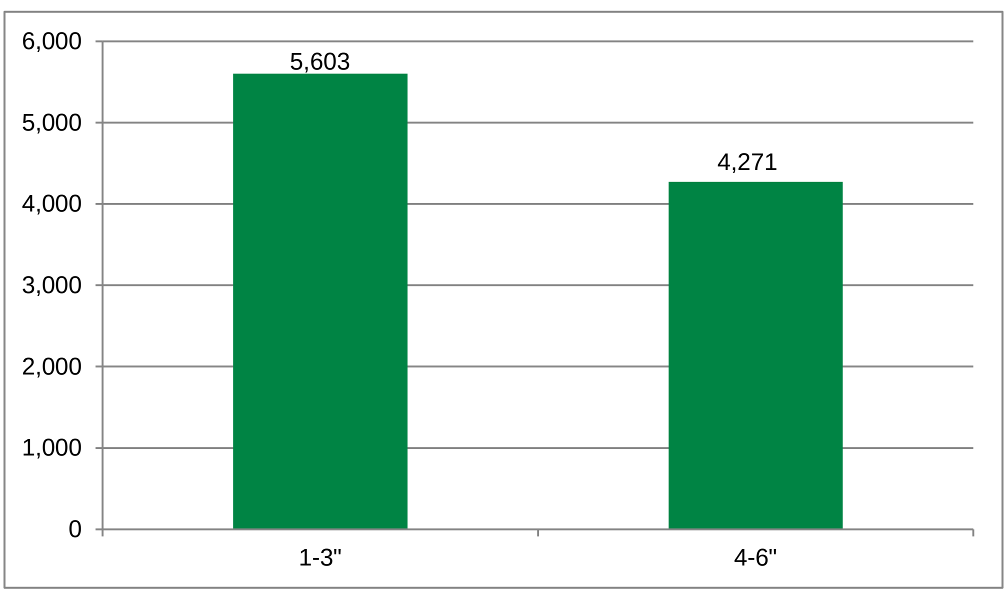


Figure 10. Trees recommended for young tree training by diameter class.

Discussion/Recommendations

Davey Resource Group recommends that Pittsburgh implement a 2-1/2-year YTT Cycle to commence immediately (see Appendix B). The YTT Cycle will include existing young trees. During the inventory, 9,873 trees less than 7 inches DBH were identified for young tree training. Strong planting programs by entities like Tree Pittsburgh and the Western Pennsylvania Conservancy have contributed to this high proportion. Davey Resource Group recommends that 3,949 young trees be structurally pruned each year beginning immediately. If trees are planted, they will need to enter the YTT Cycle after establishment, typically a few years after planting.

In future years, the number of trees in the YTT Cycle will be based on tree planting efforts and growth rates of young trees. The city should strive to prune all of Pittsburgh's young trees twice in the first five years after they have been planted.

In recent years, Tree Pittsburgh has led volunteer pruning events for young trees planted primarily through the TreeVitalize Pittsburgh program. This has been done through Tree Pittsburgh's Tree Tenders volunteer program. Tree Pittsburgh also dedicates staff time to training pruning through a winter pruning field crew. While the city relies on such programs to perform young tree training, it must also be prepared to perform this work if funding for—and participation in—such programs is reduced in the future.

RP Cycle

The RP Cycle includes established, maturing, and mature trees (mostly greater than 8 inches DBH) that need cleaning, crown raising, and reducing to remove deadwood and improve structure. Over time, routine pruning generally improves health and reduces risk as most problems can be corrected before they escalate into more costly priority tree work. Included in this cycle are Moderate and Low Risk trees that require pruning and pose some risk but have a smaller size of defect and/or less potential for target impact. The hazards found within these trees can usually be remediated during the RP Cycle.

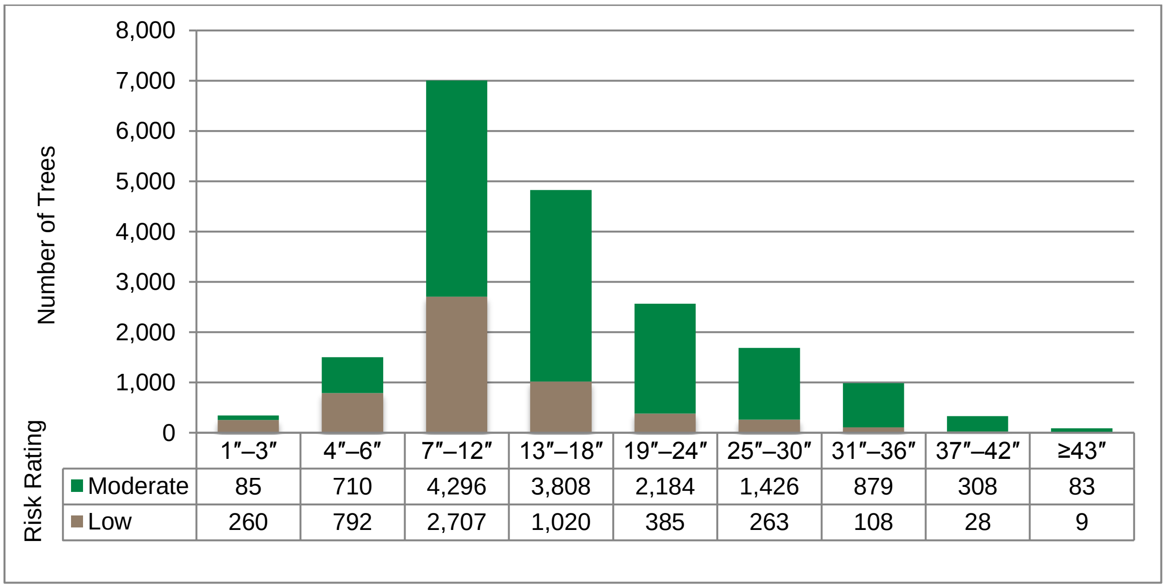
Photograph 27. Including these* Gleditsia tricanthos (*honeylocust*) *in the regular pruning cycle will help them continue to provide an aesthetic accent to the downtown business district, while avoiding undue risk.

The length of the RP Cycle is based on the size of the tree population and what was assumed to be a reasonable number of trees for a program to prune per year. The recommended RP Cycle for a tree population is generally five years but may extend to seven years if the population is large, and city budget concerns do not allow for a shorter cycle. Davey Resource Group recommends an eight-year RP Cycle for the City of Pittsburgh. If funds become available in the future, the length of the pruning cycle should be shortened as much as possible toward the five-year ideal.

Discussion/Recommendations

Davey Resource Group recommends that the city establish an 8-year RP Cycle in which approximately one-eighth of the tree population is to be pruned each year (see Appendix B). The 2014 tree inventory identified approximately 19,360 trees that should be included in the RP Cycle, or about 2,420 per year. Davey Resource Group recommends that the RP Cycle begin in Year 2 of this 10-year plan, after Severe and High Risk trees are mitigated. After the proposed cycle time frame finishes its eighth and final year (in Year 9), the cycle would start over in Year 10.

The inventory found that most trees on the street ROW needed routine pruning (58%). Figure 11 shows that a variety of tree sizes will require pruning; however, most of the trees that require routine pruning were smaller than 25 inches DBH.



Risk Rating	1″–3″	4″–6″	7″–12″	13″–18″	19″–24″	25″–30″	31″–36″	37″–42″	≥43″
Moderate	85	710	4,296	3,808	2,184	1,426	879	308	83
Low	260	792	2,707	1,020	385	263	108	28	9

Figure 11. Trees recommended for inclusion in the RP Cycle by diameter class.

Inspections

Inspections are essential to uncovering potential problems with trees. They should be performed by a qualified arborist who is trained in the art and science of planting, caring for, and maintaining individual trees. Arborists are knowledgeable about the needs of trees and are well equipped to provide proper care.

Photograph 28. Beechwood Boulevard includes trees of many ages and conditions. Regular inspections can mitigate risky situations before they cause damage or injury.

Trees along the street ROW and in parks should be regularly inspected and attended to as needed based on the inspection findings. When trees need additional or new work, they should be added to the maintenance schedule and budgeted as appropriate. In addition to locating potential hazards, inspections are an opportunity to look for signs and symptoms of pests and diseases. Pittsburgh has a large population of trees that are susceptible to pests and diseases, including maple, a target of ALB, and *Quercus* spp. (oak) trees, which are susceptible to oak wilt.

Tree Planting

Planting trees is a worthwhile goal as long as trees species are carefully selected and correctly planted. When trees are planted, they are planted selectively and with purpose. Without upfront planning and follow-up tree care, a newly planted tree may become a future problem instead of an asset to the community.

Pittsburgh currently has a highly successful and well-managed TreeVitalize planting program. When planting trees, Pittsburgh urban foresters follow these steps:

- Consider the specific purpose of the tree planting.
- Assess the site and know its limitations (i.e., confined spaces, overhead wires, and/or soil type).
- Select the species or cultivar best suited for the site conditions.
- Examine trees before buying them, and buy for quality.

