Trees for People

An Action Plan for Lancaster City's Urban Forest

Adopted October 2020

CITY OF LANCASTER

DAVEY Resource Group

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We wish to thank TreePennsylvania, and the TreeVitalize® program, for a 2019 community forestry management grant. TreeVitalize is a strong and ongoing partnership between TreePennsylvania and the Pennsylvania Department of Conservation and Natural Resources to support urban and community forests in Pennsylvania communities.

We also wish to thank the City of Lancaster Shade Tree Commission for its generous financial support of this project, in addition to the time and effort its members devote to protecting, preserving and growing Lancaster's urban forest.

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Three interconnected elements comprise this plan: an executive summary, a policy document, and appendices. These elements build upon one another to provide the structure, sustenance and fruits of Trees for People.

The executive summary presents the mission and goals of this Action Plan for Lancaster's Urban Forest. The link between trees and people is highlighted in the reason for the urban forest initiative. An Implementation Action Matrix outlines short-term actions that should be taken within the next five years to plant the seeds for a sustainable urban forest program.

The six chapters of the policy document integrate the many aspects of a comprehensive urban forest program necessary for the City and its partners to grow and sustain a healthy and verdant urban forest that benefits everyone. This element provides contextual background and is organized around principles that will help us measure our trees and their benefits, plant more trees, maintain and protect our trees, reach out to and engage the community and our partners, and manage and regulate our urban forest.

The appendices include a variety of resources that help reinforce much of the guidance material and recommendations set forth in the policy document.

Unless otherwise noted, all photographs are courtesy Lancaster Department of Public Works.

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EXECUTIVE SUMMARY

The mission of this urban forest action plan is to increase and maintain Lancaster's urban forest in a sustainable way, and to enlighten residents and property owners about the importance of the urban forest. That way, our urban forest will remain healthy and verdant, and continue to benefit all residents and visitors long into the future.

As the name *Trees for People An Action Plan for Lancaster City's Urban Forest* implies, this plan is a call to action by all stakeholders to protect, conserve and grow Lancaster's urban forest. This plan is a starting point, it provides guidance on what tools are needed and available, and how and when those tools should be used. It is the primary guiding document for making future decisions regarding the protection, preservation, conservation, and maintenance of the urban forest as well as the staff and funding so those tasks can be completed efficiently and effectively.

The City of Lancaster recognizes the intrinsic value and ecosystem benefits that trees provide to all the people who live, work and visit here. Trees:

- remove pollutants from the air and water
- capture stormwater
- conserve energy
- reduce greenhouse gas emissions
- shade streets and residences
- increase property values
- provide wildlife habitat
- facilitate social interaction
- provide educational opportunities
- offer aesthetic value
- improve physical and mental health and well-being

These benefits are realized at many levels, from individual homes to entire neighborhoods to the entire City. Therefore, it is incumbent upon us to make trees and their many benefits accessible to everyone. In addition, trees along the City's streets and in its parks and back yards are especially important for meeting the U.S. Environmental Protection Agency's mandate to reduce combined sewer overflows. This has been a driving force in many advances in "green" and sustainable practices the City has made in recent years.

Lancaster's urban forest includes trees in public areas and on private property, including along its streets, in its parks and open spaces, in backyards, and on the grounds of commercial and institutional establishments. This plan emphasizes what the City can and will do within those public areas – streets and parks, with a commitment to assisting residents and business owners with tree matters on private property.

Urban green space, such as tree-lined streets, parks, and community gardens, provides critical ecosystem services. Green space also promotes physical activity, psychological well-being, and the overall health of residents. Implementation of this plan will help to engage, educate, and empower the community on the importance of trees, especially in highly dense urban environments.

Access to green space is also increasingly recognized as an environmental justice issue. The City of Lancaster has made commitments to racial and social equity in all aspects of its governmental operations and practices. All people, regardless of socioeconomic or racial background, should be guaranteed access to trees and the green spaces where trees are often found. Trees are for all people, and all people need trees.

Trees

What is an Urban Forest?

Urban forests are "ecosystems of trees and other vegetation in and around communities that may consist of street and yard trees, vegetation within parks and along public rights of way and water systems. Urban forests provide communities with environmental, economic and social benefits and habitat for fish and wildlife." (from American Forests)

An ecosystem is a biological community of interacting organisms and their physical environment. Ecosystem services are provided by natural processes that sustain human life, including clean water, stormwater management, carbon sequestration, increased human health, increased property values, biodiversity, and wildlife habitat.

Tree canopy is the layer of leaves, branches, and stems of trees that cover the ground when viewed from above. Establishing a goal to increase our tree canopy is crucial for Lancaster as it works toward implementing its green infrastructure goals.

The responsibility for trees in Lancaster is not as clear and straightforward as it could be. The City is only truly responsible for trees on property which it owns and controls, such as parks and other government facilities. The City has limited responsibility for trees growing along its streets, alleys and other public rights-of-way. Through its Trees Ordinance, the City regulates how and where street trees are planted and how they should be maintained and protected.

Along with this 2020 Action Plan, there are other main elements of Lancaster's urban forest program. In 2011, over 9,000 street and park trees were measured and assessed. Another study showed that approximately 28% of the City is covered by tree canopy. The 2011 green infrastructure plan was updated in 2019 as Green It! Lancaster. In 2014, the City's outdated Trees Ordinance was comprehensively amended and supplemented by a tree manual to set standards for arboriculture work. This program is meant to reinforce the importance and value of the urban forest, and to guide all future efforts to preserve and grow our urban forest.

People

Lancaster's trees provide many benefits to people. And there are many people who provide the vital care for the trees.

A notable person in the history of the city's urban forest was J.P. McCaskey, Lancaster schoolteacher, principal, superintendent, and also mayor. In 1884 he introduced Arbor Day to Lancaster. Under his inspired leadership over 9,000 trees were planted, including deciduous, evergreen, and fruit species.

Shade Tree Commission

The Shade Tree Commission, in conjunction with the City Arborist, works to maximize the benefit derived from public shade trees by establishing policies for the planting, removal, maintenance and protection of trees along City streets and sidewalks and in parks and public open spaces. The members are appointed by the Mayor with the approval of City Council.

Lancaster celebrated its 42nd year as a Tree City USA in 2019

City Staff

The City Arborist carries out the urban forestry program. The Arborist and three support staff, well trained in tree work, are responsible for all aspects of trees on city-owned property and some care of street trees. They plant trees purchased by property owners through the city's residential street tree planting program. Other Department of Public Works staff support these efforts and manage tree data. The Department of Community Planning and Economic Development is responsible for trees in land development and zoning matters. Overall, there is insufficient staff to carry out the many tasks, resulting in inefficiencies and gaps

Partners

There are many partners in the effort to grow and preserve the urban forest, and a goal of this plan is to engage more people and groups. One partner stands above the others. Lancaster Tree Tenders was formed in 2016 to "increase and enhance Lancaster's urban forest by engaging and empowering neighborhoods to plant and care for trees". This is a collaborative effort between the City, the Alliance for the Chesapeake Bay, the Lancaster City Alliance and residents. Since its inception, Lancaster Tree Tenders has been instrumental in planting more than 680 street trees and over 1,000 trees in riparian buffers.

An Action Plan

The Urban Forest Management Plan

The six chapters of the plan consider the diversity, distribution, and general condition of the inventoried trees, and also provide prioritized system for managing public trees.

Chapter 1: *Urban Tree Canopy - Inventory and Analysis* summarizes the tree inventory data and presents trends, results, and observations.

Chapter 2: *Benefits of the Urban Forest* summarizes the economic, environmental, and social benefits that trees provide to the community. This section presents statistics of a benefits analysis using i-Tree Streets software.

Chapter 3: *Tree Management Program* utilizes the inventory data to develop a recommended maintenance schedule and projected budget over a five-year period. The section reviews the needs of all the trees in the inventory.

Chapter 4: *Operations Review* summarizes existing city tree field operations and administration, identifies gaps, and recommends goals, guidelines, and specific improvements to enhance efficiency and cost-effectiveness.

Chapter 5: *Policy and Ordinance Review* summarizes findings, recommended changes, or additions which are consistent with current industry standards and practices and meet community needs.

Chapter 6: *Conclusions & Recommendations*

Goals - Objectives - Actions

An action matrix has been provided to help guide short-term implementation of the urban forest plan recommendations. The strategic actions below are derived from the recommendations set forth in Chapter 6 of the plan and are intended to achieve the three goals of the urban forest program. In addition, the suggested outcomes are established to measure implementation successes or failures at regular intervals and should be further refined as actions are implemented.

Goal 1: Grow a more extensive urban forest throughout the city

Goal 2: Improve and maintain the health of the urban forest

Goal 3: Increase support for and understanding of the urban forest

The goals are supported by the objectives and strategic actions that the City and its partners are willing and able to implement.

When so many of the actions in this plan are interdependent and build upon one another, it becomes difficult to prioritize them as short- or long-term. Equally difficult has been trying to assign an action to a single objective, and any one objective to a corresponding goal. The actions listed in the implementation matrix below were identified as some of the most critical and should therefore be implemented first. Most actions in the matrix do not correspond directly to any single recommendation in Chapter 6; many are amalgamations on two or more recommendations.

The Priority Sequence for each action is intended to define the order in which the actions should be addressed and implemented. If during the course of implementation, it would be more effective to implement actions in a different order, so be it. This Plan and the guidance provided is meant to be flexible.

Outcomes will be used to measure success at regular intervals. Once implemented, these actions become a standard part of the tree program. Based on annual reviews, additional recommendations from the plan will be evaluated for implementation.

Objective	Action	Priority Sequence	Outcome
MEASURE OUR TREES AND THEIR BENEFITS	Conduct a complete inventory and risk assessment of all trees on streets and on public property	1	Inventory and risk assessment completed and integrated with GIS
	Determine areas with low canopy cover	1	Analysis completed and areas mapped
	Develop schedules for regular inspections, inventory updates, hazard surveys, and tree canopy updates to track progress	1	Schedules implemented
	Use i-Tree software tools to determine tree benefits and to guide species selection and location to optimize benefits	2	Staff trained on i-Tree tools and planting strategies developed
PLANT MORE TREES	Prioritize planting large canopy trees	1	Ensure integration into existing planting strategy
	Enhance species diversity to ensure resilience	1	Ensure integration into existing planting strategy
	Plant the right tree in each specific place	1	Ensure integration into existing planting strategy
	Plant existing open tree sites first, then potential tree sites	1	Ensure integration into existing planting strategy
	Prioritize plantings in areas currently with low canopy cover	1	Planting strategy in place
	Establish attainable 25-year goals for canopy and for trees per street mile	2	Goals established and planting schedule implemented
	Develop policies to replace canopy following removals and in developments	2	Regulations adopted
MAINTAIN AND PROTECT OUR TREES	Enforce protection of trees during construction projects	1	Enforcement protocols established and implemented
	Develop plans to manage new pests or diseases (as needed)	1	Comprehensive pest management plan in place
	Develop a watering program for all new trees	2	Watering schedule is an established function
	Preserve large canopy trees as long as feasible	2	Mature tree protections in all codes and regulations
	Implement a program for municipal responsibility for pruning and other maintenance	3	Routine pruning and maintenance schedules and staff in place
REACH OUT AND ENGAGE COMMUNITY AND PARTNERS	Develop neighborhood-focused outreach and education about health and other benefits of trees	1	Public education and outreach strategy implemented
	Enhance volunteer and community programs for tree planting and stewardship	1	Increased involvement of volunteers and community programs
	Strengthen and develop alliances with community partner organizations and businesses	1	Existing alliances strengthened and new alliances established
	Create internship and workforce development programs with partners	3	Programs are in place
MANAGE AND REGULATE OUR URBAN FOREST	Create a full-time position for certified urban forest administrator as “tree point person” with cross-departmental responsibility for administering all aspects of the urban forest	1	One employee hired in Dept. of Public Works to administer full time the entire urban forest program
	Ensure best management practices are followed in all aspects of tree program	1	Best management practices are integral to all operations
	Review all tree-related job descriptions; determine all tree-related tasks and staff currently responsible	1	All job descriptions revised, and clear assignment of tasks established
	Establish clear responsibility and procedures for enforcement of all tree regulations	1	Enforcement policies and procedures in place
	Evaluate procedures and fees for tree permits, removals and replacements, etc.	1	Evaluation completed and revisions implemented
	Explore and utilize all potential sources of revenue for tree planting, maintenance, and community engagement	1	Sustainable funding streams established
	Develop an integrated annual report to the community covering tree activities of all programs	1	Staff prepares integrated report annually
	Establish an oversight committee to guide implementation of the plan and ensure accountability	1	Shade Tree Commission granted oversight of urban forest plan
	Use inventory software for real-time field updating of planting, removal, and maintenance	2	Procedures established and equipment provided for updating inventory and maintenance records
	Review and revise tree related provisions of all city ordinances, specifications, manuals, plans, etc. to achieve clear, consistent, and comprehensive regulation and to optimize planting and protection	3	All documents amended and staff trained
	Establish protection for trees on private property	3	All documents amended and staff trained
	Hire sufficient city staff or contractors as the tree program grows	3	Sufficient personnel available for all tree program needs

CHAPTER 1: URBAN TREE CANOPY – INVENTORY AND ANALYSIS

Introduction

The first step in developing a management plan for trees or any other asset is to determine what we have, in terms of both quantity and quality. How many trees are there? Where are they located? What areas lack sufficient trees? What species of trees are present? How big and how old are the trees? Are the trees healthy or not? This chapter addresses such questions and provides recommendations to ensure that the City always has accurate and up-to-date information to guide management decisions.

Trees grow; trees can be harmed by extreme weather, accidents, or pests; trees decline with age; new trees are planted. To remain useful, inventories must be constantly updated, ideally in real time. Maintenance records need to be integrated into the inventory. And periodically inventories must be completely redone.

Figure 1-1. City of Lancaster Tree Canopy

A tree canopy assessment and an inventory of trees and planting sites are essential tools for managing a community's trees. This chapter describes the analyses conducted on the City of Lancaster's trees over the past decade. Those efforts began in 2010-2011 with a street tree inventory, urban tree canopy analysis and green infrastructure plan. Although those initial efforts helped Lancaster change the way it views and cares for its urban forest, there is still a long way to go before it is as healthy and verdant as desired.

Recognizing trends in the data can help guide short- and long-term management planning. In this plan, we relied on data from a 2011 inventory, partially updated to 2016 and including the parks tree inventory. With these data, we evaluated the following standard metrics, attributes and characteristics to understand the resource and make recommendations.

- Assessment of Tree Inventory Data
- Urban Tree Canopy (UTC) Change
- Street Right-of-Way (ROW) Stocking Level
- Species Diversity
- Diameter Size Distribution
- Infrastructure and Utility Conflicts
- Growing Space
- Potential Threats from Pests

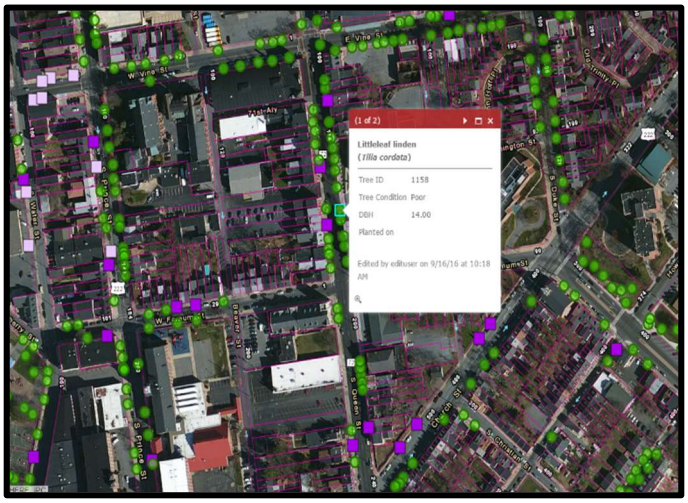
Assessment of Tree Inventory Data

During the summer 2011, a street tree inventory was conducted by staff under the supervision of Dr. Bill Elmendorf, Associate Professor and Extension Specialist, Community and Urban Forestry, Penn State School of Forest Resources.

Findings

Recognizing that trees inherently pose a certain degree of hazard and risk, the inventory was designed to assess the condition of street trees in the City. Intended to be used by the City for "tree removal and other work," additional purposes for the inventory were to "indicate trees that may be potentially hazardous; indicate trees that may require removal; indicate trees in need of maintenance, such as pruning; and indicate possible tree planting sites."

Figure 1-2. City Trees Public Viewer Screen shot



The total number of street trees inventoried was 5,489, with 1,277 potential planting sites also inventoried.

The Tree Inventory and Report comprehensively covered a broad range of topics related to trees and a municipal tree program. The Report briefly explained the importance of a tree inventory and described the tree benefits and costs empirically using 13 site attributes, 12 tree attributes and nine maintenance descriptions. In addition to the site and tree attributes, the tree's location was accurately recorded using a physical address, location on the property and geographic coordinates.

Table 1-1. Lancaster Tree Inventory Data Types and Counts

Data Inventory Source	Raw Count
Total inventoried trees	9,148
Park trees	2,818
Street trees	6,129
Yard trees	122
Missing data	79
Planting sites* and stumps	3,059

*Potential planting sites include those identified in the inventory as well as those identified by field surveys conducted in several areas (primarily large parts of the Southeast, Southwest, and Northeast) recently by City interns and Lancaster Tree Tenders volunteers. Large areas of the city remain to be surveyed for potential sites.

A complete inventory had not been done for decades before. Subsequently, an inventory of trees in city parks was completed in 2012; some updates to the street tree inventory were made through 2015. The fact that the original inventories are nearly a decade old, with only minor updating done in the interim, indicates that a paramount need is for a complete re-inventory. As discussed below, working with this inventory has revealed some shortcomings which can be dealt with in carefully setting the parameters for a new inventory. Also, the city should commit to a schedule for periodic re-inventories, along with a system for real-time updating of the inventory. Keeping the inventory updated can save money long-term.

Unless otherwise noted, data presented in this Management Plan includes the original inventory, the parks inventory and any update through 2016, and corresponds to the Tree Map accessible on the City of Lancaster website at https://lancaster-pa.maps.arcgis.com/View/index.html?appid=2f1ca18840d74a9bad523d785ccdfaed. The data used here is not completely accurate because of limited updating. Since trees are long-lived, the decade-old data are still somewhat useful overall, but the data do not reflect the tree planting efforts and removals of the last few years. In addition, there are significant gaps in knowing the full inventory of trees in the city. The park inventory did not inventory trees within large tree masses, for example, possibly half of all trees in Long's Park and Conestoga Pines Park were not counted. Different types of studies provide different types of information. We have limited data on trees on private property, such as found in backyards, wood lots, and commercial parking lots. This incomplete data is especially true for areas of the City referred to as the annexed areas such as Eden Manor and the areas around Lampeter Rd.

Discussion

The inventory reported on the results as well as providing recommendations. Street tree condition, tree species and age distribution, hardscape (sidewalk) damage and maintenance needs were highlighted. Although the conclusions and recommendations in the inventory report were intended to provide guidance to the City on minimizing hazardous conditions, the authors clearly pointed out that there is no "guarantee or certainty that efforts to identify and correct unsafe conditions will prevent breakage or failure of a tree." Furthermore, the City had not established standard operating procedures for fully utilizing the inventory as intended, which should also include assigning priority for imminent and potential hazards.

In addition to assessing risk within public areas, the tree inventory has provided the City with valuable data on the make-up of its urban forest. With this information, we are able to further evaluate a broad range of urban forest characteristics including, but not limited to, what trees are overplanted, what trees are susceptible to a new pest, and where there are too few trees.

Not all the conclusions and recommendations of the Tree Inventory and Summary Report are presented here because after nearly ten years the inventory is out-of-date and must be redone. However, several of the conclusions and recommendations are worth noting. These can set a baseline for future tree inventory analyses.

- Maple species, red and Norway in particular, are overabundant. The City should increase both tree species and age diversity by limiting the planting of these tree species.
- While there is an overabundance of some species, there is good overall diversity of species. New plantings should focus on including a variety of species, especially those occurring less commonly in the current inventory.

- The overall age/size distribution of trees was indicative of the patterns of attrition with age typically seen in urban forests and reflects ongoing replacement of street trees.
- A majority (74%) of the trees are in excellent or good condition. Of these, the majority are in good condition (59% of total population).
- About one-third of evaluated sidewalks showed damage, mostly thought to be caused by trees.

A top priority of this Urban Forest Management Plan is updating the tree inventory in a manner that includes all trees in or over the right of way and that covers the entire city.

Urban Tree Canopy Analysis

According to the U.S. Department of Agriculture Forest Service, "[a]n Urban Tree Canopy (UTC) assessment, which provides a measure of a community's tree canopy cover, is important for understanding the extent of a community's forest or tree resource." Along with the tree inventory, the UTC provides the foundation for this urban forest management plan.

In February 2011, the USDA Forest Service published *A Report on the City of Lancaster's Existing and Possible Tree Canopy.* The analysis of Lancaster's existing and possible tree canopy was a collaboration with the City of Lancaster, Lancaster County, the University of Vermont, the Northern Research Station, and PA Department of Conservation and Natural Resources Bureau of Forestry. The full report can be found online at https://www.cityoflancasterpa.com/services/trees/

The goal of the project was to apply the USDA Forest Service's tree canopy assessment protocols to the City of Lancaster so the City could set tree canopy goals.

The Report described tree canopy as "the layer of leaves, branches, and stems of trees that cover the ground when viewed from above. Tree canopy provides many benefits to communities, improving water quality, saving energy, lowering city temperatures, reducing air pollution, enhancing property values, providing wildlife habitat, facilitating social and educational opportunities, and providing aesthetic benefits." Although the Report did not establish a tree canopy goal, it did analyze the Urban Tree Canopy (UTC) and provided "estimates for the amount of tree canopy currently present in a city as well as the amount of tree canopy that could theoretically be established." The Report provided the data necessary for the City to begin the goal-setting process.

As more communities focus attention on the role of trees in promoting public health, environmental sustainability, and community development, urban forest management has become increasingly dependent on geographic information systems (GIS). GIS is a powerful tool for UTC mapping and analysis and can provide data on leaf surface area. The amount and distribution of leaf surface area is the driving force behind the urban forest's ability to produce benefits for the community (Clark et al, 1997). In 2010 and again in 2016, the University of Vermont Spatial Analysis Lab, in collaboration with the United States Forest Service, provided Lancaster with a tree canopy analysis. Go to https://www.cityoflancasterpa.com/services/trees/ for more information on the City's UTC.

Trees provide benefits to the community that extend beyond property lines. These benefits, listed below, can be quantified for their value to the community (See Chapter 2). Identifying priority planting areas that yield the most return on investment is an important aspect of promoting community betterment.

- Stormwater management
- Public health (reduced air pollution, reduced summer heat, reduced mental stress)
- Energy savings (reduced cooling and heating costs)
- Water quality
- Aesthetics
- Community and social development
- Economic development
- Wildlife habitat

Understanding the location and extent of tree canopy is key to developing and implementing sound management strategies that promote the sustainability and growth of Lancaster's urban forest resource and the benefits it provides.

Existing and Possible Tree Canopy Assessment 2011

The 2011 assessment of Lancaster's existing and possible tree canopy was based on land cover data derived from high-resolution aerial imagery and LiDAR (Light Detection and Ranging) acquired in 2010. It found that 1,299 acres of the city were covered by tree canopy, representing 28% of all land in the city.

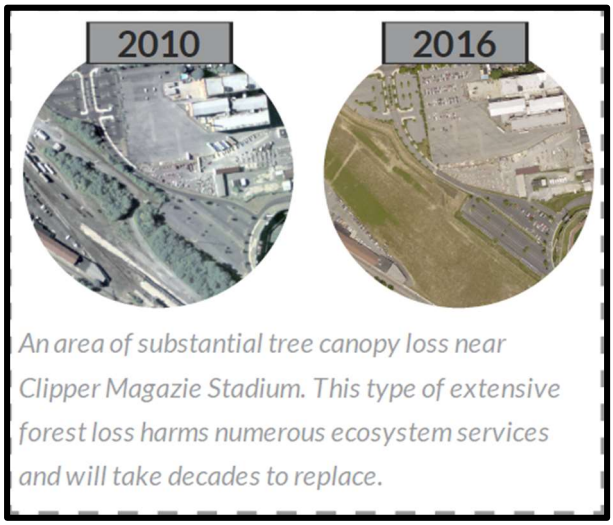
For the study, the land use data were aggregated into thirteen general categories. Existing and Possible tree canopy was summarized for the thirteen aggregated land use classes. For each land use category, Tree Canopy (TC) metrics were calculated as a percentage of all land in the City, as a percentage of land area in the specified land use category, and as a percentage of the area for TC type. Existing and Possible TC was also analyzed by Zoning category.