Photograph 29. This planting in the Central Business District is an example of continued efforts to increase Pittsburgh's tree canopy.

Inventoried Street ROW Planting Space

The goal of tree planting is to have a vigorous, healthy tree that lives to the limits of its natural longevity. That can be difficult to achieve in an urban growing environment because the soils can typically be of poor quality and irrigation is limited. However, proper planning, species selection, tree planting techniques, and follow-up tree maintenance will improve the chance of tree planting success.

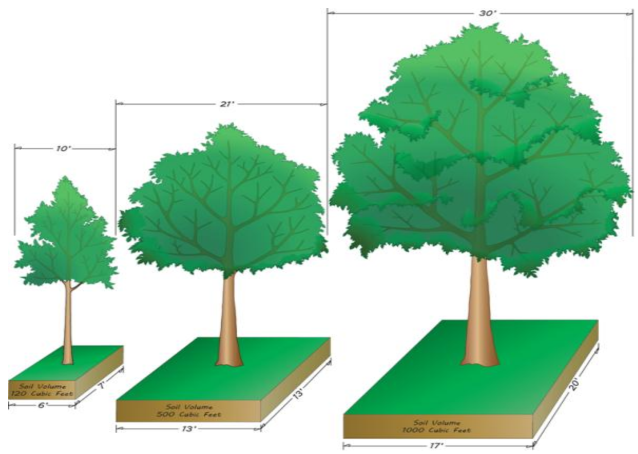


Illustration of tree size and site considerations based on the work of Casey Trees (2008).

<u>Findings</u>

During the inventory all existing tree pits and tree lawns three feet wide or greater were identified as vacant planting sites. Table 8 shows that the inventory found 3,550 vacant planting sites. Sites between 3 and 5 feet wide or which have overhead utilities present are only appropriate for small-sized trees species. Table 8 shows that 69% of planting sites were consistent with this specification. Approximately 6% of the planting sites were between 5 and 7 feet in width, had no overhead utilities present, and are appropriate for planting with medium-sized species. About 1% of vacant sites were wider than 7 feet, had no overhead utilities present, and are appropriate for large-sized species. About 24% of all sites were tree pits with a width of less than 3 feet and will need to be expanded before they can be planted. These sites were identified as "vacant not suitable".

Table 8. Vacant Sites Identified for Tree Planting by Space Size Category

Planting Site Type	Occurrences
Vacant site large	44
Vacant site medium	215
Vacant site small	2,440
Vacant not suitable	851

Planting to Fill Vacancies

Recommendations

Pittsburgh's unique infrastructure challenges make existing vacant planting sites a rarity. To expand canopy cover, we recommend that 2,550 of 3,550 vacant sites identified during the 2014 inventory be planted over the next 10 years. Of these existing tree sites, 851 are much smaller than the standard Pittsburgh planting space and will need to be expanded before replacing. At the recommended planting rate, 611 of these sites will need such improvement.

Tree Removal Replacement Planting

Recommendations

To maintain canopy cover, we recommend that every tree that is removed be replaced with a newly planted tree; 3,097 trees were identified for removal and should be replaced. An estimated 1,250 of these existing tree sites are much smaller than the standard Pittsburgh planting space and will need to be expanded before replacing.

Canopy Investment Planting

Recommendations

While planting in existing planting sites and replacing removed trees will help maintain the current canopy, it will not help expand the canopy in areas that have never had trees before. It is recommended that the city and its partners plant at least 150 additional trees per year in areas that are currently underserved by trees and have few—if any—vacant planting sites. All of these sites will need to have new spaces created.

Based on all of our combined planting recommendations, Davey Resource Group encourages the city to plant 715 trees per year (See Appendix B). An estimated 336 sites will need to be created or expanded each year before all of the proposed planting can be completed.

Tree Species Selection

Selecting a limited number of species could simplify decision-making processes; however, careful deliberation and selection of a wide variety of species is more beneficial and can save money. Planting a variety of species can decrease the impact of species-specific pests and diseases by limiting the number of susceptible trees in a population. This reduces time and money spent to mitigate pest- or disease-related problems. A variety of tree species can help limit the impacts from physical events, as different tree species react differently to stress. Species diversity helps withstand drought, ice, flooding, strong storms, and wind. The city and its partners have many expert urban foresters who rely on the *Pittsburgh Urban Forest Master Plan* to guide their species selections.

Pittsburgh is officially located in USDA Hardiness Zone 6b, which is identified as a climatic region with average annual minimum temperatures between −5°F and 0°F. However, recent harsh winters have caused a high rate of mortality among zone 6 tree species. Tree species selected for planting in Pittsburgh should be hardy for Zone 5, except in planting sites which are sheltered from the winter conditions.

Tree species should be selected for their durability and low-maintenance characteristics. These attributes are highly dependent on site characteristics below ground (drainage, nutrients, road salt, root spacing, soil pH, soil texture, and soil structure). Matching a species to its favored soil conditions is the most important task when planning for a low-maintenance landscape. Plants that are well matched to their environmental site conditions are much more likely to resist pathogens and insect pests. Such plants require less maintenance overall.

"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. 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 some shade may be a priority, but it is important to consider how a tree may impact existing utility lines as it grows taller, wider, and deeper. If the tree's canopy, at maturity, will reach overhead lines, it is best to choose another tree or a different location. Taking the time to consider location before planting can prevent power disturbances and improper utility pruning practices.

A major consideration for street trees is the amount of litter dropped by mature trees. Trees such as *Acer saccharinum* (silver maple) have weak wood and typically drop many small branches during a growing season. Others, such as *Liquidambar styraciflua* (American sweetgum), drop high volumes of fruit. In certain species, such as *Ginkgo biloba* (ginkgo), female trees produce offensive smelling large fruit; male ginkgo trees, however, produce no fruit. Furthermore, a few species of trees, including *Crataegus* spp. (hawthorn) and *Gleditsia triacanthos* (honeylocust), may have substantial thorns. These species should be avoided in high-traffic areas.

Seasonal color should also be considered when planning tree plantings. Flowering varieties are particularly welcome in the spring and deciduous trees that display bright colors in autumn can add a great deal of interest to surrounding landscapes.

The City of Pittsburgh has a list of tree species recommended for planting, which is a good beginning for future species selection (City of Pittsburgh 2015). This list provides expected height at maturity for each species and is designed to promote species diversity. However, this list should be regularly updated due to changing environmental conditions, new invasions of foreign pests and diseases, and the introduction of new tree species and cultivars in the nursery trade.

The 2015 Pittsburgh i-Tree Ecosystem Analysis identified several high-performing but underutilized trees based on inventory findings. London planetree was found to be one of the highest performers and should be planted as a replacement when like trees are being removed. American elm, ginkgo, honey locust, sweetgum, and *Zelkova serrata* (Japanese zelkova) have all proven to be strong performers over time.

Photograph 30. This* Parrotia persica *(Persian ironwood) is an excellent small-statured tree to plant under utility wires as shown in Shadyside.

The urban foresters with Tree Pittsburgh and the Western Pennsylvania Conservancy have done an excellent job over the past seven years in expanding the diversity of tree species being planted on Pittsburgh streets. *Cotinus obovatus* (American smoketree), *Gymnoclaudus dioecus* (Kentucky coffee tree), *Maackia amurensis* (Amur maackia), *Metasequoia glyptostroboides* (dawn redwood), *Nyssa sylvatica* (black tupelo), *Parrotia persica* (Persian ironwood), *Quercus acutissima* (sawtooth oak), *Q. macrocarpa* (bur oak), *Q. robur* (English oak), and *Ulmus* (elm) hybrid cultivars have all performed well as young trees when planted in the proper site. With the assistance of these organizations, the performance of these species should be monitored and promoted, especially if they continue performing well.

The city should explore new species and cultivars to plant on a trial basis. Attempts could be made to begin the planting of native species that are rarely planted in the city, such as *Betula alleghaniensis* (yellow birch) and *Carya* (hickory). There are also new cultivars of trees such as the thornless *Maclura pomifera* (osage orange) 'Wichita,' which make such cultivars more suitable for street tree planting than the naturally occurring species.

Appendix D of the *Pittsburgh Urban Forest Master Plan* has already set forth guidelines for Pittsburgh to follow so that the city's most severe diversity challenges are overcome. Maple already occupies 29% of the street ROW which is well in excess of the recommended maximum for a genus (20% of the population). Norway maple (11%) and red maple (10%) are just at the point at which any planting of these species will push them further above the recommended maximum for species diversity (10% of the population). The master plan dictates that the planting of maples be less than 5% of any new planting project. Planting of Norway maple has been banned completely since it has invasive qualities. Likewise, the planting of *Pyrus calleryana* (Callery pear) has been banned due to its invasive tendencies and its likelihood of failure during extreme weather events.

The master plan also has restricted the planting of *Ulmus parvifolia* (Chinese elm), which has been a very weak performer in Pittsburgh; and red oak group species like northern red oak and pin oak which have proven to be susceptible to many pests and diseases. As conditions change, Pittsburgh foresters should continue to adjust the recommended and restricted tree species and cultivars.

Newly Planted and Young Tree Maintenance

Equally important to planting trees is caring for them after they are planted. After a tree is planted, maintenance is essential for several years.

Watering

Initially, watering is the key to survival; new trees typically require at least 60 days of watering to establish. Determine how frequently trees should be irrigated based on time of planting, drought status, species selection, and site condition.

Mulching

Mulch can be applied to the growspace around a newly planted tree (or even a more mature tree) to ensure that no weeds grow, that the tree is protected from mechanical damage, and that the growspace is moist. Mulch should be applied in a thin layer, generally 1 to 2 inches, and the growing area should be covered. Mulch should not touch the tree trunk, nor should it be piled up around the tree.

Life-Long Tree Care

Once the tree is established, it will require routine tree care, which includes inspections, routine pruning, watering, plant health care, and integrated pest management as needed.

The city should employ qualified arborists to provide most of the routine tree care. An arborist can determine the type of pruning necessary to maintain or improve the health, appearance, and safety of trees.

These techniques may include: eliminating branches that rub against each other; removing limbs that interfere with wires and buildings or that obstruct streets, sidewalks or signage; removing dead, damaged, or weak limbs that pose a hazard or may ultimately decay; removing diseased or insect-infested limbs; creating better structure to lessen wind resistance and reduce the potential for storm damage; and removing branches—or thinning—to increase light penetration.

An arborist can help decide whether a tree should be removed and, if so, to what extent removal is needed. Additionally, an arborist can perform—and provide advice on—tree maintenance when disasters such as storms or droughts occur. Storm-damaged trees can often be dangerous to remove or trim. An arborist can assist in advising or performing the job in a safe manner while reducing further risk of damage to property.

Plant Health Care, a preventive maintenance process, helps keep trees in good health and helps trees defend themselves against insects, disease, and site problems. Arborists can help determine proper plant health so that Pittsburgh's tree population will remain healthy and provide benefits to the community for as long as possible.

Integrated Pest Management is a process that involves common sense and sound solutions for treating and controlling pests. These solutions incorporate basic steps: identifying the problem, understanding pest biology, monitoring trees, and determining action thresholds. The practice of Integrated Pest Management can vary depending on each site and each individual tree. A qualified arborist will be able to make sure that the city's trees are properly diagnosed and that a beneficial and realistic action plan is developed.

The arborist can also help with cabling or bracing for added support to branches with weak attachment, aeration to improve root growth, and installation of lightning protection systems.

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

Pittsburgh Urban Forestry Partners

There are two non-governmental and one semi-governmental organizations that provide vital contributions to the advancement of Pittsburgh's urban forest. The Western Pennsylvania Conservancy, the Pittsburgh Shade Tree Commission, and Tree Pittsburgh have provided funding and knowledge that made the 2014 tree inventory and associated reports possible.

The Western Pennsylvania Conservancy is a nonprofit organization dedicated to protecting the region's exceptional natural areas. The Western Pennsylvania Conservancy provided the majority of the funding and guidance for this project. Through the TreeVitalize Pittsburgh program, the Western Pennsylvania Conservancy has planted 23,000 trees throughout the Pittsburgh area since 2008. This organization plans to continue its leading role in the expansion of city canopy by contributing funds and labor for improving planting sites, purchasing plant material, installation of young trees, and early tree care.

The Shade Tree Commission is an appointed advisory board for the Mayor's office with the task of restoring and maintaining the city's tree population. The Shade Tree Commission has provided both funding and guidance for the current project.

The Shade Tree Commission determines the species selection list, publishes policies and procedures for planting and maintaining trees, applies for Tree City USA designation, and promotes compliance with existing forestry ordinances. The Shade Tree Commission established Treekeeper®, an online inventory to document the status of all Pittsburgh street trees. The Shade Tree Commission also contributes funds for planting and tree care to maintain and expand Pittsburgh's current canopy cover.

Tree Pittsburgh is an environmental non-profit organization dedicated to enhancing the city's vitality by restoring and protecting the urban forest through tree maintenance, planting, education, and advocacy. This organization has contributed a great amount of expertise for the conduct of this inventory project. Tree Pittsburgh specializes in community outreach; its Tree Tenders program has been responsible for the majority of young tree training in Pittsburgh over the past decade. During the same period, the program has planted more than 450 trees in the Lawrenceville, Uptown, Southside, Carrick, and Friendship neighborhoods. Tree Pittsburgh plans on continuing its planting and young tree care programs.

Community Outreach

The data that have been collected and analyzed to develop this plan contribute significant information about the tree population and can be utilized to guide the proactive management of that resource. These data can also be utilized to promote the value of the urban forest and the tree management program in the following ways:

- Tree inventory data can be utilized to justify needed priority and proactive tree maintenance activities as well as tree planting and preservation initiatives.
- Species data can be utilized to guide the development of tree species selection for planting projects with an objective of improving species diversity and limiting the introduction of invasive pests and diseases.
- Information in this plan can be utilized to advise citizens about threats to urban trees, such as Asian longhorned beetle and oak wilt.

Non-profit and semi-governmental organizations such as the Western Pennsylvania Conservancy, the Pittsburgh Shade Tree Commission, and Tree Pittsburgh already do an excellent job spearheading community involvement in the expansion and maintenance of Pittsburgh's urban forest. Various avenues for expanding outreach by Pittsburgh's urban forestry partners will be planned and implemented over the course of 2015. Efforts will include outreach to elected officials, municipal staff, partner organizations, and the general public.

Pittsburgh's data are a good barometer for providing tangible and meaningful outreach about the urban forest.

Photograph 31. Community planting events are great ways to educate people about trees, create a feeling of investment in the urban forest, and save money in the long term. This group of Tree Pittsburgh volunteers helped beautify the East Liberty neighborhood of Pittsburgh (Photograph courtesy of Tree Pittsburgh).

Inventory and Plan Updates

Davey Resource Group recommends that the inventory and management plan be updated so that the city can sustain its program and accurately project future program and budget needs:

- Conduct inspections of trees after all severe weather events. Record changes in tree condition, maintenance needs, and risk/risk rating in the inventory database. Update the tree maintenance schedule and acquire the funds needed to promote public safety. Schedule and prioritize work based on risk.
- Perform routine inspections of public trees as needed. Windshield surveys (inspections performed from a vehicle) in line with *ANSI A300 (Part 9)* (ANSI 2011) will help city staff stay apprised of changing conditions. Update the tree maintenance schedule and the budget as needed so that identified tree work may be efficiently performed. Schedule and prioritize work based on risk.
- If the recommended work cannot be completed as suggested in this plan, modify maintenance schedules and budgets accordingly.
- Update the inventory database as work is performed. Add new tree work to the schedule when work is identified through inspections or a citizen call process.
- Re-inventory the street ROW and parks, and update all data fields after five to seven years.
- Revise the *Tree Management Plan* after five or seven years when the re-inventory has been completed.

Maintenance Schedule

Utilizing data from the 2014 City of Pittsburgh tree inventory, an annual maintenance schedule was developed that details the number and type of tasks recommended for completion each year. Davey Resource Group made budget projections utilizing industry knowledge and public bid tabulations. Actual cost estimates were provided by Pittsburgh's Forestry Division. A summary of the maintenance schedule is presented here, and the complete table of estimated costs for Pittsburgh's 10-year tree management program is presented in Appendix B.

The schedule provides a framework for completing the inventory maintenance recommendations over the next 10 years. Following this schedule can help tree care activities evolve from an on-demand system to a more proactive tree care program.

Annual budget funds are needed to ensure that hazard trees are remediated and that critical YTT and RP Cycles can begin. With proper professional tree care, the safety, health, and beauty of the urban forest will improve.