These parcel-based TC metrics were integrated into the City's existing GIS database to perform a variety of parcel specific analysis such as estimating tree loss in a development or setting TC goals for individual properties. Additional analyses were done for Parks, Priority Habitat Restoration Areas, Riparian Buffers, and Roads and Rights-of-Way.

Conclusions of the report show that planting new trees on much of the land showing potential such as recreation fields and parking lots may not be socially desirable or financially feasible. Before setting an achievable goal, an in-depth feasibility assessment should be conducted. Following is a summary of the UTC report's conclusions.

- UTC is a vital city asset that provides many environmental, social and economic benefits.
- 45% of the land in Lancaster could theoretically support tree canopy.
- Focus should be on parcels that have large, contiguous impervious surfaces.
- The majority of the existing UTC is on residential land.
- Long-term efforts must include educational programs on tree stewardship and tree planting incentives.
- Streets and other rights-of-way contain 24% Existing TC and an additional 24% Possible TC. Streets and other rights-of-way include all streets, highways, alleys, trails, paths and similar conveyances.
- Tree plantings should be tied into stormwater management projects.
- Increase public education and participation through tree-planting activities.
- Landscape design should be added to development ordinances.

Figure 1-3. Example of Tree Loss



An area of substantial tree canopy loss near Clipper Magazie Stadium. This type of extensive forest loss harms numerous ecosystem services and will take decades to replace.

2016 UTC Assessment Update

In 2016, the University of Vermont analyzed the tree canopy change from the analysis conducted in 2010. The result of the new analysis was no net change in tree canopy, counter to what many other communities have experienced, which is a loss of tree canopy. It would be a mistake to take this comparison as a positive because it shows we have not made progress toward the UTC goal established in 2011. Figure 1-3 visualizes an example of tree loss from that analysis.

Establishing Urban Tree Canopy Goals

Throughout this Urban Forest Management Plan and other City of Lancaster plans and reports, a 40% tree canopy goal is often referenced. The April 2011 Green Infrastructure Plan referred to "various studies" that indicate the feasibility of a 40% tree canopy. The GI Plan also noted that the nonprofit conservation organization American Forests advocated for a 40% urban tree canopy. However, American Forests no longer recommends a universal 40% tree canopy, instead suggesting a more nuanced approach to establish tree canopy goals.

A 40% UTC goal might be a realistic goal for Lancaster, but that needs to be determined through the analysis of empirical data as well as parameters such as development and land use patterns, ordinances and regulations, and climate. Although the 2011 UTC assessment concluded that "45% of the land in Lancaster could theoretically support tree canopy," it also pointed out that "much of this land may not be social[sic] desirable (e.g. recreation fields) or financially feasible (e.g. parking lots)." A feasibility assessment to establish UTC goals is not part of the Urban Forest Management Plan. This plan only identifies tools and strategies for increasing and maintaining UTC. Goal setting is a separate exercise we have never really undertaken. Those tools and strategies can be used to achieve identified objectives by measurable amounts, such as reducing urban heat island temperatures or stormwater runoff.

Findings

The UTC analysis includes all of Lancaster's tree canopy within the city limits and not only the supplied tree inventory. Notably, trees on private property or in wooded areas are included. Thus, a UTC analysis and an inventory are complementary tools for urban forestry planning and management.

Everywhere in the City trees grew, some were pruned or removed, and new trees were planted. Canopy cover over various land use areas (such as streets, parks, schools, etc.) can be separately analyzed. Of particular interest to this report is the canopy over the public right of way as illustrated in Figure 1-4.

Discussion

During the period from 2010 to 2016 and thereafter, there were many efforts to plant trees. Of course, those hundreds of new trees are much too small to make any significant contribution to the UTC. In time, their impact will be seen in the UTC and in the benefits to the community. We are planting trees now for future generations. Having a reasonable goal would help guide tree planting.

Equally important is the preservation of our existing trees. All trees, but especially mature trees, benefit us now and into the future. Managing an urban forest is a long-term commitment and ongoing process. The fact that we did not lose more canopy suggests some success in maintaining those mature trees, even though some will inevitably decline or die each year. It should be pointed out that since 2016, as demand for housing and office space in the City remains high, several acres of wooded land have been cleared for such development.

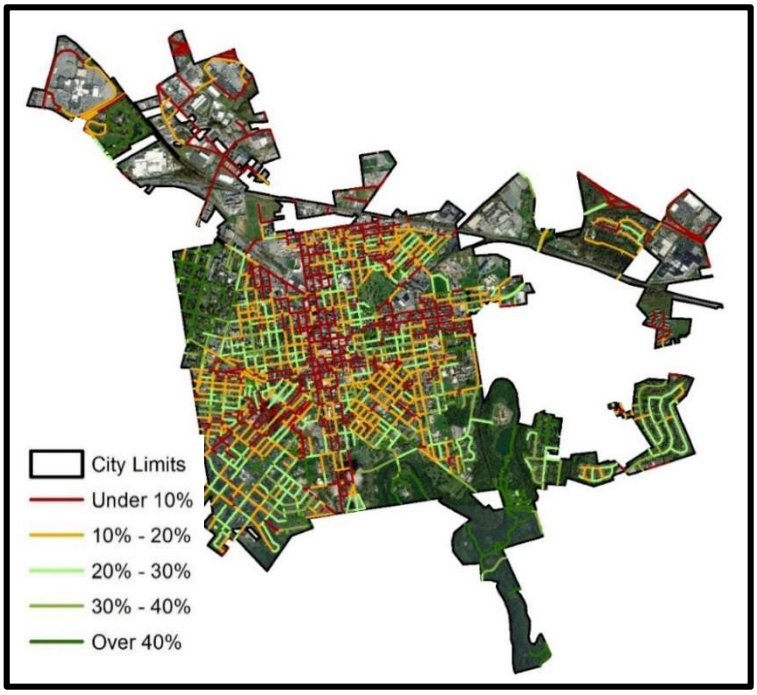
In addition to known gains and losses to TC, areas with less canopy cover deserve further analysis to see if more trees can be planted. In this way the UTC study and the inventory can support one another in the planning process.

UTC analyses should be performed periodically to assess overall change. Coordination with Lancaster County or other agencies should be attempted to reduce the cost of such an initiative. A reasonable interval would be every 8 to 10 years.

Street ROW Stocking Level

Stocking is a traditional forestry term used to measure the density and distribution of trees. For an urban/community forest such as Lancaster's, stocking level is used to estimate the total number of sites along the street right-of-way (ROW) that could contain trees. Park trees are excluded from this measurement.

Figure 1-4. Canopy cover percentages along ROW in Lancaster in 2016



Stocking level is the percent of street ROW spaces occupied by trees relative 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 planting sites would have a stocking level of 75%.

For an urban area, Davey Resource Group (DRG) 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. For this analysis, the total number of street trees and all planting sites in the data provided were evaluated as indicated in Figure 1-4 that shows the percentage of TC along the City's rights-of-way.

Findings

Along the City's 120 miles of streets, the inventory showed 6,179 existing trees and 3,059 potential planting sites including vacant tree wells. Using those numbers, the current stocking level is 67%. Of the 3,059 planting sites, 1,288 were existing sites (such as open pits or stumps) that could theoretically be utilized immediately for plantings, as well as the remaining 1,771 sites identified as "potential." However, all possible planting sites, existing or potential, should be field verified

using the tree siting criteria developed by the City to be sure the right tree is planted in the right place. It is important to note that some areas of the city have not yet been fully surveyed for existing street trees and planting sites, so the actual citywide stocking level is not known at this time. As noted previously, the inventory data from which a stocking level analysis is done, has not been completely or accurately maintained. Therefore, a top priority of this Urban Forest Management Plan is updating the tree inventory in a manner that includes all trees along the city's rights-of-ways including trees not between the street and sidewalks.

Another way to assess the city's street tree population is to calculate the number of trees per street mile. Based on the 2011 inventory, Lancaster has 51.5 street trees per street mile. Determining this ratio for particular areas can be useful in prioritizing tree planting programs. In comparison, a survey of many cities in New York state revealed an average of 80 trees per street mile. A related measurement is street trees per person; Lancaster's value of 0.1 is below that found in surveys of other cities.

Discussion

Fully stocking the street ROW with trees is a worthy goal. Inadequate tree planting and maintenance budgets, along with tree mortality, will result in lower stocking levels. Nevertheless, working to attain a fully stocked street ROW is important to promote canopy continuity and environmental sustainability. Therefore, it is important to encourage plantings which increase Lancaster's street tree population toward achieving the ideal of 90% or better. Generally, this entails a planned program of planting, care, and maintenance for Lancaster's street trees. Focus should be placed on planting public trees where maintenance, fertilizing, pruning, and young tree training are easily performed.

Currently 7.4% of TC is street trees, and only 14% of all streets and sidewalks are covered by tree canopy, which is equal to about 50 trees per street mile. These percentages do not include alleys and private streets. Considering that each street has two frontages for planting trees, the average distance between street trees is approximately 180 feet. We should strive for a separation distance closer to 50 feet. Therefore, the City should develop small area plans for strategically planting trees along its streets to triple the percent of TC over streets and sidewalks.

The least cost scenario to improve tree canopy with greater speed is to utilize the existing planting sites identified in the inventory first, then focus on the potential sites (some of which would require more capital and outreach to achieve similar canopy results). Density of development and utility conflicts will determine which sites are feasible, some sites will not be utilized due to cost of remediation to create suitable planting sites.

DRG recommends planting 200 trees per year and placing these new trees under municipal care. At that level, it would take over 15 years to complete the planting of the over 3,000 identified sites, not accounting for the hundreds or thousands of yet-to-be surveyed sites, which is not within the five to ten years for a typical scope of municipal forestry management plans. The nuance of private property owners planting and caring for street trees adds to an already challenging situation. Areas with the greatest need for tree benefits may be not align with property owner desires. Overcoming this situation by incrementally moving street trees under municipal care is a recommended theme for improvement. Therefore, it is imperative for the City to develop a specific strategy for street tree planting. This strategy must also substantially increase the annual tree planting for progress toward the canopy goal. Regardless of the methodology used for developing a strategy, planting efforts should be prioritized, such as focusing efforts on residential areas with low canopy cover.

Tree Attributes

As noted previously, it is important for the City to plant the right tree in the right place, especially along streets and in green infrastructure. Trees adapted to the planting site are more likely to survive into maturity and provide the most ecosystem benefits.

This section is a review of two characteristics of the existing inventoried street and park trees: species diversity and diameter size distribution. This discussion includes recommendations for selecting trees to offer the greatest good to the City. It should be noted that not all tree attributes are being presented here. Tree planting, site selection and care parameters will be discussed briefly in Chapters 3 and 4.

Species Diversity

Species diversity affects maintenance costs, planting goals, canopy continuity, 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 or related species) can lead to severe losses in the event of species-specific epidemics such as the devastating results of Dutch elm disease (*Ophiostoma novo-ulmi*) throughout the MidAtlantic. Due to the spread of Dutch elm disease beginning in the 1930s, combined with the disease's prevalence today, massive numbers of *Ulmus americana* (American elm), a very popular street tree in American cities and towns, have perished (Karnosky 1979). Many communities were stripped of most of their mature shade trees, creating a drastic void in canopy cover.

Figure 1-5. Photo of Rapid Effects of Emerald Ash Borer

More recently, many cities in the Midwest and Northeast have suffered massive losses from the Emerald Ash Borer, an invasive pest. It is estimated that over 30 million ash trees have been killed. Figure 1-5 shows how once-leafy streets, planted with a single species, have been devastated by the loss of essentially every tree. Fortunately, Lancaster had relatively few ash trees - about two-thirds of the 300 ash trees were removed. But our urban forest, overplanted with certain species, could experience a similar loss to a future pest or disease.

There are many benefits to a maintaining a diverse urban forest. One rule of thumb often followed for the composition of a tree population is the 10-20-30 Rule for species diversity: a single species

should represent no more than 10% of the urban forest, a single genus no more than 20%, and a single family no more than 30%. However, the Morton Arboretum in Chicago recommends a 5-10-15 rule: "In any community, no more than 5 percent of trees should be of the same species; no more than 10 percent should be from the same genus; and no more than 15 percent should be from the same family."

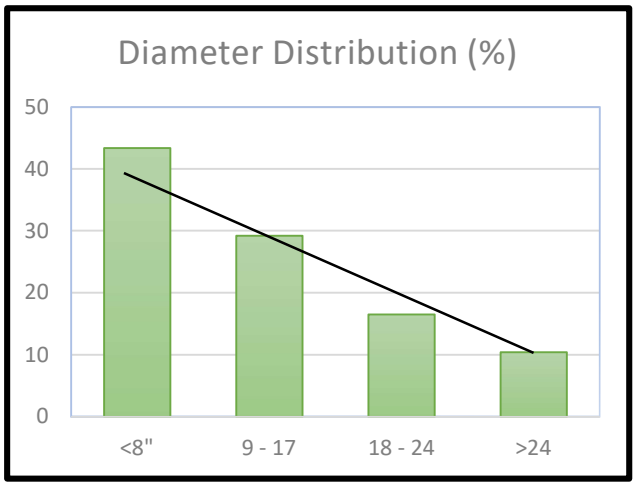
Regardless what, if any, rule is followed, an urban forest comprised of many different genera and species will provide sustainability benefits long into the future. When choosing a tree to plant, make sure it is suitable for the growing conditions of the site and try something new. Sometimes, looking around a neighborhood to see what other trees are growing there, and choosing something different can work just as well as the more scientific rules.

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

Diameter Size Class Distribution

Complementary to species diversity is a diversity of ages. Analyzing the diameter size class distribution provides an estimate of the relative age of a tree population and offers insight into planting and maintenance practices and needs. The inventoried trees were categorized into the following diameter size classes: young trees (0–8 inches diameter at breast height (DBH)), established (9–17 inches DBH), maturing (18–24 inches DBH), and mature trees (greater than 24 inches DBH). This distribution is shown in Figure 1-6. These categories were chosen so that the population could be analyzed according to Richards' ideal distribution (1983). Richards proposed an ideal diameter size class where the largest fraction of trees should be young, while a smaller fraction should be in the large-diameter size class. 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. But it is important to note that larger trees provide the greatest ecological, health and social benefit, and should be carefully preserved to the maximum extent possible. It takes decades for a new tree to make the contributions of a majestic oak or sycamore.

Figure 1-6. Diameter size class distribution



Findings

Analysis of Lancaster's tree inventory data for street and park trees indicated that the urban forest has a relatively good diversity, with 64 genera and 215 species represented. Along Lancaster's streets are 54 genera and 110 species.

With regard to street trees, Figure 1-7 shows the five most common genera and Figure 1-8 shows the five most common species identified in the inventory. Although many varieties of *Acer rubrum* (red maple) are found in Lancaster, it far exceeds any recommended maximum for a single species in a population, and all other inventoried tree species. The next four most abundant species *are Acer platanoides* (Norway maple), *Pyrus calleryana* (Callery pear), *Quercus rubrum* (red oak) and *Tilia cordata* (littleleaf linden), all of which are less than 10% of the total inventoried.

Increasing plant diversity can alleviate losses from future pests. Some professionals in the industry recommend monotypic species, for which there is only one or two species in a single genus.

Based on the guideline for no more than 20% of the population in a given genus, we found that maples represent 31% of the inventoried trees, far exceeding any recommendations for a single genus. No other genus has more than 8% of the population.

Along with species diversity, age diversity is important in sustainably maintaining a healthy urban forest. Figure 1-9 compares Lancaster's diameter size class distribution of the inventoried tree population to the ideal proposed by Richards (1983). Richards' ideal distribution suggests that the largest fraction of trees (approximately 40% of the population) should be young (less than 8 inches DBH), while a smaller fraction (approximately 10%) should be in the large-diameter size class (greater than 24 inches DBH). Overall, the diameter size class distribution of Lancaster's trees is close to the ideal. The goal is to have a stock of younger trees to replace the older trees as they are removed. Forty-three percent of the inventoried street trees are less than eight inches DBH, while 10% are greater than 24 inches DBH, meeting the desired size distribution.

Figure 1-7. Five most abundant genera

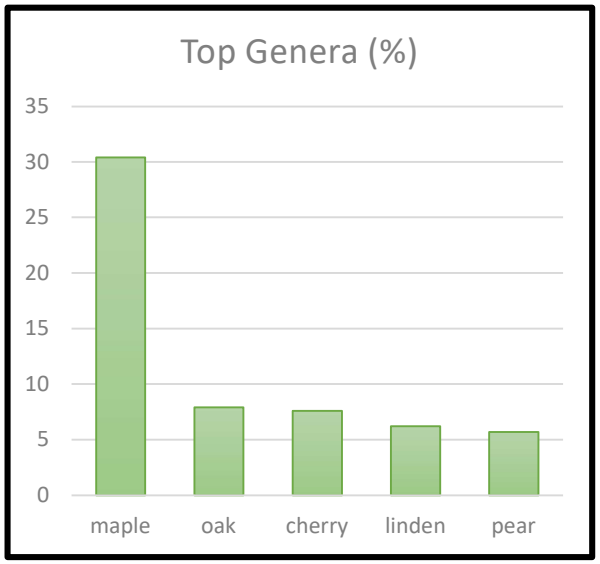
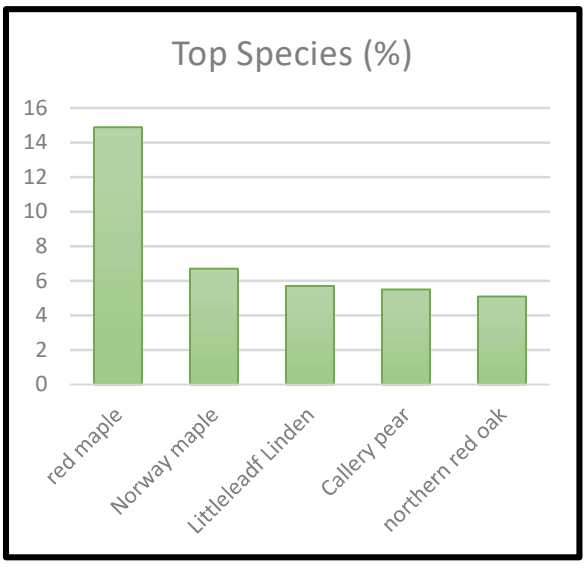


Figure 1-8. Five most abundant species



Discussion

Maples are very common in the streets and parks, creating a biodiversity concern due to a monoculture landscape susceptible to potential disease and pests which could decimate the inventory if a large quantity were lost. Enhancing diversity of tree species is an important objective that will ensure Lancaster's urban forest is sustainable and resilient to future invasive pest infestations.

Planting monocultures may seem visually appealing and somewhat easy to fulfill (classic elm tree lined streets); but this is very ill-advised. Planting similar species trees in close proximity is an invitation to the spread of tree diseases and pests from one host tree to the next. An entire block could lose its tree canopy at once. Neighboring trees of different genera is the best option; consider a palette of trees choices, using trees with complementary forms.

It is of special concern that both Norway maple and Callery pear are considered invasive species; native species should be used when replacing these trees. Although red oak is native and a majestic tree that is an important part of our forest ecosystem, it is no longer recommended here because of disease problems; there are other oak species that can substitute.

Lancaster must encourage and support a strong planting and maintenance program to maintain a sustainable age diversity in the tree population. This can be done by ensuring that young, healthy trees are planted to fill in gaps in tree canopy and replace older declining trees. Although there is clearly no deficiency of young trees, the need for enhanced planting must be continued to achieve the ambitious goal of 40% tree canopy. The relatively large proportion of the largest trees indicates that they are being cared for and preserved for their major benefits. A strategy should be developed to protect many of these mature trees from substantial losses in the foreseeable future. However, such trees may need to be removed when their condition falls below the threshold of acceptable risk. The city must promote tree preservation and proactive tree care to ensure the long-term survival of older trees.

However, a certain number of trees should be removed each year, a certain number planted, and a certain number maintained. This removal and planting strategy will help keep the community forest safe and provide a diversity of age and species for the public forest. Age and species diversity will help provide a more sustainable mixed-age and mixed-species tree population and canopy on each street. An uneven aged forest structure will improve landscape beauty while regulating storm damage, tree removal, and maintenance efforts and costs in the long-run. Uneven age structure also provides for canopy replacement as larger trees are removed. As an example, if two percent of the total street tree population is removed each year a 50-year separation in age classes would be developed over time on the city streets. This coupled with species diversity is the best strategy for a healthy and well-structured landscape.

Site Characteristics

In the discussion above on tree attributes, it was noted how important it is to plant the right tree in the right place. The previous section covered the right tree, this section will briefly address the right place. The type and condition of sites will be discussed as well as growing space and infrastructure and utilities conflicts. All data presented is for existing inventoried street trees. This discussion includes recommendations for selecting sites for planting trees. Not all site characteristics are being presented here. Additional site selection parameters will be discussed briefly in Chapters 3 and 4.

Figure 1-9. Median

Site Type

The type of tree planting sites described here are taken from the 2011 *Lancaster City Tree Inventory: Summary Report*. Two examples are show in the figures on this page.

Tree pit or tree well is the most common type of street tree planting site. A tree pit is typically cut out of a sidewalk or otherwise surrounded by impervious hardscape. They are generally small, less than 16 square feet, and hold only one tree. The current city regulations require at least 25 square feet. Some of the current problems with street trees relate to the large number of older, smaller pits, which sometimes continue to be installed.

Figure 1-10. Appropriately sized tree pits

The next most common site type is the tree lawn, often also known as a planting strip or beauty strip. The tree lawn is a continuous unpaved strip located between a street curb and sidewalk, typically less than 4 feet wide. Tree lawns vary in length, from a single property to the entire block, and are often planted with multiple trees. A median is similar to a tree lawn that is located in an island median of a street. A tree trench is a large tree pit extending parallel to the street similar to a tree lawn or planting strip. The tree trench is typically located within the sidewalk area and often includes a pervious surface that allows water to infiltrate while maintaining sidewalk space. The surface could be groundcover or permeable pavers. This type of site might also be referred to as a stormwater best management practice.

As used in the tree inventory, a yard is a site "unbounded within 8 feet on at least 3 sides." Very few street trees in Lancaster are planted in yards because this type of planting site is usually available only when a sidewalk is not present, or if the sidewalk is adjacent to the street, with trees planted behind the sidewalk.

Site Condition

A variety of site attributes are compiled to determine the site condition based on sidewalk damage, growing space and infrastructure conflicts. In the 2011 inventory of street trees, site condition rating is described as "the suitability of a site as a planting site based on potential conflicts."

Sidewalk and hardscape damage

Trees can adversely impact hardscape, which affects tree root and trunk systems. Inventories can record damage related to trees, causing curbs, sidewalks, and other hardscape features to lift. This data should be used to schedule pruning and plan repairs to damaged infrastructure.

To limit hardscape damage caused by trees, trees should only be planted in growing spaces where adequate above ground and below ground space is provided. Pictured in Figure 1-11 is a Northern red oak with a DBH greater than 50 inches that has lifted and cracked a large section of sidewalk. It has also reduced the clear passage width to less than the minimum four feet required by the Americans with Disabilities Act. It is one of the largest street trees in Lancaster and every effort should be made to preserve this healthy landmark tree.

Figure 1-11. Sidewalk damaged by street tree

Growing Space

Growing space includes both horizontal and vertical space around the tree, such as the height of the lowest branches over the street and sidewalk and the distance away from buildings, sign and street furnishings and appurtenances. The tree canopy should not interfere with vehicular or pedestrian traffic, nor should it rest on buildings or block signs, signals, or lights. Pruning to avoid clearance issues and raise tree crowns should meet the city's regulations: 14 feet over streets; nine feet over sidewalks; and five feet from buildings, signs, signals, or lights. The limitations of Lancaster's narrow streets, small lots, etc. may lead to trees planted in less than ideal locations, but with proper selection and care, these trees can flourish, as they have for generations.

Growing space also includes the area of the tree pit or lawn provided for the tree. A minimum of 25 square feet is required in the City's Tree Manual for tree pits in new construction and a minimum of four feet wide for tree lawns.

Infrastructure and Utility 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 pose risks to public health and safety. The costs for treating deficient trees must be considered to determine whether removing and replacing the tree is the more viable option.

Adequate clearance should be maintained at all times to keep trees from blocking the visibility of traffic signs or signals, streetlights, or other safety devices. Light conflict occurs when tree parts

interfere with a streetlight, blocking light dispersion. Sign conflict is when tree trunks and branches block visibility of nearby signage. The incidence of such conflicts should be used to schedule pruning activities.