Year 1 $1,962,448

- 499 Severe and High Risk Removals
- 846 Severe and High Risk Pruning
- 715 Trees Recommended for Planting and Follow-Up Care
- 336 Sites Prepared for Planting
- 239 Stumps for Removal
- YTT Cycle: 3,949 Trees
- Inclusion of Newly Found Priority Tree Work (Removal or
- Pruning): Costs To Be Determined

Year 2 $1,795,872

- 1,001 High Risk Removals
- 323 Moderate and Low Risk Removals
- 330 Severe and High Risk Pruning
- 239 Stumps for Removal
- RP Cycle: 1/8 of Public Trees Cleaned
- YTT Cycle: 3,949 Trees
- 715 Trees Recommended for Planting and Follow-Up Care
- 336 Sites Prepared for Planting
- Inclusion of Newly Found Priority Tree Work (Removal or
- Pruning): Costs To Be Determined

Year 3 $1,444,277

- 322 Moderate and Low Risk Removals
- 236 Stumps for Removal
- RP Cycle: 1/8 of Public Trees Cleaned
- YTT Cycle: 3,949 Trees
- 715 Trees Recommended for Planting and Follow-Up Care
- 336 Sites Prepared for Planting
- Inclusion of Newly Found Priority Tree Work (Removal or
- Pruning): Costs To Be Determined

Year 4 $1,437,656

- 319 Moderate and Low Risk Removals
- 234 Stumps for Removal
- RP Cycle: 1/8 of Public Trees Cleaned
- YTT Cycle: 3,949 Trees
- 715 Trees Recommended for Planting and Follow-Up Care
- 336 Sites Prepared for Planting
- Inclusion of Newly Found Priority Tree Work (Removal or
- Pruning): Costs To Be Determined

Year 5 $1,437,656

- 318 Moderate and Low Risk Removals
- 234 Stumps for Removal
- RP Cycle: 1/8 of Public Trees Cleaned
- YTT Cycle: 3,949 Trees
- 715 Trees Recommended for Planting and Follow-Up Care
- 336 Sites Prepared for Planting
- Inclusion of Newly Found Priority Tree Work (Removal or
- Pruning): Costs To Be Determined

Year 6 $1,418,352

- 315 Moderate and Low Risk Removals
- RP Cycle: 1/8 of Public Trees Cleaned
- YTT Cycle: 3,949 Trees
- 715 Trees Recommended for Planting and Follow-Up Care
- 336 Sites Prepared for Planting
- Inclusion of Newly Found Priority Tree Work (Removal or Pruning):
- Costs To Be Determined.

Year 7 $1,347,148

- RP Cycle: 1/8 of Public Trees Cleaned
- YTT Cycle: 3,949 Trees
- 715 Trees Recommended for Planting and Follow-Up Care
- 336 Sites Prepared for Planting
- Inclusion of Newly Found Priority Tree Work (Removal or Pruning):
- Costs To Be Determined.

Year 8 $1,347,148

- RP Cycle: 1/8 of Public Trees Cleaned
- YTT Cycle: 3,949 Trees
- 715 Trees Recommended for Planting and Follow-Up Care
- 336 Sites Prepared for Planting
- Inclusion of Newly Found Priority Tree Work (Removal or Pruning):
- Costs To Be Determined.

Year 9 $1,347,148

- RP Cycle: 1/8 of Public Trees Cleaned
- YTT Cycle: 3,949 Trees
- 715 Trees Recommended for Planting and Follow-Up Care
- 336 Sites Prepared for Planting
- Inclusion of Newly Found Priority Tree Work (Removal or Pruning):
- Costs To Be Determined.

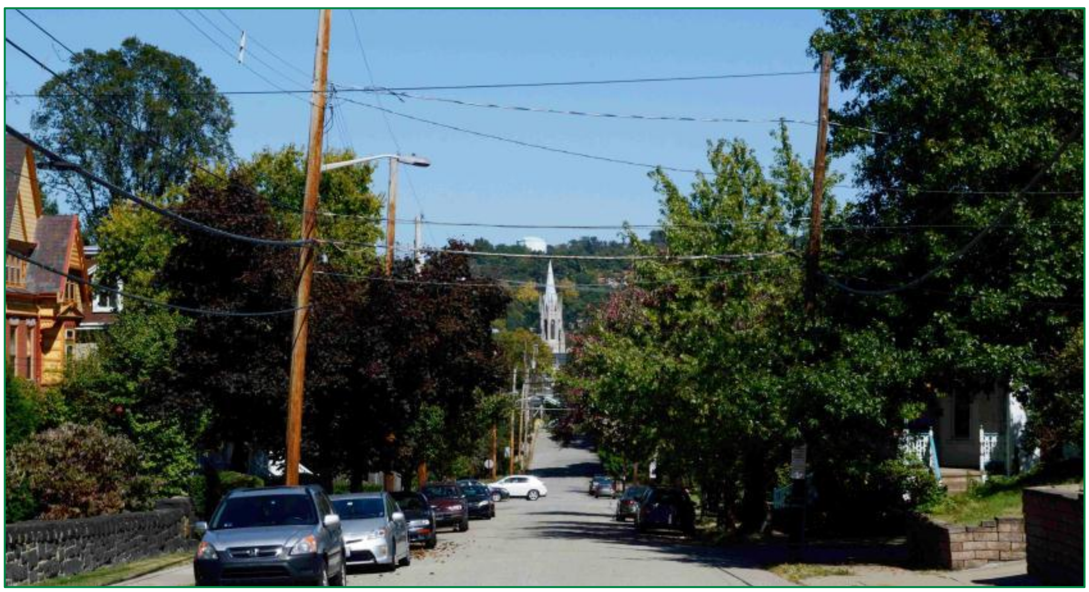
Year 10 $1,347,148

- RP Cycle: 1/8 of Public Trees Cleaned
- YTT Cycle: 3,949 Trees
- 715 Trees Recommended for Planting and Follow-Up Care
- 336 Sites Prepared for Planting
- Inclusion of Newly Found Priority Tree Work (Removal or Pruning):
- Costs To Be Determined.

Appendix B shows the approximate expenditures that would be necessary if the City of Pittsburgh conducted all removals and pruning on trees less than 25 inches DBH and on stumps with a diameter of less than 25 inches. Also included in these expenditures is maintenance work of local contractors, including removals, pruning, and stump removals on all larger trees and stumps. The budget also includes the costs of all recommended training pruning, planting site expansion, and planting activities, which have largely been developed by Tree Pittsburgh and the Western Pennsylvania Conservancy over the past seven years. Although both organizations plan to continue providing these services for Pittsburgh's urban forest, the ultimate responsibility for street trees rests with the City of Pittsburgh.

Furthermore, it is important to recognize the importance of non-profit organizations and the value of their contributions to Pittsburgh's urban forest. In the proposed 10-year budget, non-profits estimate that they will contribute approximately $7,850,000 (53% of the total budget) worth of time and materials. This includes all young tree training and planting costs. However, this contribution is dependent on funding and the willingness of volunteers.

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



Photograph 32. A well-managed, well-funded urban forestry program will help ensure that the entire city enjoys the benefits that trees provide to the Point Breeze Neighborhood.

Conclusions

Every hour of every day, public trees in Pittsburgh are supporting and improving the quality of life. When properly maintained, trees provide abundant environmental, economic, and social benefits far in excess of the time and money invested in planting, pruning, protection, and removal. It is estimated that Pittsburgh street trees provide $2.24 million of annual benefits.

Photograph 33. A young woman shows her love for Pittsburgh's urban forest in the Highland Park neighborhood.

Managing trees in urban areas is often complicated. Navigating the recommendations of experts, the needs of residents, pressures of local economics and politics, concerns for public safety and liability, physical aspects of trees, forces of nature and severe weather events, and the expectation that these issues are resolved all at once is a considerable challenge.

The city must carefully consider these challenges to fully understand the needs of maintaining an urban forest. With the knowledge and wherewithal to address the needs of the city's trees, the town is well positioned to thrive. If the management program is successfully implemented, the health and safety of Pittsburgh's trees and citizens will be maintained for years to come.

Glossary

aboveground utilities (data field): Shows the presence or absence of overhead utilities at the tree site.

address number (data field): The address number was recorded based on the visual observation by the Davey Resource Group arborist at the time of the inventory of the actual address number posted on a building at the inventoried site. In instances where there was no posted address number on a building or sites were located by vacant lots with no GIS parcel addressing data available, the address number assigned was matched as closely as possible to opposite or adjacent addresses by the arborist(s) and an "X" was added to the number in the database to indicate that the address number was assigned.

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* standards:** 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.

block side (data field): Address information for a site that includes the *on street*, *from street*, and *to street*. The *on street* is the street that the site is actually located on. The *from street* is the cross street one is moving away from when moving in the direction of traffic flow. The *to street* is the cross street one is moving toward when moving in the direction of traffic flow.

Benefit-Cost Ratio (BCR): The i-Tree Streets (BCR) is the ratio of the cumulative benefits provided by the landscape trees, expressed in monetary terms, compared to the costs associated with their management, also expressed in monetary terms.

canopy assessment: See **urban tree canopy (UTC) assessment**.

canopy cover: As seen from above, it is the area of land surface that is covered by tree canopy.

canopy spread (data field): Estimates the width of a tree's canopy in 5-foot increments.

canopy: Branches and foliage that make up a tree's crown.

clean (primary maintenance need): Based on *ANSI A300 Standards*, selective removal of dead, dying, broken, and/or diseased wood to minimize potential risk.

clearance requirements (data field): Illustrates the need for pruning to meet clearance standards over streets and sidewalks, or where branches are considered to be interfering with the movement of vehicles or pedestrians or where they are obstructing signs and street or traffic lights.

community forest: see **urban forest**.

condition (data field): The general condition of each tree rated during the inventory according to the following categories adapted from the International Society of Arboriculture's rating system: Excellent (100%), Very Good (90%), Good (80%), Fair (60%), Poor, (40%), Critical (20%), Dead (0%).

cycle: Planned length of time between vegetation maintenance activities.

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

diameter: See **tree size**.

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.

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 give you 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.

grow space size (data field): Identifies the minimum width of the tree grow space for root development.

grow space type (data field): Best identifies the type of location where a tree is growing. During the inventory, grow space types were categorized as island, median, open/restricted, open/unrestricted, raised planter, tree lawn/parkway, unmaintained/natural area, or well/pit.

hardscape damage (data field): Indicates trees damaged by hardscape or hardscape damaged by trees (for example, damage to curbs, cracking, lifting of sidewalk pavement one inch or more).

High Risk tree: Tree that cannot be cost-effectively or practically treated. Most High Risk trees have multiple or significant defects affecting less than 40% of the trunk, crown, or critical root zone. Defective trees and/or tree parts are most likely between 4–20 inches in diameter and can be found in areas of frequent occupation, such as a main thoroughfare, congested streets, and/or near schools.

invasive, exotic 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**.

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.

location (data fields): A collection of data fields collected during the inventory to aid in finding trees, including address number, street name, site number, side, and block side.

location rating (data field): Describes/rates the position of a tree based on existing land use of the site, the functional and aesthetic contributions of the tree to the site, and surrounding structures or landscapes. Categories for location value include: Excellent, Good, Fair, and Poor. The location rating, along with species, size, and condition ratings, is used in determining a tree's value.

Low Risk tree: Tree with minor visible structural defects or wounds in areas with moderate to low public access.

Management Costs: Used in i-Tree Streets, they are the expenditures associated with street tree management presented in total dollars, dollars per tree, and dollars per capita.

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

Moderate Risk tree: Tree with defects that may be cost-effectively or practically treated. Most of the trees in this category exhibit several moderate defects affecting more than 40% of a tree's trunk, crown, or critical root zone.

monoculture: A population dominated by one single species or very few species.

none (risk rating): Equal to zero. It is used only for planting sites and stumps.

none (secondary maintenance need): Used to show that no secondary maintenance is recommended for the tree. Usually a vacant planting site or stump will have a secondary maintenance need of *none*.

notes (data field): Describes additional pertinent information.

observations (data field): When conditions with a specific tree warrant recognition, it was described in this data field. Observations include cavity decay, grate guard, improperly installed, improperly mulched, improperly pruned, mechanical damage, memorial tree, nutrient deficiency, pest problem, poor location, poor root system, poor structure, remove hardware, serious decline, and signs of stress.

ordinance: See **tree ordinance**.

plant tree (primary maintenance need): If collected during an inventory, this data field identifies vacant planting sites as small, medium, or large (indicating the ultimate size that the tree will attain), depending on the growspace available and the presence of overhead wires.

primary maintenance need (data field): The type of tree work needed to reduce immediate risk.

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

raise (secondary maintenance need): Signifies a maintenance need for a tree. Raising the crown is pruning to remove low branches that interfere with sight and/or traffic. It is based on *ANSI A300 Standards*.

reduce (secondary maintenance need): Signifies a maintenance need for a tree. Reducing the crown is selective pruning to decrease height and/or spread of the crown in order to provide clearance for electric utilities and lighting.

removal (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.

restore (secondary maintenance need): Signifies a maintenance need for a tree. Restoring is selective pruning to improve the structure, form, and appearance of trees that have been severely headed, vandalized, or damaged.

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

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

risk assessment (data fields): The risk assessment is a point-based assessment of each tree by an arborist using a protocol based on the US Forest Service Community Tree Risk Rating System. In the field, the probability of tree or tree part failure is assigned 1–4 points (identifies the most likely failure and rates the likelihood that the structural defect(s) will result in failure based on observed, current conditions), the size of defective tree part is assigned 1–3 points (rates the size of the part most likely to fail), the probability of target impact by the tree or tree part is assigned 1–3 points (rates the use and occupancy of the area that would be struck by the defective part), and other risk factors are assigned 0–2 points (used if professional judgment suggests the need to increase the risk rating). The data from the risk assessment is used to calculate the risk rating that is ultimately assigned to the tree.

risk rating (data fields): Calculated from the field risk assessment data (see **risk assessment**), this is the sum of total risk assessment values. Risk ratings range from 3–10, with 3 being the lowest risk and 10 being the highest risk. In this Plan, the risk rating was used to identify the severity of risk assigned to a tree and to prioritize tree maintenance needs. The following categories were used:

- risk rating of 9 or 10 = Severe Risk tree
- risk rating of 7 or 8 = High Risk tree
- risk rating of 5 or 6 = Moderate Risk tree
- risk rating of 3 or 4 = Low Risk tree
- risk rating of 0 = no risk (used only for planting sites and stumps)

secondary maintenance need (data field): Recommended maintenance for a tree, which may be risk oriented, such as raising the crown for clearance, but generally was geared toward improving the structure of the tree and enhancing aesthetics.

Severe Risk tree: Tree rated to be Severe Risk cannot be cost-effectively or practically treated. Most Severe Risk trees have multiple and significant defects present in the trunk, crown, or critical root zone. Defective trees and/or tree parts are most likely larger than 20 inches in diameter and can be found in areas of frequent occupation, such as a main thoroughfare, congested streets, and/or near schools.

side value (data field): Each site is assigned a side value to aid in locating the site. Side values include: *front*, *side to*, *side away*, *median* (includes islands), and *rear* based on the site's location in relation the lot's street frontage. The *front* side is the side that faces the address street. *Side to* is the name of the street the arborist is walking towards as data is being collected. The *side from* is the name of the street the arborist is walking away from while collecting data. *Median* indicates a median or island. The *rear* is the side of the lot opposite the front.

site number (data field): All sites at an address are assigned a *site number*. Sites numbers are not unique; they are sequential to the side of the address only (the only unique number is the tree identification number assigned to each site). Site numbers are collected in the direction of vehicular traffic flow. The only exception is a one-way street. Site numbers along a one-way street are collected as if the street were actually a two-way street, so some site numbers will oppose traffic.

species (data fields): 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.

stems (data field): Identifies the number of stems or trunks splitting less than one foot above ground level.

street right-of-way (ROW): A strip of land generally owned by a public entity over which facilities, such as highways, railroads, or power lines, are built.

street tree: A street tree is defined as a tree within the right-of-way.

structural defect: A feature, condition, or deformity of a tree or tree part that indicates weak structure and contributes to the likelihood of failure.

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

thin (secondary maintenance need): Signifies a maintenance need for a tree. Thinning the crown is the selective removal of water sprouts, epicormic branches, and live branches to reduce density.

topping: Topping, reducing tree size using intermodal cuts without regard to tree health or structural integrity, is not an acceptable pruning practice.

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 height (data field): If collected during the inventory, it is the height of the tree estimated by the arborist and recorded in 10-foot increments.

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

tree ordinance: Tree ordinances are policy tools used by communities striving to attain a healthy, vigorous, and well-managed urban forest. Tree ordinances simply provide the authorization and standards for management activities.

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

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.

urban forest: All of the trees within a municipality or a community. This can include the trees along streets or rights-of-way, in parks and greenspaces, in forests, and on private property.

urban tree canopy (UTC) assessment: A study performed of land cover classes to gain an understanding of the tree canopy coverage, particularly as it relates to the amount of tree canopy that currently exists and the amount of tree canopy that could exist. Typically performed using aerial photographs, GIS data, or Lidar.

utility (secondary maintenance need): Selective pruning to prevent the loss of service, comply with mandated clearance laws, prevent damage to equipment, avoid access impairment, and uphold the intended usage of the facility/utility space.

young tree train (primary maintenance need): Data field based on *ANSI A300* standards, pruning of young trees to correct or eliminate weak, interfering, or objectionable branches to improve structure. These trees, up to 20 feet in height, can be worked with a pole pruner by a person standing on the ground.

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Appendix A
Site Location Methods

Equipment and Base Maps

Inventory arborists use CF-19 Panasonic Toughbook® unit(s) and Trimble® GPS Pathfinder® ProXH™ receiver(s).

Base map layers were loaded onto these unit(s) to help locate sites during the inventory. Table 1 lists the base map layers utilized along with source and format information for each layer.

Table 1. Base Map Layers Utilized for Inventory

Imagery/Data Source	Date	Projection
Pittsburgh Department of City Planning	2014	NAD 1983 State Plane Pennsylvania South Feet

Street ROW Site Location

Individual street ROW sites (trees, stumps, or vacant planting sites) were located using a methodology developed by Davey Resource Group that identifies sites by *address number*, *street name*, *side*, *site number*, and *block side*. This methodology allows for consistent assignment of location.

Address Number and Street Name

The *address number* was recorded based on visual observation by the arborist at the time of the inventory (the address number posted on a building at the inventoried site). Where there was no posted address number on a building or where the site was located by a vacant lot with no GIS parcel addressing data available, the address number assigned was matched as closely as possible to opposite or adjacent addresses by the arborist and an "X" was added to the number in the database to indicate that it was assigned (for example, "37X Choice Avenue").