Overhead utilities such as electric and communications wires are the most visible utility conflict. The presence of overhead utility lines above a tree or planting site should be noted; it is important to consider these data when planning tree pruning activities and selecting tree species for planting (see Figure 1-12 for pruning conflicts and Figure 1-16 percent of utility conflits). Less visible are the gas, water and sewer lines underground. The lines themselves do not often conflict with trees, however, the vents and valve boxes often located in sidewalks and tree lawns pose a common tree conflict.

Figure 1-12. Tree pruned for overhead wires

Findings

Trees need sufficient growing space at ground level for the trunk taper, root collar, and immediate large diameter structural roots. As shown in Figure 1-9, almost 2/3 of all street trees in Lancaster are planted in tree pits. According to Davey Resource Group, the ideal width of the street tree lawn or tree pit should be four to five feet for small trees, six to seven feet for medium trees, and eight feet or more for large trees. Such conditions are rarely encountered in Lancaster, where the majority of trees are growing in spaces four feet wide or less. Nonetheless, Lancaster's street trees can do well. Although the ground-level growing space is an important consideration in tree selection, the data in the tree inventory does not reveal a negative correlation between growing space and tree condition. Regardless, best practices should be followed whenever possible to plant the right tree in the right place, even if we cannot achieve these ideals.

Although they often do not appear to be so, many of the City sidewalk rights-of-way are a minimum 10 feet in width. Encroachments such as stoops, porches, utility poles, signs, streetlights and fire hydrants often take away space for planting trees. The majority of the City's street trees are growing in spaces significantly less than the recommended, resulting in numerous conflicts and causing damage to sidewalks and occasionally to underground utilities. Although only 15% of the inventoried street trees have no conflict, the overall site condition of more than 80% of street trees is good or excellent. Figure 1-13 shows the primary conflicts for street trees within the public right-of-way. Figure 1-14 shows the percentage for site conditions.

At the time of the inventory, 1,004 trees were in conflict with nearby buildings, 94 trees were blocking or partially blocking a streetlight, 391 trees were blocking visibility or nearby signs, 1,383 trees interfered with walkways, and 1,478 trees were extending lower than 16 feet above streets. At that time, more than 2,500 trees had a site size of less than 4 feet as measured perpendicularly to the adjacent road. Although trees within the ROW are the responsibility of adjacent property owners, when the City is made aware of trees obstructing signs, lights and other conditions, pruning is often performed as needed. Some conflicts are easily fixable by pruning or removing excess concrete to enlarge a tree pit.

Figure 1-13. Conflicts for street trees

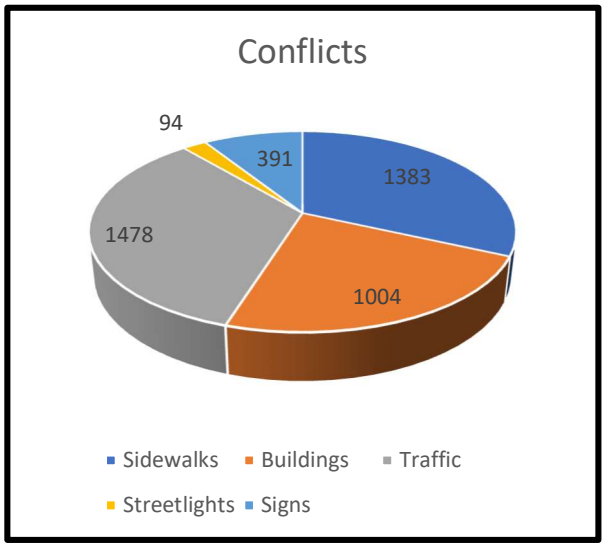
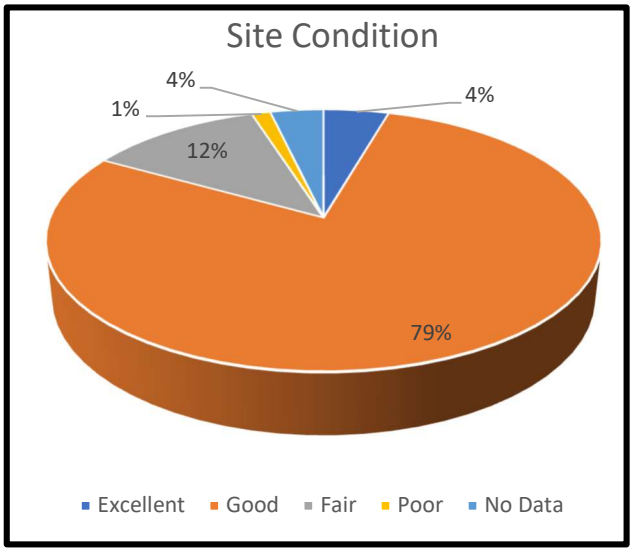
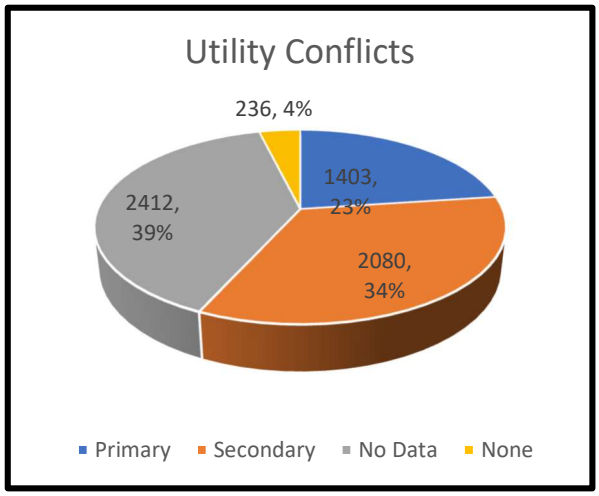


Figure 1-14. Site Condition for street trees



Primary utility conflicts are conflicts with the high voltage overhead electric transmission wires for which the electric utility prunes limbs and branches often in a V-shape. Secondary and communications conflicts are for telephone, cable and lower voltage electric cables often placed lower on the poles and traversing through trees without imminent hazard. Nearly 60% of street trees exhibit some level of conflict with electric and communications wires, some of which can cause inconvenience and even hazards to persons and property during severe weather events.

Figure 1-16. Street Tree Utility Conflicts



Discussion/Recommendations

Consider planting new trees of correct size and type for the location. The widely adopted mantra in the urban forestry profession is, "Right Tree, Right Place." However, we are not just planting trees, we must also preserve the maturing and mature trees along our streets, in our parks and in our yards. Strategies such as planting only small-growing trees within 20 feet of overhead utilities, medium-size trees within 20 to 40 feet, and large-growing trees outside 40 feet are common in urban forest planning. Implementing such strategies could help improve tree conditions and minimize conflicts. However, separation distances of these amounts are completely impractical for an old compact city like Lancaster.

The useful life of a public tree ends when the cost of maintenance exceeds the value contributed by the tree. This can be due to increased maintenance required by a tree in decline, or it can be due to the costs of repairing damage caused by the tree's presence in a restrictive site. Tree selection in Lancaster should be centered on site restrictions in the narrow right of ways. Clearly, there is no shortage to the challenges to planting the right tree in the right place.

Tree-sidewalk conflicts in restricted sites can be lessened by choosing trees that are less likely to have surface roots, using planting practices that encourage deep rooting, and paying careful attention to proper site and soil preparation. Sidewalk design and using alternatives to concrete are also important. The City has already innovated with alternative techniques in some of its recent green infrastructure projects, such as tree trenches, flexible pavements, and curb extensions.

Another recommendation based on site size restrictions is increasing the utilization of the established planting easement program. Some older residential areas have little room for trees. Near-term planting activities should focus on planting sites in locations that are under the city's care and/or other public ROW locations that have the least conflicts and largest growing space.

As with the existing ROW tree ownership paradigm, the infrastructure and capital needed to retrofit some planting sites in the densely developed urban areas with limited planting space is beyond the ability of most local property owners. Unfortunately, these areas are also where the greatest need to plant exists. Areas of dense residential dwellings with little or no tree lawns, are also often areas with limited on-street parking adding to the challenge of retrofitting public space. Since many street trees are growing in tree pits less than 25 square feet or tree lawns less than 4 feet wide, willingness and creativity must be part of the solution to planting more street trees in these neighborhoods.

The process for selecting pilot sites to begin retrofitting to accommodate municipally owned street trees must include neighborhood input. Proven techniques such as structural soils, tree trenches, and modular subsurface pavement systems are readily available, but are typically cost prohibitive for private property owners. A less costly method is curb extension that can be used to protect existing trees as well as provide space for new trees. These should be placed where parking is already prohibited to maintain support from the neighborhood. Where space allows, strategies such as providing radius sidewalks can greatly enhance success for new and existing trees.

Plantings sites with known utility conflicts should be further investigated for proper tree selection. When tree inventories are undertaken, potential planting sites should be identified and evaluated. In addition, the next tree inventory should measure tree pits and tree lawns by width and length. Remember that healthy trees provide the maximum return of the entire bundle of tree benefits. Tree canopy should not interfere with vehicular or pedestrian traffic, nor should it rest on buildings or block signs, signals, or lights. Pruning to avoid clearance issues and raise tree crowns should be completed in accordance with *ANSI A300 (Part 9)* (2011).

Condition

The health and condition of each street tree was assessed during the inventory survey. Rating of tree condition was based on the health and structure of the tree and its parts. Categorical ratings are excellent, good, fair, poor, and dead. Ratings are assigned based on individual tree condition and relative ratings applied to other trees of the same and similar species found at similar sites. Visible defects and other tree attribute data provide detail for the assigned condition ratings. Structural and health factors that cannot be seen cannot be considered (e.g., root rot). The extent of the defect was not indicated in the inventory. The greater the number of individual health or structural defects or problems with a tree, the lesser the condition rating assigned.

Structural defects easily observable from the ground (Figure 1-17) include natural or manmade wounds, visible decay and cavities, as well as girdling roots and any objects physically attached

or situated close to the trunk or branches and causing injury to the tree. The presence of storm damage and codominant trunks, and the amount and size of deadwood were also noted.

Signs of ill or declining health reported in the inventory include necrosis and chlorosis, the death and yellowing of foliage, respectively, and the overall thinning of foliage and live branches. The signs or symptoms of disease pathogens and damaging insects were also noted in the inventory. As defined in the 2011 Inventory Report, decline is the "Overall thinning of foliage and live branches due to stress.

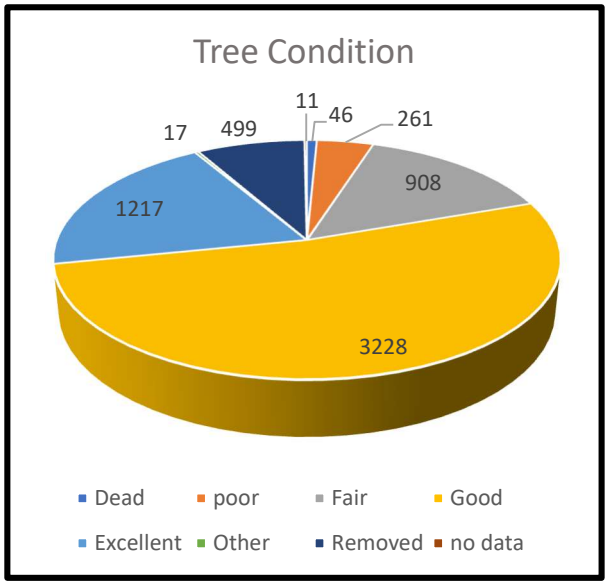
Figure 1-17. Dead Tree in back yard

Findings

As shown in Figure 1-18, the bulk of the inventoried trees (72%) is rated at good or excellent, with Poor or Dead trees at only 5%. Since the inventory data used in this plan is from 2016, the dead trees have been removed, and if any of the poor trees died, they too would have been removed in the intervening years.

The primary structural defects found in the street trees inventoried are wounds (2,698), deadwood (2,554), codominant trunks (2,432) and girdling roots (1,152). Over 500 trees had wounds, deadwood, and codominant trunks; while 130 trees had all four defects, 50 of which had been removed since the original 2011 inventory that identified the defects.

Figure 1-18. Lancaster's inventory of overall street tree condition.



Discussion

Condition analysis provides insight into maintenance needs and historical maintenance practices. The inventory reveals that 40% of street trees have at least one negative tree condition and 10% have two or more. Multiple defects or signs of ill health affect even trees considered to be in Excellent condition. Therefore, all street trees should be continually monitored for structural defects and evidence of disease, pests and overall decline.

The majority of Fair or better tree conditions observed among street and park trees reveal that growing conditions and/or past management of trees were consistent. Trees in poor condition should be removed because of their failed health; these trees will likely not recover, even with increased care, and may become hazardous. It is not financially feasible to continue to care for trees in poor condition. Any standing dead trees should be removed at once due to aesthetics and increased public risk.

Younger trees rated in Good or Fair condition may benefit from pruning to improve their structure to improve their health over time. Pruning should follow ANSI A300 (Part 1) (ANSI 2008).

Condition is important as a function of public return of benefits. Healthy trees in the best condition return higher benefits to the public rather than trees in poor health of similar size. Encouraging the use of best management practices, including but not limited to mulching, watering, pruning, pesticide application, and construction protection zones, is the path to optimal tree performance.

CHAPTER 2: BENEFITS OF THE URBAN FOREST

The urban forest plays an important role in supporting and improving the quality of life in urban areas. When properly maintained, trees will provide Lancaster with abundant health, environmental, economic, and social benefits that exceed the time and money invested in planting, pruning, protection, and removal. By using extensive scientific studies and practical research, many of these benefits can now be confidently calculated using tree inventory information.

Trees are essential green infrastructure; they should be treated as a capital investment that delivers multiple sustainability benefits (or city services) for many years and decades to come.

"There's almost no public health, crime, or environmental quality metric that you can look at that isn't made better by the presence of trees." – Deborah Marton, New York Restoration Project

Introduction

The City of Lancaster recognizes the intrinsic value and ecosystem benefits that trees provide to its citizens. Trees help to remove pollutants from the air and water, capture stormwater, shade streets and residences, increase property values, provide wildlife habitat, facilitate social interaction, provide educational opportunities, improve physical and mental well-being, and offer aesthetic value. These benefits are realized at many levels, from individual homes and neighborhoods to the entire City.

Health Benefits

Recently, much medical attention has been focused on the role of trees in providing public health benefits. The two health areas of concern are high temperatures and air pollution.

Heat waves are a fact of life in Lancaster. Young children and especially the elderly are particularly susceptible to extreme heat and accompanying humidity because their bodies are unable to readily adjust. Those with existing heart or lung disease are at great risk. In Chicago the 1995 heat wave led to an estimated 700 deaths over expected for the period. Victims were mainly elderly poor residents (Whitman et al. 1997). Often these people had no air conditioning or could not afford the electricity (Changnon et al. 1996). Hospital admissions rose by about 35% among the elderly (Semenza et al. 1999, Nature Conservancy 2016).

It is well known that Lancaster County has poor air quality – indeed, the worst in the state according to a recent report (PennEnvironment 2020, LNP 2020). Particulate matter is one hazard of polluted air and is the greatest problem here. These fine particles can penetrate deeply into the lungs, contributing to lung diseases such as asthma and cardiovascular diseases such as heart attacks and strokes (McDonald 2015).

Where do trees fit in? Trees can help with BOTH problems. A dense canopy of leaves can capture particulate matter, simply because of the large surface area. Trees can reduce urban temperature in two ways. (1). By shading streets, buildings, etc., trees reduce the heat that is absorbed and retained. This absorbed heat creates the urban heat island effect, which is particularly evident with excessively warm nights. (2). Trees release substantial amounts of water vapor through their leaves (50 or more gallons a day for a mature oak tree); this evaporation causes cooling, just as our evaporating perspiration does (Chicago Tribune 2015, McDonald 2016).

Figure 2-1. Tree-lined Lancaster City Street

Strikingly, recent Nature Conservancy reports show that urban trees could save lives (McDonald 2015). In the 2003 European heat wave, urban neighborhoods that were greener were cooler, and each 1.8 degree decline in temperature reduced the chance of death by 21%. Examining many studies, researchers concluded that within about 300 feet of trees, particulate matter can be reduced 7 to 24% and air temperature can be reduced 2 to 4 degrees. There is little or no effect further away. In Syracuse, NY, (population about three times larger than Lancaster City), the existing urban trees remove enough particulate matter to reduce annual health impacts by about $1.1 million (Nature Conservancy 2017).

Are trees cost-effective in delivering these benefits? Expressed as dollars per degree of temperature reduction, tree planting can be more cost effective than most other approaches. Expressed as dollars per ton of particulate matter removed, tree planting is somewhat more costly than reducing industrial pollution at the source and comparable to some other gray infrastructure strategies (McDonald 2015).

The City of Lancaster Municipal Climate Action Plan, completed in 2019, described ways in which trees can contribute to mitigating the negative effects of climate change. The Climate Action Plan noted how, in Lancaster, carbon offsets, which are measurable greenhouse gas (GHG) emissions reductions that are generated by other sources than one's own, might include the continued planting of trees that absorb carbon dioxide (CO_2), thereby improving energy efficiency to reduce emissions. In addition, stormwater systems can also be designed to direct water towards trees and other vegetation, reducing the need for watering.

And, as explained in the following sections, trees deliver many other benefits. Overall, then, trees can be more cost-effective than traditional gray infrastructure strategies in delivering a wide range of benefits.

Triple Bottom Line Benefits

The triple bottom line is a belief that in all we do, focus should be placed on social and environmental concerns no less than economic concerns.

The urban forest, especially trees growing along the public streets, constitutes a valuable community resource. Trees provide numerous tangible and intangible benefits, such as pollution control, energy reduction, stormwater management, property value increases, wildlife habitat, and aesthetics; services and benefits that were once considered to be unquantifiable.

How can the value of these urban forest benefits be quantified? The functional and structural value of an urban forest must be quantified and established. This is more than just calculating the timber value of a forest. Functional value is a calculation of the combined values of environmental, economic and social benefits the urban forest provides.

Figure 2-2. The Aesthetic Value of Trees

These values are not simply estimating the cost to replace all of the trees, they are more than just an estimate of the investment in all the time and resources committed to establishing and maintaining the urban forest. Since people are willing to pay more for a house on a tree-lined street, these value estimations take into account the effect trees have on property values. They should also include a more nuanced estimation of the benefits of the urban forest's hard to measure characteristics such as aesthetics, health, and happiness.

Figure 2-3. Triple Bottom Line Benefits.

The following sections briefly describe some of the social, economic and environmental benefits provided by the urban forest as well as a benefit-cost analysis using the i-Tree Streets modeling program.

Social Equity Benefits

- Tree-lined streets are safer; traffic speeds and the amount of stress drivers feel are reduced, which likely reduces road rage/aggressive driving (Wolf 1998a, Kuo and Sullivan 2001a).
- Employees who see trees from their desks experience 23% less sick time and report greater job satisfaction than those who do not (Wolf 1998a).
- Hospital patients recovering from surgery who had a view of a grove of trees through their windows required fewer pain relievers, experienced fewer complications, and left the hospital sooner than similar patients who had a view of a brick wall (Ulrich 1984, 1986).
- Tree-lined streets make people happy. A 2019 study of nearly 47,000 urban residents, conducted by the University of Washington's College of the Environment, in Seattle, showed "that those who lived in areas shaded by tree canopy reported less psychological distress and better general health over six years."

Economic Benefits

- Trees increase property values. Commercial property rental rates are higher when trees are on the property (Wolf 2007).
- Trees moderate temperatures in the summer and winter, saving on heating and cooling expenses (North Carolina State University 2012, Heisler 1986).
- On average, consumers will pay more for goods in landscaped areas (Wolf 1998b, Wolf 1999, and Wolf 2003).
- Consumers feel the quality of products is better in business districts surrounded by trees (Wolf 1998b).

Environmental Benefits

- Trees decrease energy consumption and moderate local climates by providing shade, cooling streets, and acting as windbreaks.
- Trees help to slow and reduce the amount of stormwater runoff that reaches drains, rivers, and lakes (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 (Coder 1996). Lovasi (2008) suggested that children who live on tree-lined streets have lower rates of asthma.
- Trees stabilize soil and provide habitat for wildlife.

Tree Benefit Analysis

The results of applying a proven, defensible model and method that determines tree benefit values for Lancaster's tree inventory data are summarized in this report using the i-Tree Streets application. The results of this analysis provide insight into the overall health of the Lancaster's public trees and the management activities needed to maintain and increase the benefits of trees into the future.

The benefits provided by a given tree depend on many factors. The models developed in i-Tree use research-based value for trees of a particular size, species, etc. Some tree benefits, such as

shading from summer heat, depend on how close and in what direction a tree is to a house or other structure. Other benefits, such as reducing the entire city's stormwater runoff are independent of location. Residents and planners should consider these factors as they evaluate individual, neighborhood, and community-wide tree projects.

Using i-Tree Tools

The U. S. Forest Service's i-Tree Tools (www.itreetools.org) offers a variety of state-of-the-art, peer-reviewed urban forestry analysis and benefits assessment tools, calculators, and reference materials. The i-Tree Tools help communities to strengthen their urban forest management and advocacy efforts by quantifying the structure of trees and forests, and the environmental services that trees provide. The i-Tree program used in this plan is i-Tree Streets, which became a legacy tool in the I-Tree Tools suite soon after the analyses were completed at the end of 2019. Regardless, i-Tree Streets used updated inventory data to project the value of ecosystem services, like air and water quality improvements, stormwater management, energy conservation, and aesthetic value that the street and park trees provide the City and its citizens. The benefit-cost analysis of Lancaster's inventoried trees was performed using i-Tree Streets and is presented in the following sections.

Other tools in the suite to consider are i-Tree Canopy, i-Tree Eco and i-Tree Design. i-Tree Canopy can be used to track the location, extent, and growth of the city's entire UTC. The i-Tree Canopy tool can be helpful in evaluating the success of tree planting and preservation efforts. The i-Tree Eco tool is a new, more sophisticated tool that replaces i-Tree Streets to establish the value of ecosystem services trees provide. i-Tree Design calculates both the benefits to date and future benefits of a tree. It is especially useful when talking to a property owner about the benefits that will be obtained from placing a certain species of tree in a certain location on the property, or from maintaining an existing tree. Furthermore, the suite of i-Tree Tools can be used to assess and evaluate the benefits and impacts the urban forest has on resident and migratory wildlife.

The City can use the information, statistics, and mapping that results from using i-Tree tools for gauging program success, understanding where improvements are needed, and for educating the public and gaining support for the urban forestry program. This would also be a good tool to reference when seeking grant funding.

The analysis presented here is based on this particular model and set of assumptions. Using different variables, such as a different maintenance cycle length or number of trees (based on an updated inventory), would yield different results, but the principle still holds.

i-Tree Streets

To identify the dollar value provided and returned to the community, Lancaster's street tree inventory data were formatted for use in the i-Tree Streets benefit-cost assessment tool. i-Tree Streets analyzes an inventoried tree population's structure to estimate the costs and benefits of that tree population. The assessment tool creates an annual benefit report that demonstrates the value street trees provide to a community:

These quantified benefits and the reports generated are described below.

- **Aesthetic/Other Benefits:** Shows the benefits of trees reflected by increases in property values (in dollars).
- **Stormwater:** Presents reductions in annual stormwater runoff due to rainfall interception by trees measured in gallons.

- **Carbon Stored and Carbon Sequestered:** Storage tallies all of the carbon dioxide (CO_2) stored in the urban forest over the life of its trees as a result of sequestration. Carbon stored is measured in pounds and has been translated to tons for this report. Sequestration is the annual reduction in atmospheric CO_2 due to uptake by trees and the reduced emissions from power plants due to reductions in the community's energy use. This is measured in pounds and has been translated to tons for this report. The model also accounts for CO_2 released as trees die and decompose and CO_2 released during the care and maintenance of trees. This is an important metric as we work toward reducing greenhouse gas production.
- **Energy:** Presents the contribution of the urban forest toward conserving energy in terms of reduced natural gas use in the winter (measured in therms) and reduced electricity use for air conditioning in the summer (measured in Megawatt-hours (MWh). Natural gas use represents all heating fuels in this model.
- **Air Quality:** Quantifies the air pollutants (ozone [O_3], nitrogen dioxide [NO_2], sulfur dioxide [SO_2], particulate matter less than 10 micrometers in diameter [PM_{10}]) deposited on tree surfaces, and reduced emissions from power plants (NO_2, PM_{10}, volatile organic compounds [VOCs], SO_2) due to reduced electricity use in pounds.

Figure 2-4. i-Tree Streets Analysis Summary

i-Tree Streets Analysis (8,761 trees)			
Feature	Total Value	Value per Tree	Value per capita
Aesthetic Value	$189,305	$21.61	$3.16
Stormwater Capture	$3,058,134	$349.06	$50.97
Carbon Storage & Sequestration	$155,634	$17.77	$2.61
Energy reduction (electricity and NG)	$484,631	$55.32	$8.08
Pollution Removal	$88,754	$10.13	$1.48
Total Annual Benefit	$3,832,714	$437.47	$64.19
Highest Value Species	White oak	$1,237.85	

i-Tree Streets Inputs

In addition to tree inventory data, regional data, including energy prices, property values, and stormwater costs are used to generate the environmental and economic benefits trees provide. If local economic data are not available, i-Tree Streets uses default economic inputs from a reference city selected by United States Department of Agriculture (USDA) Forest Service for the climate zone in which your community is located.

Lancaster's Inputs

Local data were available at the time of this plan and were used to the greatest extent possible with i-Tree Streets to calculate the benefits Lancaster's trees provide its residents. The Lancaster tree inventory data was collected in 2010 and 2011 and includes updates through 2016. i-Tree Streets analysis used data on 8,761 street and park trees as summarized in table in Figure 2-4. The per capita value is based on Lancaster's 2018 estimated population of 59,708. Figure 2-5 presents the total value for the five different benefits evaluated.

In 2019, Davey Resource Group (DRG) performed a separate analysis of Lancaster's tree inventory data using a sample of 7,500 trees. This analysis titled *i-Trees Ecosystem Analysis, Urban Forest Effects and Values, May 2019* can be viewed in the Department of Public Works.

Any modeling program has its limitations. As presented here, the quality of the data input and the analysis of the output determine the ultimate value of the assessment. Unless otherwise noted, all values presented here are from the City of Lancaster's 2016 i-Tree Streets analysis.

It should also be noted that i-Tree Streets cannot be used to analyze the larger-scale, contributive cooling trees provide for reducing the heat island effect, nor can it be used to calculate the contribution trees make to happiness and well-being. Regardless of this limitation to i-Trees Streets, the City should find and use available tools to address these issues in a prompt and effective manner.

Table 2-5. Value of Benefits

Common Trees	Benefits Provided in Dollars				
Common Name	Aesthetic	Stormwater	Carbon	Energy	Air Quality
Red maple	5,406.23	352,540.19	10,508.98	58,921.13	10,089.26
Norway maple	20,186.37	255,426.52	18,790.35	43,827.34	8,246.08
Prunus species	3,189.91	49,041.26	4,205.47	13,519.02	2,137.46
Littleleaf linden	6,728.30	139,854.22	6,188.66	28,883.14	4,798.03
Callery pear	23,237.66	180,400.59	5,691.11	25,743.68	5,653.03
Northern Red oak	11,941.28	307,166.68	20,427.74	45,607.59	8,382.37
Sugar maple	8,578.59	149,920.70	8,914.85	22,024.10	3,772.98
American sycamore	11,865.52	305,766.96	17,826.26	38,500.13	7,081.80
Japanese zelkova	9,287.35	68,652.07	1,692.97	15,223.39	2,442.92
Silver maple	4,917.18	147,256.82	10,013.03	20,402.91	3,856.58

Aesthetic and Other Benefits

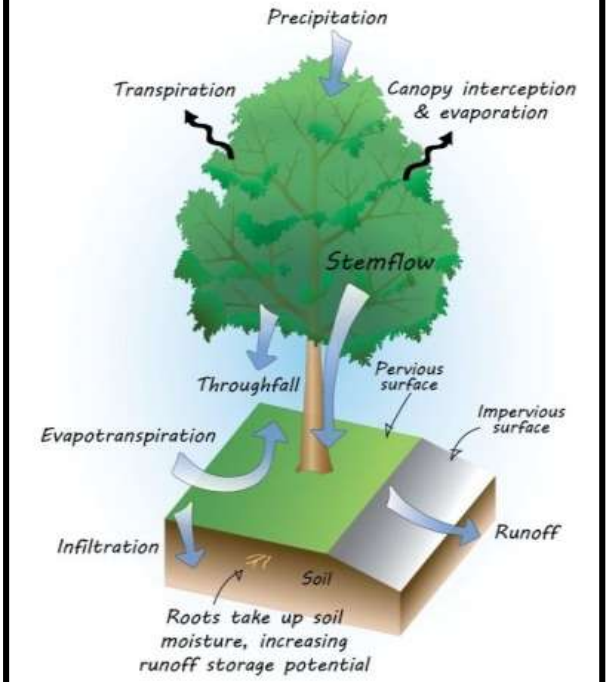
The total annual benefit associated with property value increases and other tangible and intangible benefits of street trees was $189,305. The average benefit per tree equaled $21.61 per year. In addition to increasing property values, trees also play a major role in the physical and mental health of people who live and work in the city. These other benefits are more difficult to measure and are not included in this analysis. However, models to quantitate the health benefits are being developed, and should be used as soon as they become available.

Other benefits in this category could include the measurable, but often considered subjective, feelings of happiness and well-being. Recent studies in Japan, Poland and the United States show how trees, even in winter without leaves, make people less anxious and happier.

Stormwater Benefits

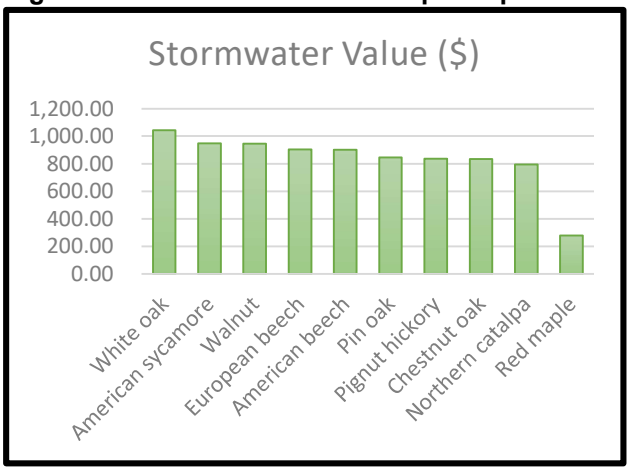
Trees intercept rainfall, which helps lower costs to manage stormwater runoff. The inventoried trees in Lancaster intercept 15.3 million gallons of rainfall annually. On average, the estimated annual savings for the city in stormwater runoff management is $3,058,133.

Figure 2-7. Hydrological Cycle



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

Figure 2-6. Stormwater Value: Top 10 Species



The i-Tree analysis shows the stormwater management benefit derived from trees comprises nearly 80% of the total dollar benefits. However, without a more thorough analysis of the City's urban tree canopy in relation to impervious surface, it is not possible to determine the complete stormwater mitigation value of trees. A simple evaluation using GIS shows that 7.4% of the canopy is made up of street trees. With three-fourths of the inventoried trees found along streets, the potential green infrastructure value of trees is immense.

Of all species inventoried, red maple was the highest species contributor to the annual stormwater benefits. Although the population of red maple intercepted approximately 1.7 million gallons of rainfall, this is due to the overabundance of the species in the overall inventory.

Compare the percentages in the inventory of Red maples (>14%) to Northern red oak (5.5%) and American sycamore (4%) and note that both have nearly the same total savings as Red maples. Further analysis of the inventory data should be done to conclude the best trees for

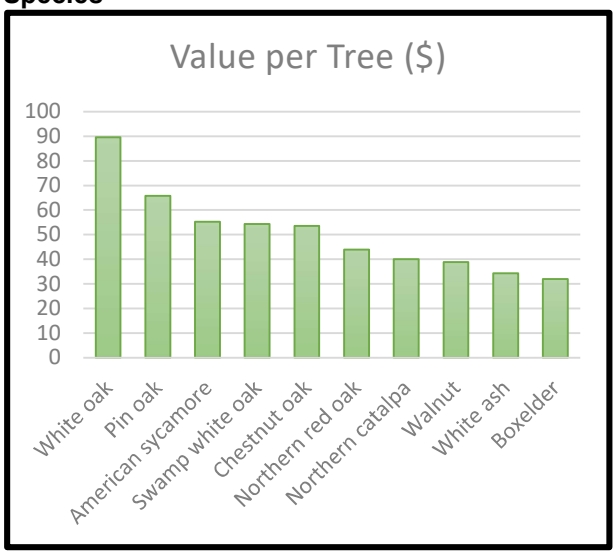
managing stormwater. As seen in Table 2-6, future plantings should consider less *Acer* (maple) and more large-statured trees with broad canopies and larger individual surface area like *Quercus* (oaks) and *Platanus* (sycamore), or even the less common Northern catalpa, all of which offer the greater benefit with regard to stormwater interception. To maximize the stormwater benefit of trees, strategically plant in areas where runoff reductions would be the greatest, such as adjacent to impervious surfaces along streets and in parking lots.

Figure 2-7 depicts the hydrological cycle performed by trees that reduces stormwater runoff.

Carbon Sequestration and Carbon Storage

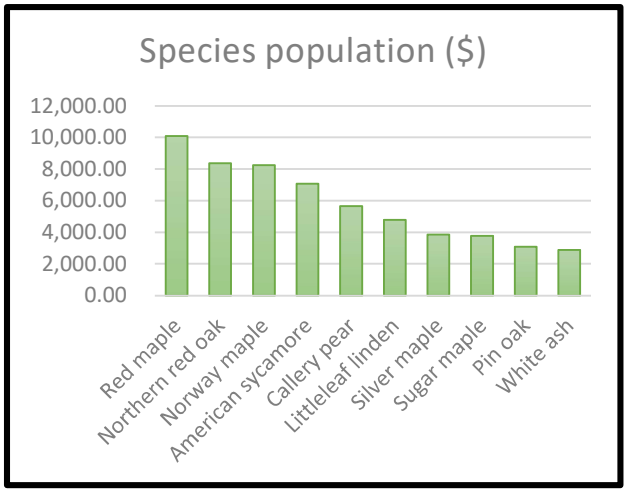
Trees store carbon from the carbon dioxide (CO_2) they absorb through photosynthesis. Trees act as a carbon sink, reducing available carbon, as they annually sequester some of the CO_2 in the air during growth (Nowak *et al.* 2013). The i-Tree Streets calculation also considers the carbon emissions that are avoided or *not* released from power stations due to the reduced energy needed in buildings (less heating in winter and less air conditioning in summer). It also calculates emissions released during tree care and maintenance, such as driving to the site and operating equipment. The i-Tree Streets analysis balances the amount of CO_2 sequestered and avoided with the amount released during decomposition of branches, leaves, etc., and maintenance activities. The net of CO_2 removed each year through sequestration and avoidance is about 3.6 million pounds, or 1,800 tons.

Figure 2-8. Carbon Storage Value: Top 10 Tree Species



Lancaster's inventoried trees store 43.6 million pounds or more than 21,000 tons of carbon (measured in CO_2 equivalents). This amount reflects the amount of carbon they have amassed during their lifetimes.

Figure 2-9. Carbon Storage and Sequestration Value: Top 10 Tree Species



Similar to the situation with stormwater, *Acer* species dominate the carbon storage and sequestration benefits list for total value. The large Red maple and Norway maple populations provided the most annual carbon benefits at greater than 8.4 million pounds; however, Northern red oak species had the largest carbon storage within the inventory at over 5 million pounds with ¼ the numbers of the two above maple species. Note that only one *Acer* species (Boxelder) is included in the ten species shown in Figure 2-8 that provide the greatest carbon benefit. The net carbon benefit is approximately $155,634 per year. When carbon removal benefits are a priority, *Quercus* and

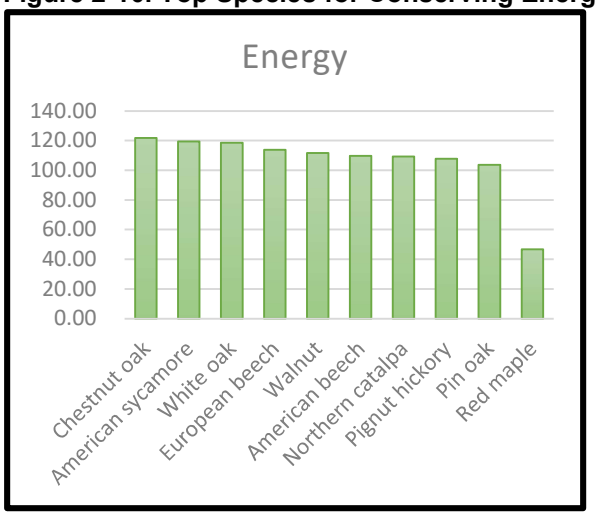
Platanus species should be considered for future plantings. White oak had the highest overall average dollar amount per tree at $85.02 annually. The average benefit per tree for all trees is $17.77 and per capita is $2.61.

Energy Benefits

All trees conserve energy by shading structures and surfaces, thus reducing electricity use for air conditioning in the summer. Trees divert wind in the winter to reduce heat loss from buildings thus reducing natural gas use (heating costs). Based on the inventoried trees, the annual electric and natural gas savings are equivalent to 750.53 MWh of electricity and 269,518 therms of natural gas, which accounts for an annual savings of $484,631 in energy consumption. When converted into dollars and cents using i-Tree, this accounts for an annual savings of $55.32 per tree on average. For the i-Tree analysis, natural gas has been used as a proxy for all heating fuels.

Trees properly sited around a building can thus provide a significant saving for residents. Depending on site factors, both street trees and yard trees can be considered for this and other benefits. For properties where a street tree cannot be planted, then yard trees should be planted. The i-Tree Design tool can be used to provide guidance on species selection and tree location in conversations with residents. Indeed, any of the i-Tree tools would be very valuable in schools and other educational settings as part of the environmental education and other curricular areas. The city should work with community groups and educators to develop grade-level appropriate lesson plans.

Figure 2-10. Top Species for Conserving Energy



The populations of Red maple and Norway maple in the inventory again contribute the largest amount of energy benefits. In contrast, Figure 2-10 shows which individual types of tree provide the greatest benefits. Note that the individual average value of Red Maple is significantly lower than the top species.

After consideration of site requirements, consider new plantings from the figure above as a function of maximum return for the long-term investment of public trees. Strategically placed trees can be as effective as other energy saving home improvements, such as insulation and the installation of weather-tight windows and doors. Adopting development regulations that maximize the energy saving benefits of trees through proper siting should be considered.

Air Quality Improvements

The 8,671 street and park trees analyzed remove an estimated 9,124 pounds of air pollutants annually through deposition, including ozone (O_3), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), and particulate matter (PM_{10}). In addition, reduced air temperatures from tree canopy reduce ozone production further improving air quality. Through reduced fossil fuel use for energy, this population also avoids approximately 10,534 pounds of NO_2, SO_2, and PM_{10} annually. The net total value of these benefits is estimated to be $88,754, with a per tree benefit of $10. The inventoried trees removed or avoided more pollutants than they emitted due to biogenic volatile organic compounds (BVOC), resulting in a positive economic value.

Discussion

The i-Tree Streets analysis shows that Lancaster's street trees provide environmental and economic benefits to the community by virtue of their mere presence.

The i-Tree Streets model estimated that the inventoried trees provide a total annual benefit of $3,832,714. Essentially, the City's street trees saved the inhabitants of Lancaster $3,832,714 for cooling buildings, managing stormwater, reducing CO2 and cleaning the air. In addition, community aesthetics were improved, and property values increased because of the presence of trees.

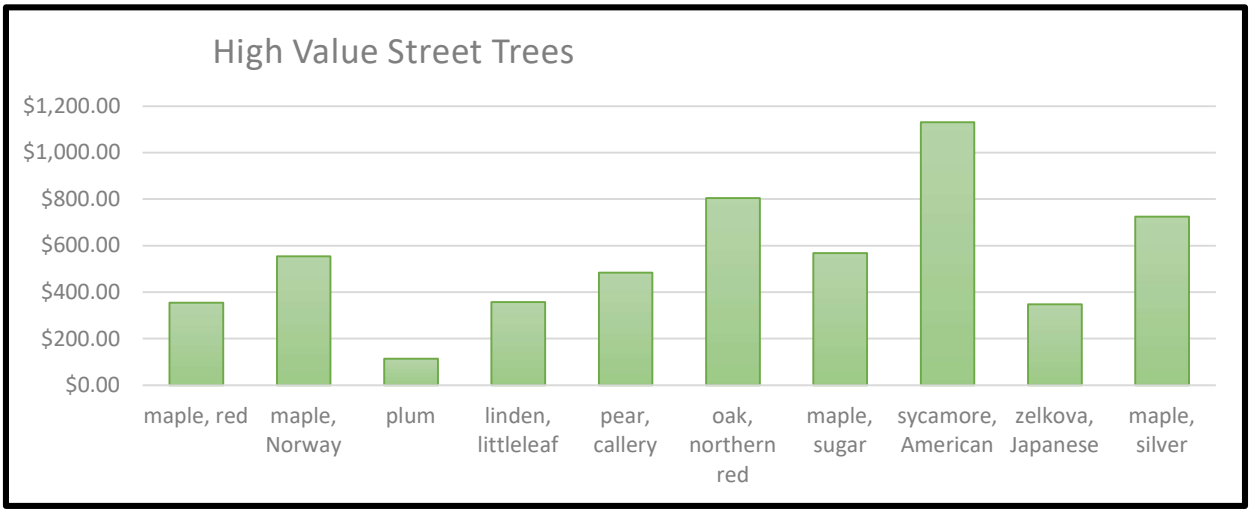
The 2017 population of Lancaster was estimated to be 59,708, therefore, the inventoried trees, predominately street trees, provide $64.19 of annual benefit per person. According to an analysis of the Urban Tree Canopy conducted by the City's Geographic Information System specialists, 7.4% of the City's UTC is along its streets.

Table 2-4 summarizes the annual benefits and results for Lancaster's inventory. Table 2-5 presents the monetary benefit results for top performing individual tree species in Lancaster's inventory from the i-Tree Streets analysis.

Of the five quantifiable benefits evaluated, the contribution trees make to reducing stormwater runoff offers the greatest value to the community. The property value increase provided by trees is important to stimulate economic growth. In addition to increasing aesthetics and property values, trees manage stormwater through rainfall interception, provide shade and windbreaks to reduce energy usage, and sequester CO_2. Trees intercept rainfall and reduce runoff—in Lancaster 8,400 inventoried trees intercept over 15 million gallons of rainfall.

The species shown in Figure 2-11 may or may not be the best street tree species, but the assessments provide insight as to how species selection can be viewed through the lens of different beneficial attributes as discussed in Chapter 1.

Figure 2-11. Most Beneficial Street Tree Species in Lancaster



Of all the City's street trees, the American sycamore provides the greatest overall benefit per tree, according to i-Tree Streets. Within in the entire inventory supplied, the i-Tree Streets analysis found the White oak species provided the largest amount of ecological benefits per tree; however, these inventoried trees are only found the City's parks. In sheer numbers, the Red maple

population within the inventory provides the largest amount of eco-benefits. If this species was lost to a new disease or other threats, its loss would be felt more than the community may realize.

As they reach maturity, leafy, large-stature trees consistently created the most environmental and economic benefits. See Appendix A for recommended species for Lancaster. Also use the free online i-Tree Species tool and tailor the list toward the city's goals. The tool can guide choices by user-defined benefit selection. (https://species.itreetools.org/)

Lancaster has little control over particulate matter pollution from distant sources nor over weather patterns. But planting and caring for trees is something that we CAN directly do.

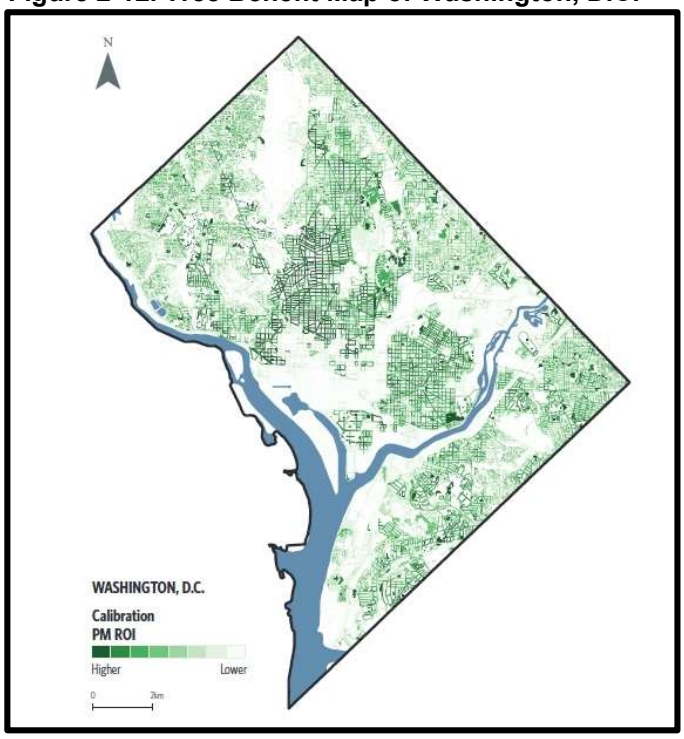
As with any other proposal, possible limitations should be recognized and considered in planting decisions. Some species produce pollen to which some people are allergic. The volatile organic compounds produced by some trees can increase ground level ozone (Nature Conservancy 2017). Particulate matter is a more serious problem in Lancaster than ozone (PennEnvironment 2020, LNP 2020).

Efforts to improve health through tree planting should consider neighborhood patterns of poverty, health, and existing tree canopy. Localized data on temperature and air pollution are important for decisions on planting given the limited spatial impact of trees (about 300 feet, at most).

It would then be possible to prioritize those areas or even blocks where the return on investment in trees would be greatest. As an example, here is a map of Washington DC, with the darker colors indicating the highest health benefits return on investment (McDonald 2015).

In addition, there are demonstrated mental health benefits (such as reduced stress) for children and adults from contact with nature in parks, tree-rich neighborhoods, and other environments. Tree-lined streets encourage people to walk, to meet their daily exercise requirements. (Nature Conservancy 2016, 2017)

Figure 2-12. Tree Benefit Map of Washington, D.C.



How can the City and its partners use this information to enhance the health of our residents?

Until now, the partners who have engaged with the City have primarily been environmental groups, community improvement groups, and civic-minded businesses and business organizations. Considering tree planting and care as a public health matter opens up a new group of potential partners among the many health care organizations in our community. We encourage the City to move in this direction, using public health in outreach efforts to our residents and businesses.

CHAPTER 3: TREE MANAGEMENT PROGRAM

Introduction

The City of Lancaster's urban forest consists of trees along its 120 miles of streets; trees in its 29 parks, playgrounds and open spaces; in back yards and parking lots; and on the grounds of schools, churches and all manner of institutions and businesses. It is a valuable municipal asset that requires proper management. This action plan is a starting point for developing a comprehensive management strategy.

Under current regulations, the City is only responsible for maintaining trees located in parks and other city-owned open spaces, and on streets adjacent to City-owned facilities such as playgrounds, fire stations, City Hall and the Police Station. All other trees, including street trees, are the responsibility of the property owners.

The analysis and recommendations in this tree management plan chapter are based on the hypothetical assumption the City of Lancaster would eventually take over the maintenance of all street trees and establish a Street Tree Maintenance Program.

> American Forests defines the urban forests as "ecosystems of trees and other vegetation in and around communities that may consist of streets and yard trees, vegetation within parks and along public rights of way and water systems. Urban forests provide communities with environmental, economic and social benefits and habitat for fish and wildlife."

In the event the City would assume the responsibility for trees within the entire public realm (streets, parks, playgrounds), it would begin caring for the more than 9,000 trees identified in the tree inventory. In addition to standing trees, more than 3,000 planting spaces have been identified, including potential sites and existing unfilled tree wells. Furthermore, preliminary evaluation of ways to expand the Urban Tree Canopy (UTC) indicates opportunities for more than doubling the number of street trees. Chapter 1 discussed the current and desired UTC and how the goal will only be realized if more than 25,000 new trees are planted and removed trees are replaced.

The necessary level of tree maintenance and planting work to achieve that goal will also require increased annual funding. The strategies and recommendations presented here are based on analysis of 9,148 street and park trees in the updated 2011 tree inventory.

Planting trees but forgoing proper management can be costly for any municipality in the long run. Vogt et al. (2015) analyzed and compared the costs of maintaining and not maintaining the urban forest. A 5-year pruning cycle for established trees is recommended as the optimal time frame for a preventive maintenance program when comparing costs with tree benefit values (Vogt et al. 2015, Miller and Sylvester 1981). However, climate zone, tree species, tree condition, and specific municipal goals and constraints will influence length of the preventive maintenance cycle chosen. The costs of the City maintaining all street and park trees are discussed in detail later in this chapter.