Sites in medians or islands were assigned an address number using the address on the right side of the street in the direction of collection closest to the site. Each segment was numbered with an assigned address that was interpolated from addresses facing that median/island. If there were multiple median/islands between cross streets, each segment was given its own assigned address.

The *street name* assigned to a site was determined by street ROW parcel information and posted street name signage.

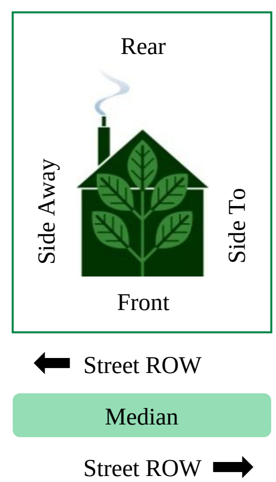


Figure 1. Side values for street ROW sites.

Side Value and Site Number

Each site was assigned a *side value* and *site number*. Side values include: *front*, *side to*, *side away*, *median* (includes islands), or *rear* based on the site's location in relation to the lot's street frontage (Figure 1). The *front side* is the side that faces the address street. *Side to* is the name of the street the arborist is walking towards as data are being collected.

The *side from* is the name of the street the arborist is walking away from while collecting data. *Median* indicates a median or island. The *rear* is the side of the lot opposite of the front.

All sites at an address are assigned a *site number*. Sites numbers are not unique; they are sequential to the side of the address only (the only unique number is the tree identification number assigned to each site). Site numbers are collected in the direction of vehicular traffic flow. The only exception is a one-way street. Site numbers along a one-way street are collected as if the street was a two-way street; thus, some site numbers will oppose traffic.

A separate site number sequence is used for each side value of the address (front, side to, side away, median, or rear). For example, trees at the front of an address may have site numbers from 1 through 999 and, if trees are located on the side to, side away, median, or rear of that same address, each side will also be numbered consecutively beginning with the number 1.

Block Side

Block side information for a site includes the *on street*, *from street*, and *to street*.

- The *on street* is the street that the site is physically located on. (The *on street* may not match the address street. A site may be physically located on a street that is different from its street address, for example, a site located on a side street.)
- The *from street* is the first cross street encountered when proceeding along the street in the direction of traffic flow.
- The *to street* is the second cross street encountered when moving in the direction of traffic flow.

Site Location Examples

Figure 2. The tree trimming crew in the truck traveling westbound on E Mac Arthur Street is trying to locate an inventoried tree with the following location information:

Address/Street Name:	226 E. Mac Arthur Street
Side:	Side To
Site Number:	1
On Street:	Davis Street
From Street:	Taft Street
To Street:	E. Mac Arthur Street.

The tree site circled in red is the site the crew is looking for. Because the tree is located on the side of the lot, the on street is Davis Street even though it is addressed as 226 East Mac Arthur Street. Moving with the flow of traffic, the from street is Taft Street, and the to street is East Mac Arthur Street.

Figure 3. Location information collected for inventoried trees at Corner Lots A and B.

<u>Corner Lot A</u>

Address/Street Name:	205 Hoover St.
Side/Site Number:	Side To / 1
On Street:	Taft St.
From Street:	E Mac Arthur St.
To Street:	Hoover St.
Address/Street Name:	205 Hoover St.
Side/Site Number:	Side To / 2
On Street:	Taft St.
From Street:	E Mac Arthur St.
To Street:	Hoover St.
Address/Street Name:	205 Hoover St.
Side/Site Number:	Side To / 3
On Street:	Taft St.
From Street:	19th St.
To Street:	Hoover St.
Address/Street Name:	205 Hoover St.
Side/Site Number:	Front / 1
On Street:	Hoover St.
From Street:	Taft St.
To Street:	Davis St.

<u>Corner Lot B</u>

Address/Street Name:	226 E Mac Arthur St.
Side/Site Number:	Side To / 1
On Street:	Davis St.
From Street:	Hoover St.
To Street:	E Mac Arthur St.
Address/Street Name:	226 E Mac Arthur St.
Side/Site Number:	Front / 1
On Street:	E Mac Arthur St.
From Street:	Davis St.
To Street:	Taft St.
Address/Street Name:	226 E Mac Arthur St.
Side/Site Number:	Front / 2
On Street:	E Mac Arthur St.
From Street:	Davis St.
To Street:	Taft St.

Appendix B
Estimated Costs for the City of Pittsburgh's Ten-Year Tree Management Program