Proper tree care practices are needed for the long-term general health of the urban forest, including ensuring newly planted trees are properly mulched and watered, and staking hardware is removed at the proper time. Following guidelines developed by the International Society of Arboriculture (ISA) and those recommended by ANSI A300 (the generally accepted arboricultural industry

standards for tree care practices.) will ensure that tree maintenance practices ultimately improve the health of the urban forest.

Methodology

The goal of assuming responsibility for all street trees would be to move from a reactive scenario to a more proactive approach that lessens the cost of the urban forestry program over time.

Utilizing data from the supplied Lancaster tree inventory, an annual maintenance schedule was developed that details the number and type of tasks recommended for completion each year. Davey Resource Group (DRG) made budget projections using industry knowledge and public bid tabulations (See Table 3.1 at the end of this Chapter). Given the lack of verified risk ratings in the inventory data, the priority of workload was based on reported tree condition as well as diameter at breast height (DBH) included in the inventory.

The cost projections are to be used as an example of what can be done if the City chooses to follow this route. A more thorough feasibility evaluation should be conducted to also determine work to be done in-house and contracted.

Working within these parameters, the largest trees in the poorest condition are the highest priority, while the smallest trees in excellent condition would be the lowest priority.

Trees noted as dead and poor condition were deemed a priority for removals and are noted in the budget table. The backlog of dead tree removal is spread over three years in the five-year budget estimation completed by DRG; however, much of this work has already been completed. Poor rated trees 25 inches or greater DBH are noted as priority removal in the first year. These limits are based on removing the highest potential risk for safety concerns first, scheduling by DBH. Larger trees have a larger potential for impacting their surroundings due to structural failure.

The need for pruning high risk trees is unknown at this time and could change the budget estimate. A thorough evaluation of all trees greater than 25 inches DBH should be completed as soon as feasible. This evaluation should assign a risk rating to the evaluated trees.

Trees noted as “removed” were addressed as existing stumps and prioritized by DBH as a function of pedestrian hazard and aesthetic concern. Smaller stumps are removed later.

Once the priority work is addressed, Lancaster is encouraged to begin an annual routine tree maintenance and planting program that requires approximately 1,000 trees in Routine Pruning (5-year cycle), and 1,000 trees in the Young Tree Training program (3-year cycle). This planting program phase includes replacing all trees removed during the priority removal phase, as well as planting existing empty tree wells and includes planting no less than 200 trees to make up for that loss. This effort is designed to only replace the trees lost and to plant empty tree wells, resulting in a no net gain of tree canopy. Planting to increase tree canopy is discussed elsewhere in this chapter.

Findings

Table 3-1 at the end of this Chapter shows a summary of the estimated costs for Lancaster’s five-year tree management program. This budget schedule provides a framework for completing the inventory maintenance and planting recommendations over the next five years. Following this schedule can shift tree care activities from an on-demand system to a more proactive tree care program. Healthier trees provide greater benefit for all – Lancaster can maximize those direct and

indirect benefits by implementing a proactive maintenance and planting program. The schedule can be modified as experience and funding dictate, or for unforeseen circumstances such as severe weather or pest and disease infestation.

An estimation of Lancaster's tree planting and maintenance requirements starts at approximately $400,000 for the first year of implementation and decreases annually as the backlog of deferred maintenance is eliminated (See Table 3-1). It should be noted that many of the dead trees identified in the original inventory have already been removed; however, trees continue to die for a variety of reasons and must be removed to avoid hazards. Annual budget funds are needed to ensure that standing dead trees and trees in poor condition are remediated, and crucial routine pruning and young tree training cycles can begin. With proper professional tree care, the safety, health, and beauty of the urban forest will improve and provide greater benefits to all of Lancaster.

The analysis presented here is based on this particular model and set of assumptions. Using different variables, such as a different cycle length or number of trees (based on an updated inventory), would yield different results, but the principle still holds.

Tree and Stump Removal

Although tree removal is usually considered a last resort and may sometimes create a reaction from the community, there are circumstances in which removal is necessary. Trees fail from natural causes, such as diseases, insects, and weather conditions, and from physical injury due to vehicles, vandalism, and root disturbances. It is recommended that trees be removed when corrective pruning will not adequately eliminate the hazard or when correcting problems would be cost prohibitive. Trees that cause obstructions or interfere with power lines or other infrastructure should be removed when their defects cannot be corrected through pruning or other maintenance practices. Trees are also often removed when they grow to a size where it is impossible to maintain a minimum sidewalk width in compliance with Americans with Disabilities Act standards.

Although it is impossible to know in advance when a new pest or disease will target a tree species, or when a severe storm will strike, a fund should be maintained to cover the costs of emergency pruning or removal. These situations often require large, short-term expenditures. Expedient removal reduces risk and promotes public safety.

The first year of the five-year budget projects removing 65 trees and 71 stumps for a total estimated cost of about $70,000. These numbers will decrease over the first five years as the backlog is eliminated. In year 5 of the budget, the estimated cost for removals is around $12,000 even as the number of trees and stumps removed increases. This is due to the small size of trees being removed.

The estimated annual cost of tree and stump removal is largely dependent on the number and size of the trees and stumps to be removed, as well as site conditions such as overhead wires and the need for street closures. Although the more trees removed means more stump grinding, there is a backlog of sites where trees have been removed, sometimes years ago, but the stump is still in place.

Sidewalk Damage

Lancaster prides itself on being a walkable city. All aspects of the streetscape contribute to that characterization. The value of a tree-lined street is greatly diminished if the sidewalks are impassible due to the roots of those majestic trees. Trees are possibly the number one cause of sidewalk damage. When property owners are required to repair or replace broken or impassible sidewalks, a decision must often be made to remove an offending tree.

The proposed budget is for the City to assume the cost of maintaining street trees. The cost of repairing and replacing sidewalks is not addressed here. Chapter 5 reviews sidewalk materials currently permissible and recommends a greater variety of alternatives to help address these challenges.

Figure 3-1. A 53" DBH Northern red oak in an 8-foot sidewalk.

Pruning Cycles

Pruning generally includes cleaning the canopy of both small and large trees to remove defects such as dead and/or broken branches that may be present even when the rest of the tree is sound. Timely pruning can correct the problem, reduce risk, and prevent larger problems in the future.

The goals of pruning cycles are to visit, assess, and prune trees on a regular schedule to improve health and reduce risk. To ensure that all trees receive the type of pruning they need to mature with better structure and lower associated risk, two pruning cycles are recommended: The Young Tree Training Cycle and the Routine Pruning Cycle. The cycles differ in the type of pruning, the general age of the target tree, and length of time. However, due to the long-term benefits of pruning cycles, it is recommended all the cycles be implemented as soon as possible.

In addition to routine pruning, high risk pruning should be taken into consideration. The inventory assessment revealed more than 2,400 trees with a codominant leader, more than 1,700 with deadwood and more than 800 trees with large deadwood. Although these situations are not always high risk, they should be evaluated and prioritized. The five-year budget did not include any numbers for high risk pruning since this is often a reactive situation that is unanticipated. Regardless, funds should be allocated for such unforeseen circumstances.

The urban forest will certainly change over time as trees are planted, age, and die. Newly planted trees will enter the Young Tree Training Cycle once they become established. As young trees reach maturity, they will be shifted into the Routine Pruning Cycle. When a tree reaches the end of its useful life, it should be removed and replaced.

The pear tree shown in Figure 3-2 below is an example of what happens when young tree pruning is not done. Since the low branch to the right had not been trimmed, it is now growing over the sidewalk and into a nearby building, and is too large to remove without severely damaging the tree.

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, the 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 5 years is optimal for urban trees.

Figure 3-2. Inadequate young tree pruning

Young Tree Training Cycle

Young tree pruning is performed to improve tree form or structure; the recommended cycle length is three years because young trees tend to grow at faster rates (on average) than more mature trees. This cycle should include all existing young trees. Trees included in the Young Tree Training Cycle are generally less than eight 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 and become impossible to remedy as the tree grows, increasing risk and creating potential liability.

In future years, the number of trees in the Young Tree Training Cycle will be based on tree planting efforts and growth rates of young trees. The City should endeavor to prune approximately one-third of its young trees each year. Young tree pruning can be performed by properly trained and supervised volunteers and other members of the community, in addition to staff and contractors. New trees will enter the cycle after establishment, typically a few years after planting. Younger trees can generally be pruned from the ground with a pole pruner or pruning shear. The objective of young tree training is to increase structural integrity.

More than 40% of the inventory, approximately 2,661 street trees are smaller than 8 inches diameter breast height (DBH) and would benefit from young tree training. There were 1,487 trees four inches or less, and 1,174 trees from four to eight inches DBH. When codominant trunks, crossing branches or other defects become obvious, the City Arborist performs needed pruning and trainings on young trees. Recognizing the long-term value in such a practice, City Parks staff have recently begun implementing a young tree training program. It is important this becomes routine and a part of the annual tree care program.

The estimated cost of young tree training in the five-year budget is approximately $25,000 annually for 1,000 trees for three years of a three-year cycle. Although not included in the full five-year budget, as more trees are planted, this would become an annual expense for only those trees planted in the past three years. Also not represented in the five-year budget estimate, is any cost savings for utilizing volunteers for tree planting and maintenance.

Routine Pruning Cycle

The Routine Pruning Cycle includes established, maturing, and mature trees (mostly greater than eight inches DBH) that need cleaning, crown raising, and reducing to remove deadwood and improve structure. Over time, Routine Pruning can reduce reactive maintenance, minimize instances of elevated risk, and provide the basis for a better tree management program.

Included in this cycle are trees noted as these condition ratings in the inventory: excellent, good, and fair. Budget priority was determined by DBH sizes and pricing. Larger trees were given priority over smaller trees that pose less potential risk. In the future, as these smaller defects are found, they can usually be remediated during the Young Tree Training Pruning Cycle.

The length of the Routine Pruning 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. Generally, the cycle recommended for a tree population is five years but may extend to seven years if the population is large. In the case of Lancaster, the inventory was given a recommended time frame of five years, with approximately 1,100 trees in the cycle per year. The estimated annual cost for those 1,100 trees is about $175,000, contributing the single largest sum to the projected 5-year budget.

Figure 3-3. Typical pruning for overhead wires

High Risk and Utility Pruning

More than 2,500 trees were identified in the inventory with deadwood, about 25% having major deadwood posing imminent hazard to persons and property. Although a line item in the proposed budget is provided for high risk pruning, the estimated cost for such work is difficult to determine because it is a reactive task. Not all deadwood poses an imminent hazard and can be addressed with routine pruning. In addition, high risk pruning includes storm damage that cannot be known in advance.

Utility pruning is work performed by the local electric utility. This work is typically completed by a contractor on a cyclical basis to remove branches close to primary electric lines. As shown Figure 3-3, utility pruning is often radical and can cause tree structure to be weakened. It should be noted that utility pruning is only done for high voltage electric lines, not for low voltage lines and not for communication lines such as cable and telephone.

Tree Planting

Any tree management plan must address tree planting along with risk and hazard mitigation and tree care. Tree planting to replace those removed and increase canopy cover, young tree training, protection during construction, and public outreach and education are all important parts of the program. All elements work together and must be adequately funded and supported.

Since 2014, an average of 200 street trees were planted in the City every year. However, through land development and other activities, about the same number of trees are removed each year. If there has been an increase in the number of trees in Lancaster, it could be due to the tree planting efforts in our parks and riparian areas.

An average of 353 municipal trees are planted yearly in cities similar in population to Lancaster. Until more funding and departmental improvements can occur, planting at least 200 trees per year is recommended to maintain the current UTC. As the City transitions to assuming full responsibility for all street trees, these 200 new trees become under the municipal care umbrella with funding for maintenance. A strategy should be developed concurrent to the five-year management plan outlined in this chapter for a phased program to assume responsibility of street trees.

Watering

Data shows that watering new trees is crucial for survival and growth. A tree that is not properly watered may die. If the tree survives the stress, recovery may take years; the tree may never reach its full potential size and thus may not provide the full potential benefits. Researchers have found

that successful urban tree programs are characterized by "rigorous and consistent young tree care" (Lara Roman, U.S. Forest Service, Philadelphia). A detailed new tree watering proposal prepared by the Lancaster Shade Tree Commission and Lancaster Tree Tenders is presented in full in Appendix C.

The planting of a tree represents a substantial investment; replacing trees comes at additional cost. Through the City's Tree Planting Program, the owner has invested on average over $200 per tree, while the City has invested even more in materials and labor to prepare the site (including stump removal or concrete cutting) and to plant the tree. Trees provided by grants are likewise not "free", but are funded, in the case of state TreeVitalize grants, through tax dollars. Lancaster Tree Tenders and the Lancaster City Alliance have received funds from donors; such support in the future could be at risk if donors see trees failing to thrive or dying.

Some funding agencies, including the state TreeVitalize program, are now "beginning to require survival monitoring as a metric of success" (Lara Roman), which could be a factor in reviews of future grant applications.

Lancaster City has set an ambitious goal to increase its tree canopy from 28% to 40%. Trees can make a meaningful contribution to achieving the reduction in storm water runoff required in the EPA consent decree. Reaching these goals requires many enhancements to our tree policies and procedures, and better watering is a critical one.

Discussion

This five year program is based on the 2011 tree inventory data; the program was designed to primarily reduce risk through prioritized tree removal and pruning, and to improve tree health and structure through proactive pruning cycles. As noted above, tree planting is a complementary task.

As tree work is accomplished, the inventory should be regularly updated to reflect planting, removal, maintenance, etc. There should be a system for real-time updating using mobile devices. The City has a GIS staff that creates and maintains a variety of tools that can be used for managing the urban forest such as the City Trees Collector app used for collecting and editing tree data in the field. This program is based on the street and park tree inventory and is compatible with a risk management program.

Updating the tree inventory data can streamline workload management and lend insight into setting accurate budgets and staffing levels. Inventory updates should be made electronically and can be implemented using TreeKeeper® or similar computer inventory software. A complete inventory update is recommended every five years, including a risk assessment. At the time of this plan, it has been almost ten years since the inventory was conducted. In 2015 and 2016, the Department of Public Works used several interns to update the inventory with trees that had been removed and planted during the intervening years. This work is reflected in the data analysis throughout this plan. If the inventory is maintained properly, a periodic update could be done cost effectively. Based on the original inventory, and a cost estimate from 2014 to conduct a new risk management analysis, the City should consider budgeting adequate funds for a complete street tree inventory and risk assessment every five to seven years.

While implementing a tree care program is an ongoing process, tree work must always be prioritized to reduce public safety risks. The existing inventory was lacking a typical risk rating. Although the information on which such ratings are based was collected, ratings were not assigned at the time. The City should complete the work identified during the inventory. In addition,

routinely monitoring the tree population is essential so that imminent hazards and high-risk trees can be identified and systematically addressed. While regular pruning cycles and tree planting are important, priority work (especially for standing dead and poor condition rated trees) must sometimes take precedence to ensure that risk is expediently managed.

In addition to removing high risk and hazardous trees, Lancaster should implement routine maintenance strategies. This could include a three-year Young Tree Training Cycle and Routine Pruning schedules as discussed in the previous sections. Although the City Arborist already does some routine pruning and young tree training, it should be performed in a systematic way as part of a tree maintenance program.

The budget in Table 3-1 references ongoing high and moderate priority removals for poor and dead trees, respectively, while also removing stumps, performing routine maintenance and beginning the Young Tree Training Cycle. However, the table is a flexible suggestion; priority should be given to the trees which pose the greatest public risk. The City should first eliminate the backlog of trees in Poor or Dead condition, and trees with large deadwood, then move onto larger (then smaller) tree pruning and implement the Young Tree Training cycle last after any risk concerns are remediated.

The budget table is meant as a guide and assumes total municipal costs if all recommended management tasks from the 2011 inventory are addressed and taken under the umbrella of municipal financial responsibility. In 2020, $216,000 has been directly budgeted for maintaining the urban forest, with an indeterminate amount of unspecified funds allocated toward tree activities in Traffic and Stormwater budgets. The first-year estimate would nearly double the existing Parks Trees budget to over $400,000. This would decline during the five-year budget period to around $300,000 in year five. It should be noted that the budget estimate in Table 3-1 is a summary of a 5-year budget found in Appendix D. This budget estimate is derived from a broad survey of municipalities with tree management programs, therefore, additional analysis should be done to determine accurate program costs for Lancaster.

Stabilization of the costs, apart from catastrophic events and storm responses, will occur as the highest priority elements are addressed first and the program moves into proactive Young Tree Training and Routine Pruning cycles after five years. High risk trees are a large contributor to unscheduled workload; reducing risk will allow the program to move toward a more proactive approach.

In a proactive program, trees are regularly assessed and pruned, which can detect and eliminate most defects before they escalate to a hazardous situation. Unless already slated for removal, future trees noted as having poor structure or cavity or decay should be inspected on a regular basis. Corrective action should be taken when warranted. If their condition worsens, tree removal may be required. 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.

For many communities, a proactive tree management program is considered unfeasible. An on-demand response to urgent situations is the norm. However, research and practice have 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 are reduced cost and reduced risk.

Furthermore, a proactive, regular watering program for newly planted trees is vital to the long-term health and survival to the City's urban forest. And finally, an oversight committee should be established to guide the implementation of plan recommendations and ensure accountability.

Risk Assessment

Risk management is based on a scenario where an inventory of trees is evaluated for their potential to affect public safety as in property damage or utility disturbance.

There are various ways to complete a hazardous tree survey. When the City undertakes an inventory update, hazard (risk) should be included. It would be less expensive to do both together than separately. Although the original inventory completed by Penn State in 2010 covered tree and site condition including a wide range of conditions that could lead to a hazardous tree, it did not include a risk assessment. A separate hazard assessment was conducted in 2009 and a systematic plan implemented to address the needs. The most hazardous street and park trees were removed and major deadwood cleared.

Once the city has a complete on-the-ground hazard tree survey, then the costs for those removals could be added to updates of Table 3-1. A methodology should be developed to estimate costs as well as prioritizing work. This can be based on the previous hazard survey, DBH, and degree of risk.

Hazardous tree surveys need to be regularly updated to stay ahead of potential issues. This can be done by periodically conducting "windshield surveys" where City staff, contractors or volunteers drive, or walk, around looking for hazards. Although not as thorough as a full inventory assessment, it is much quicker, and could be done every year or at a frequency determined by the City Arborist or Shade Tree Commission.

Pests and Diseases

Insects and diseases pose serious threats to tree health. Awareness and early diagnosis are essential to ensuring the health and continuity of street and park trees. Appendix B provides information about some of the existing and potential threats to Lancaster's trees.

In addition to past diseases such as Dutch elm disease and Chestnut blight, recently introduced pests further threaten the diversity of our urban forest. Since the early 2000s, the emerald ash borer has destroyed tens of millions of ash trees in the Midwest and Eastern US. Compared to the newest, immediate threat of the Spotted Lanternfly, the Emerald Ash Borer was relatively easy to contain through ash tree removal and chemical treatment.

Pre-emptively, Lancaster removed nearly 200 of the 300 identified ash trees in parks and along its streets. The remaining trees are being treated with an effective insecticide. Though many more ash trees remain on private property, few of these trees are being treated at this time. In 2014, the City established an Emerald Ash Borer Management Plan. This successful model could be replicated for the purpose of future plans should a new pest or disease come to town, such as the Spotted Lanternfly.

TOLEDO STREET BEFORE AND AFTER EMERALD ASH BORER

BEFORE: JUNE 2006 PHOTO COURTESY OF DAN HERMS, OSU AFTER: AUGUST 2009

Fortunately, few streets in Lancaster are planted as a monoculture. However, the City and Shade Tree Commission must be vigilant in ensuring that future development projects and other large-scale plantings avoid monocultures. The devastating consequences of lack of species diversity are shown in the photo above. A discussion on other pest and disease threats to Lancaster trees can be found in Appendix B. Establishing an integrated pest management plan would allow a proactive approach to this problem.

Table 3.1. Five Year Budget Estimation Summary

	Year 1		Year 2		Year 3		Year 4		Year 5		Five-Year Cost
Activity	Trees	Cost ($)	Trees	Cost ($)	Trees	Cost ($)	Trees	Cost ($)	Trees	Cost ($)	
High Priority Removals	9	6,545	26	5,700	26	848	0	$0	0	0	13,093
Moderate Priority Removals	56	54,340	86	41,717	101	34,988	59	5,342	55	5,140	141,527
Stump Removals	71	9,516	121	9,512	97	7,480	115	6,590	125	6,292	39,390
High Risk Pruning	0	0	0	0	0	0	0	0	0	0	0
Routine Pruning	1111	177,020	1111	177,020	1111	177,020	1111	177,020	1073	164,470	872,550
Young Tree Training	1009	25,070	2353	259,019	2340	24,990	0	0	0	0	75,130
Replacement Tree Planting	200	132,400	200	132,400	200	132,400	200	132,400	200	132,400	662,000
Cost Grand Total		404,891		391,419		377,726		321,352		308,302	1,803,690
Total w/o tree purchase cost of approximately $40,000		362,491		349,019		335,326		278,952		265,902	1,591,690

CHAPTER 4: OPERATIONS REVIEW

Introduction

The City of Lancaster's urban forest is a valuable municipal asset that appreciates over time and produces a positive return on public funds invested in its care. Proper management of this asset is fiscally prudent, since it results in safer city streets and parks, increases the quality of life in the city, and demonstrates a high degree of responsiveness to the needs of citizens. To keep Lancaster's urban forest safe, healthy, and sustainable, it is critical that the City conducts its urban forest management operations efficiently and effectively.

The purpose of this operations review is to identify the strengths, weaknesses and opportunities of the City's urban forest program, and make recommendations that will improve the program. Encouragingly, the City staff, Shade Tree Commission, and volunteer organizations, such as Lancaster Tree Tenders, realize an operations review is necessary to review both the adequacy of staff and equipment available for in-house projects and the tree related contractual services.

Guidelines for the basis of this review can be found in the 2016 publication, "Municipal Tree Care and Management in the United States: A 2014 Urban & Community Forestry Census of Tree Activities," published by the College of Natural Resources, University of Wisconsin. Many sources of information, such as staff interviews, policies and plans review, GIS and inventory data analysis, and background research were used in this operational analysis of the city's urban forestry program. The following sections evaluate existing conditions, identify gaps, and ultimately suggest recommendations for specific improvements that help optimize Lancaster's urban forestry program management.

> **According to the International Society of Arboriculture**, "[t]he municipal arborist, or forester, is the individual responsible for the long-term care and management of city trees. Duties include the application of a management plan including planting, pruning, protecting, and removal programs for public trees and associated vegetation; budget preparation; and interaction with the community (both public and private), politicians, and other agencies. Municipal arborists' activities also encompass forestry, ecology, hydrology, atmospheric science, energy, and stormwater control."

Findings

Staff

Lancaster's urban forest is cared for and maintained in part by property owners and in part by the City Department of Public Works (DPW). DPW is responsible for tree care in public spaces, with the Bureau of Operations primarily responsible for trees at government facilities and public parks and playgrounds, as well as certain tasks related to street trees. Staff from the Stormwater Bureau provide administrative support for the City's Shade Tree Commission, tree ordinance, and street tree planting program. Furthermore, the Engineering Bureau provides GIS mapping and data management support. No one person oversees or administers the urban forest program. In addition to DPW responsibilities, the Department of Community Planning and Economic Development is responsible for the provision of trees in land development and zoning matters.

The four-person tree crew is led by the city arborist and includes one tree trimmer and two tree climbers. It is a section of the Operations Bureau. The tree crew is often diverted from tree care and planting tasks for a variety of non-tree related tasks such as trash collection and snow removal at City facilities, graffiti removal, hanging seasonal decorations, and staffing City-sponsored special events and activities. If additional personnel are needed for a large tree project, staff from the Parks and Public Property section of the Bureau of Operations assists.

Figure 4-1. City Arborist demonstrating tree planting

In discussions with city officials, the tree crew is regarded as productive and most interdepartmental relationships are strong while others are evolving. Although the city arborist has not been required or encouraged to obtain ISA (International Society for Arboriculture) certification, he has kept up-to-date with the latest arboricultural methods and required certifications, particularly with pests and diseases afflicting the Lancaster urban forest. Staff and funding are stretched thin. There are no non-tree crew staff dedicated the urban forest, such as for maintaining the inventory, outreach and public relations, permitting, and enforcement. As noted above, the tree crew has multiple roles and other duties with the urban forest being just one of many.

Budget

Budgets will dictate the extent of the urban forestry resource, and in Lancaster's case, the largest barriers to improving the urban forestry program are both funding and staff.

Sources of funding are primarily through the Bureau of Operations budget in the General Fund with a small amount coming from the Stormwater Fund in the city budget. Private nonprofit and governmental grants represent another source of funding, which cannot be used for budgeting purposes. Grants such as from the Pennsylvania TreeVitalize program and the National Fish and Wildlife Foundation are actively pursued and have been previously awarded.

The analysis of the provided 2011 inventory reveals that on average, approximately $400,000 annually will be required to establish the Street Tree Maintenance Program presented in Chapter 3. This estimated cost is approximately twice the current annual tree program budget and includes annual priority and routine maintenance and young tree training as well as tree planting. Of that total amount, $130,000 should be allocated annually for replacement tree planting, and the care and watering of new trees.

The $400,000 estimated cost does not include the cost for maintaining trees in the City's parks and playgrounds, nor does it include equipment purchases, rentals, or other capital expenditures; additional staffing, staff training and development, and public outreach; plant health care or invasive pest management; and necessary tree inventory work. The current budget levels are insufficient for these other important activities to be done effectively.

Two items not fully reflected in the estimated proposed budget are the Stormwater Bureau staff expenses and a more accurate estimate of the number of trees that need to be planted annually to

meet the UTC goal of 40%. City staff estimates that more than 1,000 new trees will need to be planted annually to achieve 40% tree canopy by 2050.

Other tree related items for which funds have been allocated in the Operations Bureau's 2020 budget include contracted services for tree trimming related to traffic issues, a variety of Parks administration advertising and mailing expenses, and overtime for tree planting and storm damaged tree removal. In addition, the Stormwater Management Fund covers the annual lease-purchase payments on a tree bucket truck and funds to be used for contracted treatment for ash trees in Long's Park against the Emerald Ash Borer.

Equipment

The City has the necessary equipment to perform typical tree removals, crown raising, crown thinning to remove deadwood, and other basic care and maintenance tasks. However, some equipment is dated and needs to be replaced such as the specialized stump grinder.

To accomplish the work plan of this management plan, any additional or specialty equipment needed can likely be provided by the contractual tree and landscape crews who will perform the work. The city currently has a line in its budget to rent necessary equipment if required.

Training and Personnel Development

Staff education should include new-hire training on the city's programs and operations; introducing new technical concepts, practical techniques, and safety principles to the field staff; and a new computer software system for urban forest management tasks and administrative personnel.

A quality training program, via workshops, webinars, short courses, etc. is essential for keeping staff safe, efficient in their work, and motivated about learning new skills. Currently, there is no formal arboricultural training program and only $200 budgeted for this purpose in the City's 2020 General Fund Budget.

Figure 4-2. In grown tree guard.

Tree Guard should be removed before more trunk damage occurs.

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

- ANSI A300 pruning, maintenance, and protection standards
- ANSI Z133.1 safety requirement
- Chainsaw safety
- Defensive driving
- Electrical hazards awareness program
- First Aid, CPR
- Job site set-up, flagging, and safety
- OSHA compliance
- Tree identification and basic tree physiology

Inspections and Inventory Updates

Tree care in Lancaster is largely placed on the shoulders of property owners, creating an inconsistent continuum of care across the city. A variety of factors can contribute to this disparity of care.

In addition to identifying potential tree problems and hazards, inspections are an opportunity to look for signs and symptoms of pests and diseases. In Lancaster, tree inspections are ad hoc, primarily occurring when the city arborist observes a problem or is notified by City staff or a private individual that there is a tree problem. There are no regular or systematic inspections of the trees by City staff or contractors. Municipalities that have street tree care under the municipal care umbrella often perform inspections that are essential in uncovering potential problems with their trees. Many municipalities use appropriate computer management software such as TreeKeeper® to update inventory data and work records.

Except for Notices of Violation (NOV) issued by the Arborist or other authorized city staff, all other concerns are tracked through informal phone logs and notes, not a centralized source. At present, no spatial data are used to track the concerns. Local officials deem the system mostly reactive at this juncture. Work production is not adequately addressed. NOV are issued when the violation is observed or reported, and tree pruning and removal permits are issued when requested.

Volunteers

Lancaster relies on volunteers to administer portions of its urban forestry program. Much of the volunteer effort is led by the Shade Tree Commission, as well as Lancaster Tree Tenders (LTT), a cooperative effort with the Alliance for the Chesapeake Bay. LTT partners with the City of Lancaster and the Lancaster City Alliance to identify tree planting opportunities, organize tree planting events and offer training and education for volunteers interested in the urban forest.

Figure 4-3. Volunteers at 2017 Tree Planting

LTT participates in Arbor Day celebrations and has organized or participated in more than 20 separate events including street tree and riparian buffer plantings, educational outreach, and tree giveaways. More than 800 volunteers have participated in the tree plantings and more than 2,000 trees have been planted. LTT also helps the City organize the street tree plantings and yard tree giveaways through the lancastertreetenders.org website. This website was designed so residents had an online option to request a street tree evaluation and/or yard tree.

LTT also plays a major role in educating the public on the importance of trees and the urban forest. A wide variety of printed and online English and Spanish language materials are produced and disseminated. Watering reminders are hung from newly planted trees or attached to the watering bags that come with all street trees. In the past four years, more than 2,000 postcards were mailed to property owners with a potential street tree planting site. In 2017, two educational videos were produced, one for park tree plantings and the other for street tree plantings.

Table 4-1. Lancaster Tree Tenders

Lancaster Tree Tenders
Expanding our urban canopy

	2016	2017	2018	2019	4-year Total
Street Trees Planted	73	185	333	92	683
Yard Trees Distributed	50	296	395	834	1,575
Riparian Buffer Trees Planted	360	220		1,019	1,599
Planting Sites Identified	483	935	603	327	2,348
Volunteers	130	152	210	362	854
Volunteer Hours	268	487	632	941	2,328

Contractors

Most cities have the option of performing urban forestry tasks using in-house staffing and equipment or using contractors who specialize in various arboricultural disciplines and services. Often, a combination of using both in-house personnel and contractors is chosen to ensure that the urban forest management services provided are performed at the lowest possible cost, as efficiently as possible, and with the greatest level of expertise.

Table 4-2. Society of Municipal Arborists Standards for Tree Maintenance Production

Diameter Class	SMA Reported Removal Production Rates (Trees/Crew Day)	SMA Reported Pruning Production Rates (Trees/Crew Day)
1–3”	7	10
4–6”	7	11
7–12”	3.5	11
13–18”	1.2	6
19–24”	1	3
25–30”	0.75	2
31–36”	0.75	2
37–42”	0.75	1.5
43+”	0.75	1.5

Contracted tree work is performed and evaluated from a maintained list of reputable bonded contractors with the city. In recent years, the City has contracted for a variety of tasks associated with managing the Emerald Ash Borer, including removing nearly 100 ash trees from parks and along city streets, as well as biennial treatment of 50 ash trees. Contractors are also secured for hazardous tree removal when the tree is too large or located in places the City tree crew cannot access with its equipment. In these situations, the City typically requests quotes and accepts the lowest responsible price.

The national average of dedicated urban forestry program employees for cities with populations of between 50,000 and 99,999 is 6 full-time and 3 part-time or seasonal workers (Hauer, Richard & D. Petersen, Ward 2016). Table 4-2 presents the national standards for tree removal and pruning production rates of both public and contracted crews. This information was compiled by the Society of Municipal Arborists (SMA) and can be useful for determining future staffing needs.

Municipal Management

According to a municipal survey DRG sent to cities similar to Lancaster's demographics, about 10% responded that they had a systematic approach to urban forestry—more proactive than reactive, with nearly 70% maintaining continuous urban forestry staffing throughout the year. Most tree plantings occurred as a planned improvement event, with replacement of removed trees as the secondary source of organized tree plantings. New trees were mostly purchased from a nursery, with only 16% of 580 total communities surveyed having their own nursery. In terms of tree removal, nearly half of the cities responded removals were based on tree health concerns.

Pruning cycles were typically reported as having a 6.6-year average cycle length, although most municipalities had hoped for a 5-year pruning cycle. On average though, based on DRG's experience with urban forests and cities in the United States, a 5- to 10-year Routine Pruning program is an acceptable rotation time to efficiently sustain an urban forest. If Lancaster delays implementing a proactive program citywide, longer term maintenance costs may increase, and tree condition and tree benefit values will decline.

San Francisco's Tree Ownership Change

The current situation with the ownership of Lancaster's trees can be summed up by looking into a case study of San Francisco. In 2011, San Francisco's maintenance budgets were reduced, and street trees became the responsibility of the individual property owners. Owners were to follow certain guidelines or be fined; some fines were documented near $2,500. After 6 years of complaints, a troubled urban forestry program, and declining canopy, the ownership of the trees was passed back to the city by an 80% referendum in 2017. The voters passed legislation that earmarked $19 million to move the 124,800 street trees back under the umbrella of care to the city. "Both property owners and people who want to see San Francisco's civic forest remain healthy have welcomed the change" (Fracassa 2017).

Discussion

The City of Lancaster is fortunate to have a significant tree canopy, a healthy urban forest population, a tree ordinance, city staff, and contractual resources to perform tree planting and tree care work when needed. Despite these assets, the city's forestry program does not operate as proactively and efficiently as it could, and it is underfunded and understaffed for the current workload.

The positive trends are a strong Shade Tree Commission and a small but solid community volunteer program; continue these segments of Lancaster's urban forest management.

Staffing

Overall, there is insufficient staff to carry out the many tasks, resulting in inefficiencies and gaps. The tree crew spends too many hours doing work unrelated to trees and should be maintaining the City's urban forest full-time. Winter months can be spent pruning trees and maintaining equipment in preparation of planting season. If the City decides to take full responsibility of street trees, additional staff should be hired or contracted. Prior to hiring staff, job descriptions should be reviewed and revised, if needed, to cover the minimum education and experience requirements. A full-time administrative position for a certified "tree point person" should be created. Someone not necessarily working in the field on street and park trees, but conversant in all areas of the City's urban forest program, can add to the overall efficiency of the program. This person would manage and oversee the entire urban forest program and all tree activities.

To further advance productivity in the tree crew, staff in the field should have access to an iPad (or similar technology) to help manage the urban forest and coordinate work. Staff should be using TreeKeeper® or similar inventory tracking software to aid in work order management. This would provide a centralized source to track progress and all tree activity.

While training and technology are important, without adequate staff, work just won't get done Part-time seasonal employees can be used to provide urban forest management support. Finally, establishing an internship program to assist with the urban forestry program should be considered. In addition, the city should develop connections for job development with county and regional institutions, such as the Career and Technology Centers and Stevens College, with local businesses, and with various job preparation programs such as Alliance for the Chesapeake Bay's READY program. All tree-related job descriptions should be reviewed to determine staff qualifications and if tree-related tasks are being allocated effectively.

However, until additional and dedicated full- or part-time positions are approved, funded, and filled, the City should consider supplementing current staff with contractual staff for limited time periods and/or for specific projects.

Budget

The City will never meet its UTC goals without financial support. At a minimum, additional General Fund budget requests should be made to incrementally move toward accomplishing the tasks outlined in this plan such as for staff training and education, and inventory updates.

If the City is serious about growing and preserving its urban forest, it must be creative and innovative in funding the program. The City should explore alternative supplemental revenue streams, such as donations, large grants, and resource sharing with other city departments, etc. As noted in Chapter 2, the largest tangible financial benefit trees provide is through the reduction of stormwater run-off. Since Stormwater Bureau staff currently provide the primary administrative support to the City's tree program, it is not unrealistic to add a line item into the Stormwater Management Fund budget for tree program staff and contractual services.

Equipment

Like the right tree for the right place, staff must have the right tool for the right job. Without proper equipment, the tree crew will not be able to work productively or safely.

Top on the Arborist's list for equipment is an additional stump grinder beyond the current asset – one that will have similar attributes for narrow ROW access.

Staff must routinely assess fleet age, condition, and usage hours to determine when equipment used for urban forest maintenance and planting will need to be replaced. Once needs are identified, begin the purchasing process at least one year prior to the projected "aging out" date.

As needed, the City should rent or contract for specialty equipment that would not be used often for urban forest management and/or by any other department in the city.

Training and Personnel Development

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

The tree crew are highly experienced and capable professionals who should be required to attend regular and formal arboriculture training and should be incentivized to pursue and maintain arboriculture certifications. Staff who want to become International Society of Arboriculture Certified Arborists and Municipal Specialists should be allowed to do so. In addition, City staff who assist the tree crew with urban forest management tasks should receive basic safety and equipment training as well as more specialized arboriculture training such as Tree Tenders®.

Inspections and Inventory Updates

Prior to commencing an inventory update, the existing and proposed inventory parameters should be evaluated. In addition to the typical parameters such as species name, common name, DBH, and location, a risk assessment rating should be assigned for each tree. When the inventory parameters are established, a strategy should be developed to begin updating the inventory as soon as practicable. Examples of specific tasks include establishing priority areas where trees were not inventoried, assessing previously rated Fair and Poor condition trees, and increasing care where feasible for trees verified in Good and Fair conditions.

After the inventory is updated, an appropriate computer inventory software program such as TreeKeeper® should be used so the city can sustain its program and accurately project future budget needs. DRG recommends these processes after the new inventory is completed: Conduct inspections of trees after all severe weather events. Record changes in tree condition, maintenance needs, and risk rating in the inventory database. Update the tree maintenance schedule and acquire the funds needed to promote public safety. Schedule and prioritize work based on risk.

Between complete inventories, routine inspections of public trees should be performed at regular intervals. 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; therefore, all trees in poor or dead condition should be identified as soon as possible.

If the recommended work cannot be completed as suggested in the plan, modify maintenance schedules and budgets accordingly. Update the inventory database using TreeKeeper® as work is performed. Add new tree work to the schedule when work is identified through inspections or a citizen call process.

The City should consider starting an urban forestry internship program, or fund part-time contractual technical staff to assist the city with tree inventory data management/entry, outreach efforts, planting inspections, and minor tree maintenance tasks.

Volunteers and Community Outreach

Lancaster cannot achieve its UTC goals without the help of the property owners and all residents of the City. Continuing to support and encouraging the expansion of the Lancaster Tree Tenders initiative should be the number one priority.

Although the information in this plan can be used to educate residents about the benefits of and threats to urban trees, disseminating that information is what makes the difference. All printed and online materials and information should be in English and Spanish to reach the broadest possible audience.

The City should explore creating and expanding relationships with key non-profit partners to obtain funding, as well as volunteer participation, for tree planting and young tree care. This could consist of building on recent collaborations at tree plantings such as Arbor Day and riparian buffer projects. The City recognizes the importance of working with groups such as Lancaster Tree Tenders, Lancaster City Alliance, and the Alliance for the Chesapeake Bay, as well as neighborhood organizations.

Contractors

Like residents and volunteers, the City needs private contractors if it seriously desires to sustain a healthy and verdant urban forest. Therefore, it should consider using contractors to supplement tree planting, removal and pruning when the scale of these tasks exceeds in-house capacity.

Consider a practice to use and reference detailed specifications for tree removal, pruning, stump removal, tree planting, and young tree care. Detailed specifications should be incorporated with bid requests and contracts as a standard operating procedure and best management. The biggest advantage to the City of having these well-written specifications is the confidence gained that the work will be done properly and what the City expects. Clear specifications could also eliminate a wide range of bids and give the City more accountability over the expenditure of public funds.

Municipal Management

The City should move into municipal care for street trees by incrementally increasing the number of trees under its care. This can begin with the cyclical pruning program in selected areas of the City. There could also be more city-managed tree planting projects to grow the tree canopy on sparsely planted blocks. In the near term, the City should develop a strategy to prioritize where and how to begin municipal ownership of street trees. This strategy should be based on relevant socio-economic and physical criteria such as environmental justice areas, canopy cover, ROW width, stocking levels, etc. that further many of the City's programs intended to improve the overall quality of life for its residents.

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CHAPTER 5: POLICY AND ORDINANCE REVIEW

The Shade Tree Commission "works to maximize the ecosystem services derived from shade trees by establishing policies for the planting, removal, maintenance and protections of trees along City streets."

Introduction

A thorough review of existing codes and policies and interviews of urban forestry staff and stakeholders reveals what Lancaster has in place and what it is lacking with regards to the planting, protection and maintenance of its urban forest. Guidelines for the basis of this review were derived from the 2016 publication, "Municipal Tree Care and Management in the United States: A 2014 Urban & Community Forestry Census of Tree Activities," published by the College of Natural Resources, University of Wisconsin.

Shade Tree Commission

On June 4, 1929, the Council of the City of Lancaster, adopted Ordinance No. 105, accepting the provisions of the Act of May 31, 1907, P.L. 349, whereby the PA General Assembly created "a Shade-tree Commission, providing for the appointment of Commissioners to the same and prescribing their duties." This Act empowered all cities in the Commonwealth to create a Shade-tree Commission.

Lancaster became a Third Class City following the adoption of Act of June 23, 1931, the Pennsylvania Third Class Cities Code. This Act granted the City Council more specific powers to regulate shade trees along the City's streets (see text box below). The powers and duties of the Shade Tree Commission (STC) are further set forth in Chapter 22, Article III, of the Code of the City of Lancaster, the Bylaws of the Lancaster City Shade Tree Commission, amended February 2016, and Chapter 273, Trees, in the Code of the City of Lancaster. The text box on the next page provides greater detail on the authority granted the City of Lancaster through the Third Class City Code.

According to its By-laws, the STC also has an advisory role to the Department of Public Works (DPW) and the Arborist on the planting, maintenance, and removal of trees in the public realm and in development projects. Therefore, DPW and the Arborist should seek the recommendations of the STC on such matters. The STC has been granted and exercises the power to approve the removal and/or planting of street trees within the public right-of-way. The STC is also responsible for the preparation of a Tree Management Plan and may make recommendations and suggestions to the Public Works Director for revisions and amendments to city codes and ordinances as related to trees. In addition, the STC reviews and advises the Planning Commission and Community Planning and Economic Development staff on land development and zoning permit applications.

Policy Review

Two important City of Lancaster documents set the stage for all current efforts to grow and preserve the City's urban forest. The first City "policy" on its urban forest is from the 1993 Comprehensive Plan. Though dated, the recommendations are still valid. Green It! Lancaster, the 2019 update of the City's 2010 Green Infrastructure Plan, asserts the seriousness of growing and protecting the urban forest and includes several important "Urban Forest Strategies." In addition to the planning documents, reports have been issued on the tree inventory and urban tree canopy studies. These are presented in detail in Chapter 1. The Lancaster County Planning Commission

Pennsylvania's Third Class City Code - Section 12416 Shade Trees.

a) Power to Regulate.

(1) Council may, by ordinance, regulate the manner and method, if any, for the planting, trimming, removing, maintaining and protection of shade trees in, on and along or extending over the public streets, sidewalks, and rights of way of the city and provide for penalties for violations.

((2) The cost of the activities under paragraph (1) may, at council's discretion, be assessed against the owners of the properties abutting the street, sidewalk or right-of-way upon which any tree is located pursuant to Chapter 145A (relating to assessments for public improvements), except that the cost and expense of caring for trees after they have been planted shall be paid by the city.

b) Shade tree commission.

(1) Council may, by ordinance, provide for the creation of a shade tree commission and its composition, powers and duties and delegate council's authority for regulating shade trees to the commission.

(2) In lieu of an ordinance under paragraph (1), council may delegate its regulatory powers for shade trees to an existing department.

(3) If a shade tree commission is established, its meeting shall be subject to the provisions of 65 Pa.C.S. Ch. 7 (relating to open meetings).

regularly produces comprehensive plans that address contemporary issues facing all of Lancaster County's municipalities. Trees and tree canopy often feature prominently at the county and regional scale. In addition, as part of the Lancaster Inter-Municipal Committee the City collaborated on Growing Together: A Comprehensive Plan for Central Lancaster County, which is briefly described in the text box on the next page.

1993 City of Lancaster Comprehensive Plan

One of the priorities expressed by Lancastrians in 1993 was to "Protect and enhance the city's livable character created by its pedestrian-orientation, architecture, trees and other greenery, parks, and community services." This priority was reinforced with one of the policy objectives under the policy goal to strengthen neighborhoods and to make all neighborhoods desirable, safe places to live. That policy objective stated that "[t]he City should implement an urban forestry program in order to enhance the City's streetscapes, increase energy efficiency in homes and businesses, and improve air quality." The current street tree planting program was recognized as the only tree planting initiative in the City. The policy objective recommended that "a Comprehensive Landscape Plan which promotes tree planting and landscaping on public and private land and protects the city's few remaining natural areas" should be developed. It further suggested that "to enhance the City's ongoing urban forestry efforts, residential developers should be required to plant trees in accordance with a Landscape Plan."

The policy objective to implement an urban forestry program is no less valid today than it was at that time. It should be the policy of the City and a benefit to its physical and social environment that all future development, whether residential, commercial or institutional, should follow comprehensive landscaping and tree planting guidelines, beyond the few outlined in the Code and Ordinance review below.

Green It! Lancaster

In Green It! Lancaster, the 2019 update of the City's Green Infrastructure Plan, Chapter 6 put forth green infrastructure strategies for both private and public properties. In that Plan, there is a long section on Urban Forest Strategies that explained how prior to the 2011 GI Plan all urban forest efforts were focused on aesthetic value. The tree inventory and canopy assessment were conducted concurrent with the 2011 GI Plan, expanding our understanding of the true value of a healthy urban forest and its contribution to meeting our stormwater management goals. The Plan asserted that "if the City is serious about growing and maintaining a healthy and verdant urban forest, it must invest in preserving existing wooded and natural areas, and planting trees along its streets, in parks, and other public and private open spaces."

The Green It! Lancaster plan recommends that "the inventories should be maintained and updated on a regular basis" and that the City should explore how to set "realistic" urban tree canopy goals. The report also recommended that the City focus on "parcels that have large, contiguous impervious surfaces such as parking lots that contribute high amounts of stormwater runoff." The Plan highlighted how "the majority of the City's tree canopy is on private property," therefore recommending the development of "programs that educate residents and property owners on tree stewardship." It further suggested creating incentives for tree planting and increasing the support for and understanding of the urban forest by implementing "a coordinated and comprehensive outreach and education program that emphasizes neighborhood-based initiatives and solutions."

Growing Together: A Comprehensive Plan for Central Lancaster County, Pennsylvania

Growing Together was a bold comprehensive planning effort in 2006, commissioned by the Lancaster Inter-Municipal Committee (LIMC) and undertaken by 11 of the 13 LIMC municipalities, including the City of Lancaster. Growing Together is not a binding document, it provides a "framework to guide future decision-making in Central Lancaster County" by creating a "consistent policy structure." Although the plan recognizes the contribution trees make to reduce erosion on steep slopes and intercepting stormwater, there are only two strategies for increasing tree canopy – one promotes street tree plantings for aesthetic purposes and the other is to establish riparian buffers along "disturbed areas" of the County's waterways.

Greenscapes The Green Infrastructure Element of the Comprehensive Plan for Lancaster County, 2009

Greenscapes does not directly address urban forest issues in the City; its focus is more broadly applicable to all municipalities and places in Lancaster County. In addition to the environmental and health benefits of trees, Greenscapes recognizes the special benefits and effects trees have in agriculture, riparian areas, and stormwater management in urban and suburban areas. The County Plan views green infrastructure more broadly than the City, where it is directly associated with stormwater management. At the County level, green infrastructure encompasses the natural environment – the parks, greenways, open spaces, conservation easements, and agricultural lands, and all the flora and fauna found there - that has "conservation value" and is therefore worth preserving. The Plan is far reaching in its vision and goals, putting forth "objectives, strategies, and tools to preserve, conserve, restore, and enhance natural resources through the establishment of a countywide, integrated green infrastructure system."

places2040: Thinking Beyond Boundaries

Places2040, the 2018 Lancaster County comprehensive plan, carries a vision "to keep Lancaster County special – to protect the unique identity of our people and place." Planting riparian buffers and increasing tree canopy are just two of the numerous recommendations included in places2040. These quantifiable outcomes can be used for measuring progress toward conserving natural areas, protecting waterways, and improving air quality. Greenscapes, the earlier green infrastructure element, will not be updated in the future as a component of the county comprehensive plan, but will remain as a reference document.