Estimated Costs for Each Activity			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	Trees	Cost	Trees	Cost	Trees	Cost	Trees	Cost	Trees	Cost	Trees	Cost	Trees	Cost	Trees	Cost	Trees	Cost	Trees	Cost	
	1–3"	$61	0	$0	0	$0	0	$0	0	$0	0	$0		$0		$0		$0		$0		$0	$0
	4–6"	$133	0	$0	0	$0	0	$0	0	$0	0	$0		$0		$0		$0		$0		$0	$0
	7–12"	$254	1	$254	0	$0	0	$0	0	$0	0	$0		$0		$0		$0		$0		$0	$254
	13–18"	$382	0	$0	0	$0	0	$0	0	$0	0	$0		$0		$0		$0		$0		$0	$0
Severe Risk Removal*	19–24"	$764	3	$2,291	0	$0	0	$0	0	$0	0	$0		$0		$0		$0		$0		$0	$2,291
	25–30"	$1,555	6	$9,330	0	$0	0	$0	0	$0	0	$0		$0		$0		$0		$0		$0	$9,330
	31–36"	$2,215	2	$4,430	0	$0	0	$0	0	$0	0	$0		$0		$0		$0		$0		$0	$4,430
	37–42"	$2,760	2	$5,520	0	$0	0	$0	0	$0	0	$0		$0		$0		$0		$0		$0	$5,520
	43"+	$3,350	0	$0	0	$0	0	$0	0	$0	0	$0		$0		$0		$0		$0		$0	$0
Activity Total(s)			14	$21,825	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	$21,825
	1–3"	$61	0	$0	25	$1,529	0	$0	0	$0	0	$0		$0		$0		$0		$0		$0	$1,529
	4–6"	$133	0	$0	75	$9,968	0	$0	0	$0	0	$0		$0		$0		$0		$0		$0	$9,968
	7–12"	$254	0	$0	430	$109,093	0	$0	0	$0	0	$0		$0		$0		$0		$0		$0	$109,093
	13–18"	$382	0	$0	471	$179,847	0	$0	0	$0	0	$0		$0		$0		$0		$0		$0	$179,847
High Risk Removal*	19–24"	$764	245	$187,102	0	$0	0	$0	0	$0	0	$0		$0		$0		$0		$0		$0	$187,102
	25–30"	$1,555	158	$245,690	0	$0	0	$0	0	$0	0	$0		$0		$0		$0		$0		$0	$245,690
	31–36"	$2,215	58	$128,470	0	$0	0	$0	0	$0	0	$0		$0		$0		$0		$0		$0	$128,470
	37–42"	$2,760	18	$49,680	0	$0	0	$0	0	$0	0	$0		$0		$0		$0		$0		$0	$49,680
	43"+	$3,350	6	$20,100	0	$0	0	$0	0	$0	0	$0		$0		$0		$0		$0		$0	$20,100
Activity Total(s)			485	$631,042	1001	$300,436	$0	0	0	$0	0	0	$0	0	0	$0	0	0	$0	0	0	$0	$931,478
	1–3"	$61	0	$0	115	$7,035	115	$7,035	114	$6,974	114	$6,974	114	$6,974		$0		$0		$0		$0	$34,993
	4–6"	$133	0	$0	70	$9,303	70	$9,303	70	$9,303	70	$9,303	69	$9,170		$0		$0		$0		$0	$46,382
	7–12"	$254	0	$0	78	$19,789	78	$19,789	78	$19,789	78	$19,789	77	$19,535		$0		$0		$0		$0	$98,691
	13–18"	$382	0	$0	38	$14,510	38	$14,510	38	$14,510	37	$14,128	37	$14,128		$0		$0		$0		$0	$71,786
Moderate and Low Risk Removal*	19–24"	$764	0	$0	11	$8,400	11	$8,400	11	$8,400	11	$8,400	10	$7,637		$0		$0		$0		$0	$41,239
	25–30"	$1,555	0	$0	7	$10,885	6	$9,330	6	$9,330	6	$9,330	6	$9,330		$0		$0		$0		$0	$48,205
	31–36"	$2,215	0	$0	2	$4,430	2	$4,430	2	$4,430	2	$4,430	2	$4,430		$0		$0		$0		$0	$22,150
	37–42"	$2,760	0	$0	1	$2,760	1	$2,760	0	$0	0	$0	$0	$0		$0		$0		$0		$0	$5,520
	43"+	$3,350	0	$0	1	$3,350	1	$3,350	0	$0	0	$0	$0	$0		$0		$0		$0		$0	$6,700
Activity Total(s)			0	$0	323	$80,463	322	$78,908	319	$72,736	318	$72,355	315	$71,204	0	$0	0	$0	0	$0	0	$0	$375,665
	1–3"	$23	21	$476	21	$476	21	$476	21	$476	21	$476		$0		$0		$0		$0		$0	$2,379
	4–6"	$24	34	$822	34	$822	34	$822	34	$822	34	$822		$0		$0		$0		$0		$0	$4,108
	7–12"	$34	61	$2,091	61	$2,091	61	$2,091	61	$2,091	61	$2,091		$0		$0		$0		$0		$0	$10,457
	13–18"	$55	56	$3,099	56	$3,099	56	$3,099	56	$3,099	56	$3,099		$0		$0		$0		$0		$0	$15,495
Stump Removal*	19–24"	$110	28	$3,084	28	$3,084	28	$3,084	28	$3,084	28	$3,084		$0		$0		$0		$0		$0	$15,420
	25–30"	$200	18	$3,600	18	$3,600	18	$3,600	17	$3,400	17	$3,400		$0		$0		$0		$0		$0	$17,600
	31–36"	$250	10	$2,500	10	$2,500	10	$2,500	9	$2,250	9	$2,250		$0		$0		$0		$0		$0	$12,000
	37–42"	$300	6	$1,800	6	$1,800	5	$1,500	5	$1,500	5	$1,500		$0		$0		$0		$0		$0	$8,100
	43"+	$350	4	$1,400	4	$1,400	3	$1,050	3	$1,050	3	$1,050		$0		$0		$0		$0		$0	$5,950
Activity Total(s)			238	$18,872	238	$18,872	236	$18,222	234	$17,772	234	$17,772	0	$0	0	$0	0	$0	0	$0	0	$0	$91,509
	1–3"	$82		$0	1	$82		$0	0	$0	0	$0		$0		$0		$0		$0		$0	$82
	4–6"	$87		$0	2	$174		$0	0	$0	0	$0		$0		$0		$0		$0		$0	$174
	7–12"	$103		$0	112	$11,520		$0	0	$0	0	$0		$0		$0		$0		$0		$0	$11,520
	13–18"	$174		$0	215	$37,478		$0	0	$0	0	$0		$0		$0		$0		$0		$0	$37,478
Severe and High Risk Prune*	19–24"	$305	215	$65,519		$0		$0	0	$0	0	$0		$0		$0		$0		$0		$0	$65,519
	25–30"	$530	257	$136,210		$0		$0	0	$0	0	$0		$0		$0		$0		$0		$0	$136,210
	31–36"	$690	221	$152,490		$0		$0	0	$0	0	$ -		$0		$0		$0		$0		$0	$152,490
	37–42"	$890	100	$89,000		$0		$0	0	$0	0	$0		$0		$0		$0		$0		$0	$89,000
	43"+	$1,170	53	$62,010		$0		$0	0	$0	0	$0		$0		$0		$0		$0		$0	$62,010
Activity Total(s)			846	$505,229	330	$49,254	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	$554,482
	1–3"	$82	0	$0	43	$3,507	43	$3,507	43	$3,507	43	$3,507	43	$3,507	43	$3,507	43	$3,507	43	$3,507	43	$3,507	$31,567
	4–6"	$87	0	$0	188	$16,354	188	$16,354	188	$16,354	188	$16,354	188	$16,354	188	$16,354	188	$16,354	188	$16,354	188	$16,354	$147,186
	7–12"	$103	0	$0	875	$89,996	875	$89,996	875	$89,996	875	$89,996	875	$89,996	875	$89,996	875	$89,996	875	$89,996	875	$89,996	$809,967
	13–18"	$174	0	$0	604	$105,288	604	$105,288	604	$105,288	604	$105,288	604	$105,288	604	$105,288	604	$105,288	604	$105,288	604	$105,288	$947,594
Routine prune (RP Cyle)*	19–24"	$305	0	$0	321	$97,821	321	$97,821	321	$97,821	321	$97,821	321	$97,821	321	$97,821	321	$97,821	321	$97,821	321	$97,821	$880,387
	25–30"	$530	0	$0	211	$111,830	211	$111,830	211	$111,830	211	$111,830	211	$111,830	211	$111,830	211	$111,830	211	$111,830	211	$111,830	$1,006,470
	31–36"	$690	0	$0	124	$85,560	124	$85,560	124	$85,560	124	$85,560	124	$85,560	124	$85,560	124	$85,560	124	$85,560	124	$85,560	$770,040
	37–42"	$890	0	$0	42	$37,380	42	$37,380	42	$37,380	42	$37,380	42	$37,380	42	$37,380	42	$37,380	42	$37,380	42	$37,380	$336,420
	43"+	$1,170	0	$0	12	$14,040	12	$14,040	12	$14,040	12	$14,040	12	$14,040	12	$14,040	12	$14,040	12	$14,040	12	$14,040	$126,360
Routine Prune Total(s)			0	$0	2420	$561,777	2420	$561,777	2420	$561,777	2420	$561,777	2420	$561,777	2420	$561,777	2420	$561,777	2420	$561,777	2420	$561,777	$5,055,991
Young Tree Training Pruning (YTT Cycle)**	1–3"	$82	2241	$182,794	2241	$182,794	2241	$182,794	2241	$182,794	2241	$182,794	2241	$182,794	2241	$182,794	2241	$182,794	2241	$182,794	2241	$182,794	$1,827,939
	4–6"	$87	1708	$148,577	1708	$148,577	1708	$148,577	1708	$148,577	1708	$148,577	1708	$148,577	1708	$148,577	1708	$148,577	1708	$148,577	1708	$148,577	$1,485,774
YTT Total			3949	$331,371	3949	$331,371	3949	$331,371	3949	$331,371	3949	$331,371	3949	$331,371	3949	$331,371	3949	$331,371	3949	$331,371	3949	$331,371	$3,313,713
Tree Planting (Fill Vacant Sites)**	Purchasing	$200	255	$51,000	255	$51,000	255	$51,000	255	$51,000	255	$51,000	255	$51,000	255	$51,000	255	$51,000	255	$51,000	255	$51,000	$510,000
	Planting	$200	255	$51,000	255	$51,000	255	$51,000	255	$51,000	255	$51,000	255	$51,000	255	$51,000	255	$51,000	255	$51,000	255	$51,000	$510,000
	Site Prep	$500	61	$30,500	61	$30,500	61	$30,500	61	$30,500	61	$30,500	61	$30,500	61	$30,500	61	$30,500	61	$30,500	61	$30,500	$305,000
Vacancy Fill Total			255	$132,500	255	$132,500	255	$132,500	255	$132,500	255	$132,500	255	$132,500	255	$132,500	255	$132,500	255	$132,500	255	$132,500	$1,325,000
Tree Planting (Replace Removals)**	Purchasing	$200	310	$62,000	310	$62,000	310	$62,000	310	$62,000	310	$62,000	310	$62,000	310	$62,000	310	$62,000	310	$62,000	310	$62,000	$620,000
	Planting	$200	310	$62,000	310	$62,000	310	$62,000	310	$62,000	310	$62,000	310	$62,000	310	$62,000	310	$62,000	310	$62,000	310	$62,000	$620,000
	Site Prep	$500	125	$62,500	125	$62,500	125	$62,500	125	$62,500	125	$62,500	125	$62,500	125	$62,500	125	$62,500	125	$62,500	125	$62,500	$625,000
Replace Removals Total			310	186,500	310	186,500	310	186,500	310	186,500	310	186,500	310	186,500	310	186,500	310	186,500	310	186,500	310	186,500	1,865,000
Tree Planting (Canopy Investment)**	Purchasing	$200	150	$30,000	150	$30,000	150	$30,000	150	$30,000	150	$30,000	150	$30,000	150	$30,000	150	$30,000	150	$30,000	150	$30,000	$300,000
	Planting	$200	150	$30,000	150	$30,000	150	$30,000	150	$30,000	150	$30,000	150	$30,000	150	$30,000	150	$30,000	150	$30,000	150	$30,000	$300,000
	Site Prep	$500	150	$75,000	150	$75,000	150	$75,000	150	$75,000	150	$75,000	150	$75,000	150	$75,000	150	$75,000	150	$75,000	150	$75,000	$750,000
Canopy Investment Total			150	$135,000	150	$135,000	150	$135,000	150	$135,000	150	$135,000	150	$135,000	150	$135,000	150	$135,000	150	$135,000	150	$135,000	1,350,000
Planting Activity Total(s)			715	$454,000	715	$454,000	715	$454,000	715	$454,000	715	$454,000	715	$454,000	715	$454,000	715	$454,000	715	$454,000	715	$454,000	$4,540,000
Activity Grand Total			**6557**		**8976**		**7642**		**7637**		**7636**		**7399**		**7084**		**7084**		**7084**		**7084**		**38448**
Cost Grand Total				$1,962,338		$1,796,172		$1,444,277		$1,437,656		$1,437,274		$1,418,352		$1,347,148		$1,347,148		$1,347,148		$1,347,148	$14,884,662

*Costs of activities for trees and stumps less than 25 inches DBH are based on cost estimates provided by Pittsburgh's Forestry Division. Costs of activities for trees and stumps 25 inches DBH or more are based on cost estimates provided by public bid tabulations.