Lancaster City Municipal Climate Action Plan

The City of Lancaster's core mission is to serve its residents, businesses, and environment, and addressing climate change is a critical part of that mission. With funding assistance from Partners for Places, Lancaster County Community Foundation, Lancaster County Solid Waste Authority, and The Steinman Foundation, the City of Lancaster created a Municipal Climate Action Plan that provides a roadmap for mitigating 100% of greenhouse gases emitted from City operations by 2050 with an interim goal of 80% by 2025. The Plan details 25 strategies in seven key areas to progressively reduce emissions against the City's 2017 baseline (17,012 metric tons CO2e): Energy; Vehicle Fleet; Water and Wastewater; Stormwater; Waste; Building a Culture of Sustainability; and Carbon Offsets. The plan was adopted by City Council in September 2019 in coordination with Climate Week NYC, UN Climate Summit, and the Global Climate Strike. While this plan is focused on City operations only, there is a need for a community-wide climate action strategy, which will be identified in the City's forthcoming Comprehensive Plan.

Code and Ordinance Review

There are currently five chapters in the Code of the City of Lancaster that in some way refer to trees, including their planting, protection and care. Chapter 273 - Trees is the primary ordinance that specifically provides for the planting, protection and care of trees within the public right-of-way, also known as Shade Trees. Shade Trees are what the Third Class Cities Code expressly grants the city power to regulate. Other chapters in the Code of the City of Lancaster providing for trees include Chapter 260 - Stormwater Management, Chapter 262 – Streets and Sidewalks, Chapter 265 – Subdivision and Land Development, and Chapter 300 - Zoning. In addition to these Chapters, supplemental code materials include the Tree Manual: Regulations and Standards for Arboriculture Work, Curb and Sidewalk Construction Specifications, the City of Lancaster Streetscape Design Guidelines, and Green It! Lancaster, the City's 2019 updated green infrastructure plan. Copies of the ordinances can be found online at https://ecode360.com/LA1674?needHash=true, and the supplemental manuals as well as the Green It! Lancaster plan can be found on the city's website at https://www.cityoflancasterpa.com/.

Chapter 273 – Trees

Chapter 273 is the primary code regulation of trees within the public right-of-way. It has been amended three times since City Council first adopted the regulations as Article 995 in 1974. The most recent Chapter 273 was adopted in 2014, and is, therefore, due for amendment and update. Unlike previous versions of the Trees ordinance, the recent amendment of Trees acknowledges the urban forest as a necessary part of the city's green infrastructure and how trees provide crucial ecosystem services to the city. Similar to the benefits of the urban forest described in Chapter 2, the Trees Ordinance highlights the environmental, social and economic benefits provided by trees.

The ordinance carries with it a set of purposes to establish policies for the planting, removal, maintenance and protection of trees along City streets and sidewalks, within parks and public open spaces, and protected trees on private property; to protect and strengthen neighborhoods and to make all neighborhoods more desirable, safer and attractive places to live; and to further the goals, objectives and strategies set forth in the City of Lancaster Green Infrastructure Plan. Furthermore, Chapter 273 now recognizes that the ongoing challenges of adequately maintaining the urban forest and tree canopy during development create the need to further protect and conserve this valuable City resource. However, as the ordinance is currently written, the provisions for planting, maintaining and protecting trees only extend to shade trees as defined therein (see text box below). No real protections are afforded trees outside the public right of way.

Unlike most governmental functions requiring staff time and resources, Chapter 273 does not require fees for any tree related activity such as securing permits for planting, pruning and removal, or for a hearing by the Shade Tree Commission. The ordinance also requires trees removed to be replaced one-for-one, which only maintains the number of trees; it does not preserve tree canopy. Additionally, the ordinance does not adequately address how it shall be enforced and by whom.

Supplemental to Chapter 273, the Tree Manual establishes minimum standards for the design of landscapes to improve the community aesthetically, economically and environmentally. The specifications set forth are intended to reduce tree canopy loss and implement urban forest management improvements through requirements for the planting and transplanting of trees, the care and maintenance of existing trees, tree protection, and the preservation of trees.

Shade Tree as defined in Chapter 273 of the Code of the City of Lancaster - Any tree, shrub or other woody plant in or upon any public street, highway or avenue, or public park, trail, greenway or open space in the City, or that part of any tree, shrub or other woody plant which extends within the lines of any public

Although the 2014 amendment of Chapter 273 greatly expanded the reach and authority of the code to protect the city's urban forest, regulations should never be static. As codes are administered, lessons are learned, and weaknesses and shortcomings are discovered. With that in mind, a series of recommendations for amending all the ordinances reviewed in this chapter is provided in Chapter 6.

Chapter 260 Stormwater Management

The City of Lancaster Stormwater Management (SWM) Ordinance is intended to regulate activities that in any way impact stormwater runoff and soil erosion and sedimentation in the City. The regulations set forth in the SWM Ordinance apply to all land development and land disturbance and the operations and maintenance of stormwater management facilities constructed as part these activities.

In Chapter 260, trees are treated as a stormwater best management practice (BMP), primarily as a part of vegetated BMPs. This is consistent with the 2006 Pennsylvania Stormwater Best Management Practices Manual. Chapter 260 requires tree protection zones during development activities and that all trees exceeding a certain size be shown on development plans. In addition, there is a requirement to use native tree species "when practicable."

Chapter 262 Streets and Sidewalks

The only tree requirement in Chapter 262, Streets and Sidewalks is the provision of a planting strip between the curb and sidewalk "unless otherwise approved by the Bureau of Engineering." The width of the planting strip shall be dependent upon the width of the sidewalk area, alignment of existing sidewalk pavement and other circumstances particular to the location. In lieu of a planting strip, a tree well may be provided. The planting strip or tree well is required for new construction or when at least 50% of the sidewalk is being replaced. There are slightly different requirements when the property is located within the streetscape district, where the requirements in the City of Lancaster Streetscape Design Guidelines take precedence.

Article VII – Streetscape District regulations provides special streetscape standards for street rights-of-way within the boundaries of two streetscape districts and specified transportation corridors. The streetscape standards apply to the construction, repair, maintenance, design and use of streetscape components as set forth in the Streetscape Design Guidelines. The planting of street trees is addressed in the Plantings section. These Streetscape Design Guidelines are dated and need to be thoroughly reviewed and revised to comply with current standards and policy objectives of the City.

The Curb and Sidewalk Construction Specifications, which is supplemental to Chapter 262, establishes minimum standards and guidelines for the design and construction of curbs and sidewalks. Among the tree related items are provisions that allow for steel plates to be used in lieu of concrete as curbs to save existing trees, and to consider ADA requirements when locating sidewalks to still allow for trees. Although brick is permitted as a sidewalk material, special permission is needed when materials other than brick or concrete are being proposed for new or reconstructed sidewalks. However, the City has successfully used a flexible pervious material in applications that preserved mature street trees. And, on several occasions, asphalt has proved to be an inexpensive and effective alternative to preserve existing trees, especially in situations with constrained sidewalk width. The Specifications are not all inclusive, providing little information and specifics on tree planting such as for the size or placement of tree wells within sidewalk areas.

Chapter 265 Subdivision and Land Development (SALDO)

The current SALDO covers when and where shade (street) trees must be planted when part of a land development, which is only when new or reconstructed streets and sidewalks are proposed or when street trees are removed through land development activities. The code provides for the location and spacing of street trees and sets forth standards for addressing utility conflicts, the quality of nursery stock and provisions for replacing dead or dying trees. However, the SALDO does not require replacing trees during land development activities unless they are street trees, nor does it require the provision of tree lawns or protections during construction. At the time of writing this plan in the summer of 2020, the SALDO was undergoing a minor revision.

Chapter 300 - Zoning

The City's Zoning Ordinance is more far reaching than the SALDO in that it covers the use and development of private property. The land use provisions in the Zoning ordinance that encompass trees deal with landscaping requirements and minimally address the need to protect and plant trees and use terms such as "when possible" when referring to the retention of existing mature trees. The 2013 update of the Zoning Ordinance included the relatively forward-thinking green incentives and standards; however, they do not include anything on trees. The City's zoning code should include provisions that protect sensitive environmental areas beyond floodplains such as steep slopes and wooded areas.

Chapter 300 requires trees in off-street parking lots in both interior and perimeter landscaped areas. The number, type and spacing of trees is dependent upon the number of parking spaces and size and location of the landscape area. The zoning regulations allow deciduous and evergreen trees to be planted in parking lots, however, evergreens may not be planted in sight triangles. The Green It! Lancaster plan identified parking lots as one of the City's biggest opportunities for implementing green infrastructure practices. Tree planting and landscaping requirements can be expanded to help meet the City's long-term stormwater management goals. Additionally, screening and buffering provisions should extend beyond just parking lots, such as when incompatible land uses are adjacent, for example a scrap yard next to single family houses.

All trees planted pursuant to Chapters 265 and 300 should be regularly inspected and included in the tree inventory and require property owners to replace trees that die.

Ordinance Review Checklist

The following ordinance review checklist focused on Chapters 273 and compared it to industry standards found in the *Municipal Tree Care and Management in the United States: A 2014 Urban & Community Forestry Census of Tree Activities*.

The benchmark ordinance subjects found in Table 5-1 are noted as essentials for an urban forestry ordinance for municipalities with similar demographics to Lancaster. If the Lancaster code addresses the recommended topic, either "Yes" or "Partial" is indicated. For subjects graded as "No" or "Partial", the priority level (level 1 being the highest priority) combines the commonality of the ordinance subject among similar communities and the need in Lancaster's code for improvement. However, all such items should be reviewed for any needed clarification or strengthening.

Discussion

Overall, Lancaster has most of the pertinent subject matter for its ordinances in place. Two primary exceptions are the protection of landmark or heritage trees on private property and a sufficient yet reasonable tree replacement ratio. The Tree Manual is functional and allows improvement to the narrative to keep up with the industry, while not requiring an overhaul of the ordinance language. The larger weaknesses are enforcement of construction rules regarding trees and planting trees after removal. Cohesive and interwoven regulations between interagency departments can be facilitated through staff education in tree importance. Integrating all land use and development regulations into a unified development ordinance could help maintain consistency and make administration and enforcement of the City's codes and ordinances more effective and efficient.

A further challenge is the qualifications of contracted arboriculture personnel. Tree permits are already required for tree work, and the responsibility falls upon the property owner to hire qualified professionals. To ensure arboriculture standards are followed, professional arborist certification beyond insurance standards should be considered for outside contractors performing any work on trees. Tree maintenance performed by unqualified contractors will create future problems in the long run. Although a permitting process is in place, there is no centralized methodology for tree inventory tracking or maintenance calls.

Besides the International Society of Arboriculturists (ISA), there is the Society of Municipal Arborists (SMA), and an SMA citywide accreditation may be of interest to Lancaster. The SMA designation is built on the Tree City USA designation, which Lancaster has already held for over 40 years. It is based on "excellent and comprehensive management practices."

Table 5-1. Benchmark Subjects to be Addressed in Urban Forestry Municipal Codes

	Ordinance Subject	Included	Section	Comments	Priority Level
Credentials	Requires certified arborist for paid private tree work	No	N/A	Permit is vetting process. Owner is responsible. Tree manual discusses ANSI 300.	3
	Requires Certified Arborist for Public Tree Work	No	N/A	Permit is vetting process. Non-ISA certified arborist staff performs work.	2
	Requires licensing of private tree care firms	No	N/A	Permit is vetting process. Permit is through city arborist.	2
	Defines Official Authority for Public Tree Management	Yes	273-1	Introduction to the section.	N/A
Management	Requires annual community tree work plans	Partial	273-7-C	"May develop annual work plan." Shade Tree Commission also provides recommendations.	1
	Identifies Formula for Determining Monetary Tree Value	Yes	273-10-B	Appraisal noted for Council of Tree and Landscape Appraisers (CTLA) relating to construction removals.	N/A
	Requires regular public tree maintenance	Yes	273-7-C	Shade trees in public areas that are not street trees are maintained.	N/A
	Requires Particular Types Of Maintenance (E.g., Pruning)	Yes	273-5	Notice to prune or remove.	N/A
	Establishes permit system for work on public trees	Yes	273-3A.	Shade Tree work requires permit.	N/A
	Establishes Provisions for Penalties For Non-compliance	Yes	273-11 A, B, C. & 273.14 Violations	Can assess or create property lien.	N/A
	Restricts burning of solid wood waste	No	N/A	Repeat in 273 if in another section.	3
	Establishes an Insect/Disease Control Strategy	No	Tree Manual Section 3.00.	Code refers to Tree Manual.	1
	Defines tree maintenance requirements on public property	Yes	273-7-C	Shade trees in public area not street trees.	N/A
	Prohibits tree topping	Partial	Tree Manual Section 5	Code defers to Tree Manual.	1
	Regulates abatement of hazardous or public nuisance trees	Yes	273-5-B, C	Relies upon Director or city arborist authority.	N/A
	Regulates removal of dead or diseased trees	Yes	273-5-B, C	Relies upon Director or city arborist authority.	N/A
Planting	Regulates tree species which may or may not be planted on private property (approved tree list)	Partial	273-6-E	Part E notifies of existing Tree Planting Program.	1
	Requires tree planting around reconstructed parking lots	Yes	273-6-B	Parking Lot Ord. Chap 202.	N/A
	Requires replacement of removed publicly owned trees	Yes	273-6-C-3	Removal of existing trees, regardless of location.	N/A
	Requires tree plantings around new parking lots.	Yes	273-6-B	Parking Lot Ord. Chap 202.	N/A
	Requires tree plantings around new developments	Yes	273-6-C	Planting guidelines in Subdivision Regs (SALDO) Chap 265 / 300.	N/A
	Regulates tree species which may or may not be planted on public property (approved tree list).	Yes	273-6 – D2	Tree Manual referenced.	N/A
Preservation	Restricts tree cutting on private property	Partial	273-17. Protected Trees / Private Property	Must secure permit for trees greater than 12" DBH.	N/A
	Identifies preservation of heritage or significant trees.	No	N/A	Policy change needed.	2
	Requires preservation of trees during development	Yes	273-10	Appraisal, Tree Protection BMPs noted.	N/A

CHAPTER 6: CONCLUSIONS & RECOMMENDATIONS

Every hour of every day, the trees in Lancaster are supporting and improving the quality of life. Lancaster's 2011 inventory provides an annual benefit of $3.8 million. When properly maintained, trees provide numerous environmental, economic, and social benefits that exceed the time and money invested in planting, pruning, protection, and removal. Acquiring an updated inventory, complete with qualified risk assessments, is of paramount importance. Determining where the strengths and weaknesses are in the inventory will develop the path to a heathier, fully functioning urban forest.

Managing trees in urban areas is often complicated. Navigating the recommendations of experts, the needs of residents, the pressures of local economics and politics, concerns for public safety—not to mention liability, physical components of trees, forces of nature and severe weather events, and the expectation that these issues are resolved all at once—is a considerable challenge.

Beyond these, there are several additional challenges ahead for Lancaster. One complex recommendation, beginning municipal ownership of the trees, is something which will develop incrementally and require patience, time, and capital. However, the goal is to create a maximally productive urban forest, an apex of social and tangible benefits. Public health, economic development, community morale, and stormwater attenuation are top priorities for Lancaster. An exceptional urban forest which is professionally well managed will aid in these goals.

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 Lancaster's trees, Lancaster is well positioned to thrive. If the management program is successfully implemented, the health and safety of Lancaster's trees and citizens will be maintained for years to come. Below are broadly stated programmatic recommendations as well as more specific actions that should be seriously considered for growing and preserving Lancaster's urban forest.

Early in the process to create an urban forest plan, three broad goals were established:

Goal 1: Grow a more extensive urban forest throughout the city

Goal 2: Improve and maintain the health of the urban forest

Goal 3: Increase support for and understanding of the urban forest

These goals are supported by objectives and strategic actions that the City and its partners can implement. Short-term strategic actions taken from the list below are paired with one of the following policy objectives in an Implementation Action Matrix in the Executive Summary at the beginning of this Plan. Many of the objectives and strategic actions are interdependent and build upon one another. The color coding connects the following Policy Objectives and Strategic Actions to the Implementation Action Matrix in the Executive Summary.

Policy Objectives

- Measure our trees and their benefits
- Plant more trees
- Maintain and protect our trees
- Reach out and engage community and partners
- Manage and regulate our urban forest

Strategic Actions

The following strategic objectives and actions are derived from the discussions in previous chapters and are intended to complement the broad recommendations. Not all objectives include specific actions and may require additional evaluation to set tasks for achieving those objectives.

Inventory

1. Set parameters for a new/updated inventory
   a. include trees not between the street and sidewalks
   b. create user-friendly database, compatible with other city software
   c. use inventory for all tree work, conducted by the city staff and outside contractors
   d. include trees on streets, in parks and other city property
   e. Inventory all areas of the city, including annexed areas
   f. Include trees in the right of way or hanging over the right of way and alleys
   g. include an on-the-ground assessment of hazard trees and their relative risk
   h. include parking lot and easement trees required through land and other development projects
2. Commit to a schedule and funding for periodic re-inventories, and real-time updating
   a. update as trees are planted, removed, or maintained
3. Establish standard operating procedures for fully utilizing the inventory, including to address imminent and potential hazards

Urban Tree Canopy

1. Analyze areas with low canopy cover
2. Establish a reasonable UTC goal attainable in 25 years.
3. Perform periodic UTC analyses to assess overall change. (every 8 to 10 years)
4. Coordinate with other agencies to reduce the cost of UTC analyses

Street Tree Stocking Level

1. Establish a program of planting, care, and maintenance to achieve the ideal ROW stocking level and increase trees per street mile
   a. Develop small area plans for strategically planting trees along its streets
   b. Strive for an average distance between street trees of less than 50 feet
   c. triple the percent of TC over streets and sidewalks
2. Plant existing street tree planting sites first, then focus on the potential sites
3. Focus planting efforts on areas that have lower level of tree canopy

Species and age diversity

1. Enhance diversity of tree species to ensure Lancaster's urban forest is sustainable and resilient to future invasive pest infestations
   a. focus new plantings on including a variety of species, especially those occurring less commonly in the current inventory
2. Plant trees of different genera along block fronts
   a. consider a palette of tree choices, using trees with complementary forms
3. Emphasize use of native species when replacing invasive species
4. Encourage and support a strong planting and maintenance program to maintain a sustainable diversity in the tree population
5. Develop a strategy to protect mature trees
   a. promote tree preservation and proactive tree care to ensure the long-term survival of older trees

b. remove mature trees when their condition falls below the threshold of acceptable risk

Site and Tree Condition

1. Plant the right tree in the right place
   a. choose appropriate trees for narrow rights-of-way
   b. pay careful attention to proper site and soil preparation
   c. consider sidewalk design and alternatives to standard practices
2. Utilize easements where possible
3. Plant ROW locations with the least conflicts and largest growing space
4. Select pilot areas to begin municipally-owned street tree program
5. Continually monitor street trees for structural defects and evidence of disease, pests and overall decline, and add hazard data to inventory
6. Encourage the use of best management practices, including but not limited to mulching, watering, pruning, pesticide application, and construction protection zones.
7. Review and prioritize trees by level of risk
8. Remove trees that are not hazardous, but are of poor health, having served their useful life

Tree Benefits

1. Use i-Tree Tools to evaluate the benefits of the City's urban forest and gain important information for public outreach
2. Plant large-statured tree species, where possible, to increase the benefits the urban forest provides
3. Establish collaborations with local public health, educational, and community organizations to study and develop tree planting plans using new tools to estimate the value of health benefits

Stormwater Benefits

1. Further analyze inventory to identify the best trees for managing stormwater
2. Consider less *Acer* (maple) and more Quercus (oaks), *Platanus* (sycamore), and other high-benefit species plantings
3. To maximize the stormwater benefit of trees, strategically plant in areas where runoff reductions would be the greatest, such as adjacent to impervious surfaces along streets and in parking lots

CO_2 Benefits

1. *Quercus* and *Platanus* species should be considered for greatest carbon storage and sequestration benefits

Energy Conservation Benefits

1. Provide guidance to property owners, and arboriculture workers on the best trees and planting techniques to maximize heating and cooling benefits
2. Adopt development regulations that maximize the energy saving benefits of trees

Air Quality Benefits

1. Plant more trees
2. Protect the urban forest

Tree Management Plan Recommendations

1. Evaluate all trees greater than 25 inches DBH as soon as feasible and assign a risk rating to the evaluated trees
2. Replace all trees removed during the priority removal phase, and plant existing empty tree wells

3. Planting no less than 200 trees annually to make up for tree removals
4. Remove trees when corrective pruning will not adequately eliminate a hazard or when correcting problems would be cost prohibitive
5. Establish two pruning cycles: Young Tree Training Cycle and Routine Pruning Cycle
6. Complete inventory update is recommended every 5 years, including a risk assessment
7. Routinely monitor tree population to identify high-risk trees
8. Use budget table as a guide on municipal costs for municipal financial responsibility of street trees
9. Establish an integrated pest management plan and new tree watering program
10. Establish an oversight committee to guide implementation and ensure accountability
11. Develop a strategy to prioritize where and how to begin municipal ownership of street trees

Operations Recommendations

1. Create a full-time administrative position for a certified "tree point person."
2. Hire or contract additional staff if City decides to take full responsibility of street trees
3. Establish a staff training and certification incentivization program
4. Budget for training
5. Review all tree-related job descriptions for relevant qualifications and effective allocation of staff
6. Regularly inspect and maintain street trees and prioritize work based on risk
7. Using TreeKeeper® or similar inventory tracking software to aid in work order management
8. Establish an internship program to assist with the urban forestry program
9. Develop connections for job development with county and regional institutions
10. Explore alternative supplemental revenue streams
11. Budget for tree program staff and contractual services in the Stormwater Management Fund
12. Routinely assess fleet age, condition, and usage hours to determine when equipment used for urban forest maintenance and planting will need to be replaced
13. Create and nurture relationships with partners to obtain funding and expand volunteer participation for tree planting and stewardship.
14. Investigate municipal responsibility of street trees

Recommendations for code and ordinance amendments

Chapter 273

1. Incorporate applicable duties and responsibilities consistent with Shade Tree Commission by-laws
2. Broaden the scope of the ordinance to include all trees, within the public right of way, on public lands, and on private property
3. Add provisions that address hazardous trees and landmark (or heritage) trees
4. Revise the definition of Tree to expand its meaning beyond just shade and street trees
5. Expand tree protection requirement in construction and land development projects
6. Provide reasonable provisions for the replacement of tree canopy removed during construction and development
7. Resolve the issue of how tree regulations are enforced and by whom
8. Explore establishing reasonable fees to offset staff costs
9. Revise Tree Manual to reflect ordinance changes and latest best practices
10. Explore requirements for replacement of tree canopy on private property (back yards) when not a land development or construction project

Chapter 262

1. Revise sidewalk and tree regulations to be consistent with other city ordinances
2. Amend Streetscape Design Guidelines to comply with current standards and policy objectives of the City
3. Amend Curb and Sidewalk Construction Specifications to include more detailed guidance on size and location of tree wells, tree lawns and other types of tree planting areas
4. Include provisions that permit a greater variety of sidewalk materials to preserve mature street trees

Chapter 265

1. Include requirement for tree lawns and wells when new and reconstructed streets and sidewalks are proposed
2. Explore adding provisions to require trees for any land development, not just when there is street or sidewalk work
3. Include adequate replacement of tree canopy lost during land development activities

Chapter 300

1. Include provisions that protect sensitive environmental areas beyond floodplains, such as steep slopes and wooded areas
2. Expand tree and landscaping requirements in parking lots including periodic inspections
3. Add standards for screening and buffering incompatible land uses with trees and other vegetation

All City Ordinances

1. Review of all City codes and ordinances that impact the City's urban forest similar to the checklist review done for Chapter 273
2. Replace all ambiguous terms and phrases such as "when practicable" and "maximum extent practicable"
3. Integrate all land use and development regulations into a unified development ordinance
4. Establish clear responsibility and procedures for enforcement of all tree regulations
5. Evaluate procedures and fees for tree permits, removals and replacements, etc.

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APPENDIX A: RECOMENDED SPECIES FOR FUTURE PLANTINGS

Proper landscaping and tree planting are critical components of the atmosphere, livability, and ecological quality of a community's urban forest. The tree species listed below have been evaluated for factors such as size, disease and pest resistance, seed or fruit set, and availability. The following list is offered to assist all relevant community personnel in selecting appropriate tree species. These trees have been selected because of their aesthetic and functional characteristics and their ability to thrive in the majority of soil and climate conditions found throughout the eastern United States. Trees marked by an * are native to the region.

Additional information on appropriate tree species can be found in the City of Lancaster Tree Manual at https://www.cityoflancasterpa.com/wp-content/uploads/2015/01/Tree-Manual_Standards-for-Arborculture-Work_0.pdf. New species and varieties are often introduced into the marketplace, while some listed trees might no longer be suitable based on local experience, new pests or diseases, etc. Often local availability will influence the options available.