**Costs of all recommended training pruning, planting site expansion, and planting activities are based on cost estimates provided by Western Pennsylvania Conservancy and Tree Pittsburgh.

Appendix C
Comparison of 2005 and 2014 Tree Inventories

Since the Pittsburgh street tree inventory in 2005, the most recent 2014 inventory confirmed the city's strong commitment to improving the health and scope of its street tree population. Collaborating with the Pittsburgh Shade Tree Commission, Tree Pittsburgh, the Western Pennsylvania Conservancy, and Pittsburgh residents, the City of Pittsburgh has seen significant improvements in its street tree resource, as reflected by comparing data from each inventory.

Number of Street Trees

Table 1. Comparison of Number of Trees Identified During the 2005 and 2014 Tree Inventories

	2005	2014	Change
Trees	30,563	33,498	+2,935

Since the 2005 inventory, Pittsburgh's street tree population has increased by approximately 10%, which speaks to the city's commitment to tree planting over the past decade. This growth is also due in large part to the Pennsylvania DCNR program, TreeVitalize Pittsburgh. If the recommended 715 trees per year are planted, the number of Pittsburgh street trees will continue to increase at a significant rate. Stocking goals should be achieved barring any unforeseen weather events or the arrival of any destructive pests or diseases.

Species Mix

Table 2. Comparison of Top Five Most Frequently Occurring Species Identified During the 2005 and 2014 Tree Inventories

Species	2005	2014	Change
Norway maple	15.7%	10.5%	-5.2%
red maple	11.4%	10.0%	-1.4%
Callery pear	11.3%	8.9%	-2.4%
London planetree	8.9%	8.2%	-0.7%
littleleaf linden	10.9%	6.7%	-4.2%

The top five most common tree species growing on Pittsburgh's streets in 2014 were the same five most common in 2005, although London planetree has overtaken littleleaf linden as the fourth most common species on Pittsburgh's streets. The drop in the share of Norway maple, red maple, Callery pear, and littleleaf linden are all positive developments. In 2005, all four of these species exceeded the 10% threshold for species diversity. Urban foresters commonly agree that no species should represent more than 10% of the street tree population. Pittsburgh's street tree biodiversity has since improved, as the top five most frequently occurring species in 2014 have leveled out such that their composition is closer to, or below, the 10% threshold. Callery pear and littleleaf linden have fallen below the 10% threshold.

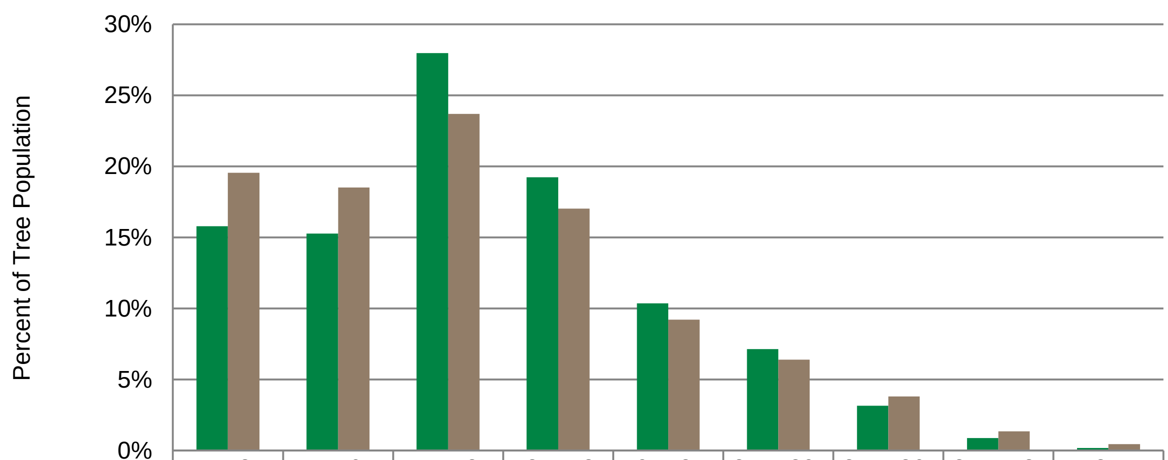
Furthermore, due to their invasiveness and generally poor structure, Norway maple, Callery pear, and littleleaf linden are all banned from planting in the *Pittsburgh Urban Forest Master Plan*. This ban is working towards reducing the populations of less desirable tree species.

In 2005, the *Acer* (maple) genus comprised 35% of the street tree population, which is well above the 20% threshold established in past management plans, along with the master plan. By 2014, the percentage of maple dropped to 29%, which still exceeds the ideal threshold but by a significantly smaller margin than it did in 2005. The *Pittsburgh Urban Forest Master Plan* requires that maple planting be limited to 5% or less of any new planting projects. This limit, as well as the ban on Norway maple, has worked towards reducing the percentage of maple on the street. If the city continues to follow the recommendations discussed in the *Pittsburgh Urban Forest Master Plan*, the percentage of maple will continue to fall.

The variety of trees represented on the streets of Pittsburgh has also significantly increased. The 2005 inventory identified 130 different species, while the 2014 inventory identified 189— an impressive increase of 45%. This is at least partly the result of urban foresters' efforts to increase species diversity in Pittsburgh.

Diameter Distribution

Since 2005, the diameter distribution has moved closer to the ideal, in which smaller diameter trees have greatly outnumbered large-statured trees, as shown in Figure 1. This margin ensures that older trees are replaced by younger trees. The proportion of younger trees on Pittsburgh streets has significantly increased due to the high level of tree planting on Pittsburgh's streets. There has also been a smaller increase in the number of trees in the largest diameter classes, which may be attributable to removal of trees in poor growing locations, but also the citywide increase of proactive tree work since the 2005 tree inventory. Trees in the middle diameter range have decreased. If planting recommendations are followed, diameter distribution will continue to move toward the ideal.



	1" - 3"	4" - 6"	7" - 12"	13" - 18"	19" - 24"	25" - 30"	31" - 36"	37" - 42"	43" +
2005 Trees	15.8%	15.3%	28.0%	19.2%	10.4%	7.1%	3.2%	0.9%	0.2%
2014 Trees	19.5%	18.5%	23.7%	17.0%	9.2%	6.4%	3.8%	1.4%	0.5%

Figure 1. Comparison of diameter distribution between the 2005 and 2014 Pittsburgh street tree inventories.

Condition

Table 3. Comparison of Trees in Each Condition Class Identified
During the 2005 and 2014 Tree Inventories

Condition	2005	2014	Change
Very Good	0.2%	0.3%	+0.1%
Good	25.0%	42.2%	+17.2%
Fair	47.6%	40.8%	-6.8%
Poor	20.9%	10.4%	-10.5%
Critical	1.7%	3.3%	+1.6%
Dead	1.7%	3.1%	+1.4%

The general health of the Pittsburgh street tree population is much improved since the 2005 inventory. Trees rated as good have increased by over 17%, while the proportion of trees rated as fair and poor dropped by 6.8% and 10.5%, respectively. The percentage of critical and dead trees increased, but this may be attributable to EAB, which has recently hit Pittsburgh.

Primary Maintenance Recommendations

Table 4. Comparison of Primary Maintenance Recommendations Made
During the 2005 and 2014 Tree Inventories

	2005		2014		Change	
Maintenance	Trees	Percentage	Trees	Percentage	Trees	Percentage
Removal	3,185	11.0%	3,097	9.2%	-88	-2.8%
Tree Clean	18,928	65.2%	20,527	61.3%	1599	+8.4%
Young Tree Train	6,904	23.8%	9,874	29.5%	2970	+43.0%
Total Trees	29,017		33,498			

The number of recommended removals since the 2005 street tree inventory dropped by 2.8%. This may be an indicator that the City of Pittsburgh has improved its ability to identify trees that need to be removed. It may also be a result of improved health in the Pittsburgh street tree population.

Infrastructure Issues

Table 5. Comparison of Tree Associated Infrastructure Issues Identified
During the 2005 and 2014 Tree Inventories

Infrastructure Issue	2005	2014	Change
Sites with hardscape damage	23.5%	15.7%	-7.8%
Trees with overhead utilities	59.6%	41.2%	-18.4%

There was a marked decrease in the proportion of trees planted under wires, along with trees that cause hardscape damage. This is an indication that planting decisions made by Pittsburgh urban foresters have carefully considered and addressed infrastructure conflicts. The improvement could also be an indication that the city and its residents have been more reactive to repairing sidewalks damaged by trees roots.