Table A-1. Large Trees: 50 Feet or More in Height When Mature

Scientific Name	Common Name	Cultivar
Acer rubrum*	red maple	'Autumn Flame' 'Bowhall' 'Brandywine' 'Karpick' 'Northwood' 'October Glory' 'Red Sunset'
Acer saccharum*	sugar maple	'Commemoration' 'Green Mountain' 'Legacy'
Acer × freemanii	freeman maple	'Armstrong' 'Autumn Blaze' 'Celebration' 'Scarlet Sentinel'
Celtis laevigata*	sugar hackberry	'All Seasons'
Celtis occidentalis*	hackberry	'Prairie Pride'
Eucommia ulmoides	hardy rubber tree	
Ginkgo biloba	ginkgo	Choose male trees only
Gleditsia triacanthos inermis*	thornless honeylocust	'Shademaster' 'Skyline'
Gymnocladus dioicus*	Kentucky coffeetree	Prairie Titan®
Liquidambar styraciflua*	sweetgum	Only fruitless varieties
Metasequoia glyptostroboides	dawn redwood	'Emerald Feathers'
Nyssa sylvatica*	black tupelo (black gum)	
Platanus × acerifolia	London planetree	'Bloodgood'

Table A-1a. Large Trees: 50 Feet or More in Height When Mature (Cont'd.)

Scientific Name	Common Name	Cultivar
Quercus bicolor*	swamp white oak	
Quercus imbricaria*	shingle oak	
Quercus macrocarpa*	burr oak	
Quercus robur	English oak	'Attention' 'Skymaster' 'Skyrocket'
Quercus shumardii*	shumard oak	
Taxodium distichum*	common baldcypress	'Shawnee Brave'
Tilia cordata Not for streets, possibly in parks	littleleaf linden	'Chancole' 'Corzam' 'Fairview' 'Glenleven' 'Greenspire'
Tilia americana*	American linden	'Redmond'
Tilia tomentosa	silver linden	'Sterling'
Tilia × euchiora	crimean linden	
Ulmus ×	hybrid elm	'Frontier' 'Homestead' 'Pioneer' 'Regal' 'Urban'
Zelkova serrata	Japanese zelkova	'Green Vase' 'Halka' 'Village Green'

Table A 2. Medium Trees: 26 to 49 Feet in Height When Mature

Scientific Name	Common Name	Cultivar
Acer campestre	hedge maple	'Queen Elizabeth' 'St. Gregory'
Acer miyabi	Miyabi maple	'State Street'
Acer truncatum ×	Norwegian sunset maple	'Keithsform'
Acer truncatum ×	pacific sunset Maple	'Warrenred'
Aesculus × carnea	red horsechesnut	'Briotii'
Carpinus betulus	European hornbeam	
Carpinus caroliniana*	American hornbeam	
Cercidiphyllum japonicum	Katsura	
Cladrastis kentukea	American yellowwood	'Rosea'
Corylus colurna	Turkish filbert	
Gleditsia triacanthos inermis*	thornless honeylocust	'Imperial'
Halesia tetraptera*	carolina silverbell	
Ostrya virginiana*	American hophornbeam	
Parrotia persica	Persian parrotia	'Vanessa'
Ulmus parvifolia	lacebark elm	'Dynasty' 'Ohio'

Table A 3. Small Trees: 10 to 25 Feet in Height when Mature

Scientific Name	Common Name	Cultivar
Acer griseum	paperbark maple	
Acer pensylvanicum*	stripled maple	
Amelanchier spp.*	serviceberry.	
Cercis canadensis	eastern redbud	'Forest Pansy'
Chionanthus retusus Caution – possible EAB host	Chinese fringetree	
Cornus kousa	Kousa dogwood	'Galzam' 'Milky Way' 'Propzam' 'Samzam' 'Satomi'
Cornus racemose*	gray dogwood	'Cuyzam' 'Ottzam'
Crataegus spp*	hawthorn	Native species only
Malus spp	flowering crabapple	Disease resistant only
Syringa reticulata	Japanese tree lilac	'Ivory Silk'

Special Use Trees

In certain areas of the city, such as the downtown business district or in areas of restricted aboveground space, the best tree choice may be those varieties that grow more upright in what is termed a fastigiate, or columnar, manner. This form achieves 2 purposes: (1) because of their tighter, upright habit, there is minimal storefront blockage; and (2) they will not be wide branching, thus avoiding sidewalk clearance concerns. The following tree species and varieties offer the described characteristics and should be considered for tight space situations:

Table A-4. Trees for Tight Spaces when Mature

Scientific Name	Common Name	Cultivar
Acer campestre	hedge maple	'Evelyn'
Acer rubrum*	red maple	'Bowhall' 'Karpick'
Amelanchier arborea*	downy serviceberry	'Cumulus' 'Robin Hill'
Carpinus betulus	European hornbeam	'Fastigiata'
Ginkgo biloba	ginkgo	'Lakeview' Princeton Sentry®
Malus species	flowering crabapple	Disease resistant only 'Centurion' 'Harvest Gold' Madonna™ 'Sentinel'
Prunus sargentii	sargent cherry	'Columnaris'
Prunus serrulata	Japanese flowering cherry	'Amanogawa'
Quercus robur	English oak	Skyrocket™

Dirr's Hardy Trees and Shrubs (Dirr 2013) and *Manual of Woody Landscape Plants (5th Edition)* (Dirr 1988) were consulted to compile this suggested species list. Cultivar selections are recommendations only and are based on DRG's experience. Tree availability will vary based on availability in the nursery trade.

APPENDIX B: PESTS AND DISEASES

Introduction

Insects and diseases pose serious threats to tree health. Awareness and early diagnosis are essential to ensuring the health and survival of all trees. The City already has a successful emerald ash borer management plan. This successful model should be documented for the purpose of future plans should a new pest or disease appear.

In today's worldwide marketplace, the volume of international trade brings increased potential for pests and diseases to invade our country. Many of these pests and diseases have seriously harmed rural and urban landscapes and have caused billions of dollars in lost revenue and millions of dollars in clean-up costs. Keeping these pests and diseases out of the country is the number one priority of the USDA's Animal and Plant Inspection Service (APHIS).

APHIS, Plant Health, Plant Pest Program Information
- www.aphis.usda.gov/plant_health/plant_pest_info

The University of Georgia, Center for Invasive Species and Ecosystem Health
- www.bugwood.org

USDA National Agricultural Library
- www.invasivespeciesinfo.gov/microbes

USDA Northeastern Areas Forest Service, Forest Health Protection
- www.na.fs.fed.us/fhp

Although some invasive species naturally enter the United States via wind, ocean currents, and other means, most invasive species enter the country with some help from human activities. Their introduction to the U.S. is a byproduct of cultivation, commerce, tourism, and travel.

Once they arrive, hungry pests grow and spread rapidly because controls, such as native predators, are lacking. Invasive pests disrupt the landscape by pushing out native species, reducing biological diversity, killing trees, altering wildfire intensity and frequency, and damaging crops. Some pests may even push species to extinction. The following sections include key pests and diseases that adversely affect trees in America at the time of this plan's development. This list is not comprehensive and may not include all threats.

It is critical to the management of community trees to routinely check APHIS, USDA Forest Service, and other websites for updates about invasive species and diseases in your area and in our country so that you can be prepared to combat their attack.

Many pests and diseases affected a limited number of species, others can affect a wider range. Emerald ash borer is an example of the former, granulate ambrosia beetle (yet to be a threat here) is an example of the latter. Granulate ambrosia beetle, should it appear here, would threaten over half of our trees. Also, the Asian long-horned beetle poses a threat to maples, which are overabundant in Lancaster.

Lancaster should be aware of the signs and symptoms of potential infestations and should be prepared to act if a significant threat is observed in its tree population or a nearby community. An integrated pest management plan should be established. The plan should focus on identifying and monitoring threats,

understanding the economic threshold, selecting the correct treatment, properly timing management strategies, recordkeeping, and evaluating results. This can be achieved with regular and systematic inspections of the trees in the city. Having a trained arborist, knowledgeable in tree entomology and pathology, assist with regular tree assessments can aid in early discovery of invasive threats. Not every threat can be stopped completely, but a proactive approach can mitigate potential catastrophic loss.

Insect Pests

Asian Long-horned Beetle

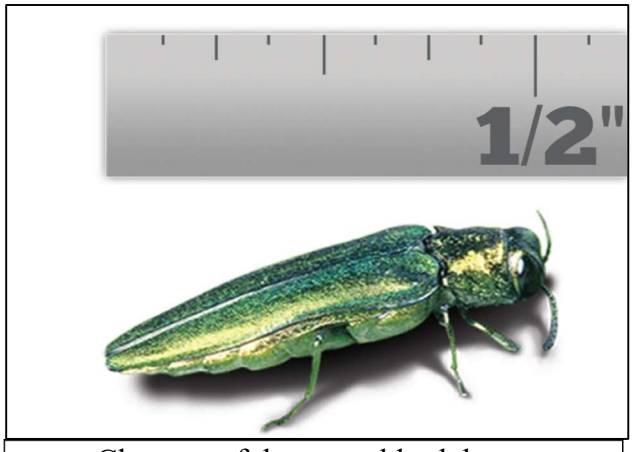
The ALB, (*Anoplophora glabripennis*) is an exotic pest that threatens a large portion of Lancaster's trees. The beetle was introduced in the United States from wood pallets and other wood-packing material accompanying cargo shipments from Asia. ALB is the most serious threat to America's hardwood tree species and is difficult to treat.

Eradication is possible, but the impact of the pest can be devastating to a community. First found in Brooklyn in 1996, ALB has since been detected in the Northeast and Midwest. The most important thing is early detection, which requires vigilant monitoring.

Adult Asian longhorned beetle

Photograph courtesy of New Bedford Guide

Adults are large (1/2- to 3/4-inch long) with very long, black and white banded antennae. The body is glossy black with irregular white spots. Adults can be seen from late spring to fall depending on the climate. ALB has a long list of host species; however, the beetle prefers hardwoods, including several maple species. Examples include: *Acer negundo* (box elder); *A. platanoides* (Norway maple); *A. rubrum* (red maple); *A. saccharinum* (silver maple); *A. saccharum* (sugar maple); *Aesculus glabra* (buckeye); *A. hippocastanum* (horsechestnut), *Betula* (birch), *Platanus* × *acerifolia* (London planetree), *Salix* (willow), and *Ulmus* (elm).



Close-up of the emerald ash borer

Photograph courtesy of APHIS (2011)

Emerald Ash Borer

The EAB-preferred host tree species are in the genus *Fraxinus* (ash).

EAB *(Agrilus planipennis*) is responsible for the death or decline of tens of millions of ash trees in throughout the American Midwest and Northeast. It is native to Asia. It likely arrived in the United States hidden in wood-packing materials commonly used to ship consumer goods, auto parts, and other products. The first official United States identification of EAB was in southeastern Michigan in 2002.

Treatment options exist but can be costly. However, without treatment, the mortality rate is 100%. Management options are provided in Chapters 1 and 3 of this Plan. Initial symptoms include yellowing and/or thinning of the foliage and longitudinal bark splitting. The entire canopy may die back, or symptoms may be restricted to certain branches. Declining trees may sprout epicormic shoots at the tree

base or on branches. Adults exit from the trunk and branches in a characteristic D-shaped exit hole that is about 1/8 inch in diameter. The loss of water and nutrients from the intense larvae tunneling can cause trees to lose between 30% and 50% of their canopies during the first year of infestation; trees can die within two years following infestation Once an ash tree is infested with EAB, branches become weak which can lead to limb failure from wind events or snow loading. Eventually, if left untreated and the infestation becomes worse, complete tree failure is probable.

Adult beetles are slender and 1/2-inch long. Males are smaller than females. Color varies but adults are usually bronze or golden green overall with metallic, emerald-green wing covers. The top of the abdomen under the wings is metallic, purplish-red and can be seen when the wings are spread.

Forest Tent Caterpillar

Forest tent caterpillar (*Malacosoma disstria*) is possibly the most damaging tent caterpillar in the United States. It attacks ash, various fruit trees, poplar, willow, and many other deciduous trees. The name may be slightly misleading as the larvae do not make a silken tent between the trunk and branches of trees as other tent caterpillars do. Instead, this larva makes a mat on the trunk for masses of caterpillars to rest on. The larval caterpillar is distinctive in the bright blue coloration along its sides with a white "keyhole"-shaped pattern running along its back.

Forest tent caterpillar larva with blue stripe and white "keyhole" pattern running down its back

Photograph courtesy of Greg Hume USDA Forest Service, Penn State Extension (2018).

Gypsy Moth

The gypsy moth (GM) *(Lymantria dispar*) is native to Europe and first arrived in the United States in Massachusetts in 1869. This moth is a significant pest because its caterpillars have an appetite for more than 300 species of trees and shrubs. GM caterpillars defoliate trees, which makes the species vulnerable to diseases and other pests that can eventually kill the tree.

Male GMs are brown with a darker brown pattern on their wings and have a 1/2-inch wingspan. Females are slightly larger with a 2-inch wingspan and are nearly white with dark, saw-toothed patterns on their wings. Although they have wings, the female GM cannot fly.

Close-up of male (darker brown) and female (whitish color) European gypsy moths

Photograph courtesy of APHIS (2011b)

The GMs prefer approximately 150 primary hosts but feed on more than 300 species of trees and shrubs. Some trees are found in these common genera: *Betula* (birch), *Juniperus* (cedar), *Larix* (larch), *Populus* (aspen, cottonwood, poplar), *Quercus* (oak), and *Salix* (willow).

Sirex Woodwasp

Close-up of female Sirex woodwasp Photograph courtesy of USDA (2005)

Sirex woodwasp (*Sirex noctillio*) is commonly found in solid wood-packing materials. Recent detections of Sirex woodwasp outside of port areas in the United States have raised concerns because this insect has the potential to cause significant mortality of pine. Awareness of the symptoms and signs of a Sirex woodwasp infestation increases the chance of early detection, thus increasing the rapid response needed to contain and manage this exotic forest pest.

Woodwasps (or horntails) are large robust insects, usually 1.0 to 1.5 inches long. Adults have a spear-shaped plate (cornus) at the tail end; in addition, females have a long ovipositor under this plate. Larvae are creamy white, legless, and have a distinctive dark spine at the rear of the abdomen. More than a dozen species of native horntails occur in North America.

Sirex woodwasps can attack living pines, while native woodwasps attack only dead and dying trees. At low populations, Sirex woodwasp selects suppressed, stressed, and injured trees for egg laying. Foliage of infested trees initially wilts, and then changes color from dark green to light green, to yellow, and finally to red, during the 3 to 6 months following attack. Infested trees may have resin beads or dribbles at the egg laying sites, but this is more common at the mid-bole level. Larval galleries are tightly packed with very fine sawdust. As adults emerge, they chew round exit holes that vary from 1/8 to 3/8 inch in diameter.

Spotted Lanternfly

The following text is from the Penn State Extension, College of Agricultural Sciences, Pennsylvania State University web site which can be found at https://extension.psu.edu/spotted-lanternfly

The Spotted lanternfly (SLF) (*Lycorma delicatula)* is an invasive insect that has spread rapidly since its discovery in neighboring Berks County in 2014. SLF feeds on the plant sap of over 70 different agricultural crops and trees. Its potential statewide economic impact has been estimated at over $300 million annually. In Lancaster nearly a quarter of our trees are red maples, which are a favorite host of this insect. Its ability to feed on many other of our city's trees (linden, sycamore, cherry, crabapple, serviceberry, oak, etc.) makes it a particularly severe threat.

SLF was abundant in Lancaster in 2019 and is expected to be found in even greater numbers in future years. The spotted lanternfly uses its piercing-sucking mouthpart to feed on the plant's sap. As SLF feeds, the insect excretes honeydew (a sugary substance). The honeydew builds up and promotes the growth of sooty mold, which can cover the plant, forest understories, patio furniture, cars, and anything else found below SLF feeding.

Egg masses deposited at the end of the season can be found on trees; from each one 50-100 insects can emerge in the spring. The eggs hatch in the spring and the insects go through several stages until the adults appear in mid-summer.

Since this is a new pest, control strategies are under development. These efforts will need to increase as the pest becomes more established in Lancaster.

Removing egg masses can help reduce the next summer's population.

The U.S. Department of Agriculture carried out a control project in Long's Park and other city-owned properties in 2019. Many trees of the preferred host, the invasive Tree of Heaven (*Ailanthus altissima*), were removed. A few others were left as insecticide-treated "trap trees" to attract the insects.

Certain insecticides can provide some control at various stages of the life cycle.

Placing bands of sticky tape around tree trunks has been suggested, but care must be taken to avoid trapping small mammals and birds.

Diseases

Anthracnose

Anthracnose is prevalent in Lancaster's London plane and American sycamore trees. It is a common foliar disease of shade trees caused by fungi. Leaf tissue will be killed, and defoliation may occur, thus reducing the aesthetic value and vitality of the affected trees. While certain management steps can be taken to reduce the prevalence of this disease (noted below), the best long term course is to focus on planting resistant tree varieties.

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

Bacterial Leaf Scorch

The following text is derived from this Missouri Botanical Garden website at https://www.missouribotanicalgarden.org/gardens-gardening/your-garden/help-for-the-home-gardener/advice-tips-resources/pests-and-problems/diseases/bacterial-spots/bacterial-leaf-scorch.aspx

Bacterial leaf scorch (BLS) is a systemic disease caused by the bacterium *Xylella fastidiosa*, which invades the xylem (water and nutrient conducting tissues) of susceptible trees. It is most commonly seen in pin, red, shingle, bur, and white oaks, but can also affect elm, other oaks, sycamore, mulberry, sweet gum, sugar maple, and red maple. Xylem-feeding leafhoppers and spittlebugs spread the bacterium from tree to tree. Transmission between trees through root grafts has also been reported. There is no cure for this disease; it is

chronic and potentially fatal. It is often seen in Lancaster and threatens many of our most valuable and beautiful trees.

The first noticeable symptom is premature browning of leaves in mid-summer. Symptoms worsen throughout late summer and fall. Leaf margins turn brown, beginning with the older leaves and moving outward, spreading to leaves toward the branch tip. In some cases dead areas of the leaf are separated from green tissue by a narrow yellow border. Symptoms become progressively worse over a period of 3 to 8 years, until the entire tree turns brown prematurely. The lack of green, chlorophyll containing leaves year after year leads to twig, branch, and limb death due to continual defoliation.

Bacterial leaf scorch can be mistaken for other diseases or for drought and heat stress, but an arborist can readily distinguish the unique features of bacterial leaf scorch. The only way to confirm the diagnosis of bacterial leaf scorch is through laboratory analysis.

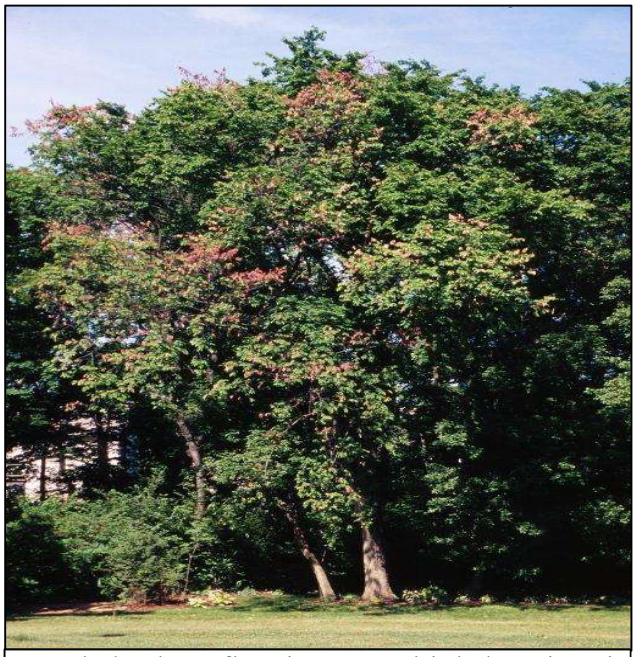
There are no viable control options for the insect vectors. Strategies for integrated pest management include: maintaining plant vigor, practicing good sanitation during tree work, removing severely infected trees, planting more resistant trees, and avoiding planting highly susceptible trees.

Dutch Elm Disease

Considered by many to be one of the most destructive, invasive diseases of shade trees in the United States, Dutch elm disease (DED) was first found in Ohio in 1930 and has since killed millions of trees. Today, it is widespread in the eastern United States, and annually kills many of the remaining and newly planted elm. The disease is caused by a fungus that attacks the vascular system of elm trees blocking the flow of water and nutrients, resulting in rapid leaf yellowing, tree decline, and death.

There are two closely-related fungi that are collectively referred to as DED. The most common is *Ophiostoma novo-ulmi*, which is thought to be responsible for most of the elm deaths since the 1970s. The fungus is transmitted to healthy elm by elm bark beetles. Two species carry the fungus: native elm bark beetle (*Hylurgopinus rufipes*) and European elm bark beetle (*Scolytus multistriatus)*.

The species most affected by DED is the *Ulmus americana* (American elm).



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

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

Oak Wilt

Oak wilt was first identified in 1944 and is caused by the fungus *Ceratocystis fagacearum*. While considered an invasive and aggressive disease, its status as an exotic pest is debated since the fungus has not been reported in any other part of the world. It can result in the decline and death of oak trees in as little as two weeks by clogging the trees' vascular system. The fungus is spread from tree to tree by borers and through root grafts underground. This disease affects the oak genus and is most devastating to those in the red oak subgenus, such as *Quercus coccinea* (scarlet oak), *Q. imbricaria* (shingle oak), *Q. palustris*

(pin oak), *Q. phellos* (willow oak), and *Q. rubra* (red oak). It also attacks trees in the white oak subgenus, although it is not as prevalent and spreads at a much slower pace in these trees.

The most resistant species include *Q. macrocarpa* (bur oak) and *Q. muehlenbergii* (chinkapin). Control and management of oak wilt involves a thorough knowledge of preventive strategies and control protocols such as wound dressings. The best preventive strategy is to limit wounding (including pruning wounds) of oak during warm weather when the insect vectors are flying.

Oak wilt symptoms on red and white oak leaves

Photograph courtesy of USDA Forest Service (2011a)

Just as with Dutch Elm Disease, oak wilt disease is caused by a fungus that clogs the vascular system of oak and results in decline and death of the tree. The fungus is carried from tree to tree by several borers common to oak, but the disease is more commonly spread through root grafts. Oak species within the same subgenus (red or white) will form root colonies with grafted roots that allow the disease to move readily from one tree to another.

Oaks are among our most valuable trees, so it is essential to protect these magnificent trees. It is hard to imagine that we would no longer plant oaks, but selecting the more resistant species would be advisable.

Verticillium Wilt

Verticillium Wilt is caused by a soil-borne fungus. It is often associated with maple but can affect several other species, including ash, Kentucky coffee tree, elm, and plum. Symptoms include yellow foliage, abnormally heavy seeding, and dieback of shoots and branches. Streaking of vascular tissue can accompany external symptoms. The fungus will persist in the soil indefinitely. If replacement of trees affected with Verticillium wilt is needed, replace with species not susceptible to the fungus such as birch, gingko, pear, or poplar. Be aware of using wood chips from trees which have been infected with the Wilt. Some trees respond to benzimidazole fungicide, but consult with a licensed pesticide applicator for tree and soil treatments.

Thousand Cankers Disease

A complex disease referred to as Thousand Cankers disease (TCD) was first observed in Colorado in 2008. TCD is considered to be native to the United States and refers to numerous cankers developing in association with insect galleries.

TCD results from the combined activity of the *Geosmithia morbida* fungus and the walnut twig beetle (WTB, *Pityophthorus juglandis*). The WTB has expanded both its geographical and host range over the past two decades, and coupled with the *Geosmithia morbida* fungus, *Juglans* (walnut) mortality has manifested throughout the United States, including in Lancaster. In July 2010, TCD was reported in Knoxville, Tennessee. The infestation is believed to be at least 10 years old and was previously attributed to drought stress. Both native and introduced walnut species may suffer severe decline and mortality.

The tree species preferred as hosts for TCD are walnuts.

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APPENDIX C: THE CASE FOR A COMPREHENSIVE TREE WATERING PROGRAM IN LANCASTER CITY

Presented in 2018 by Lancaster Tree Tenders and Lancaster City Shade Tree Commission

Overview

Many factors are essential if a tree is to flourish, in the harsh environment of a city street. These include putting the right tree in right place, site preparation, choosing good nursery stock, proper planting, and after-planting care. Our focus here is on a critical element of after-planting care, watering for the first few years.

Care of trees is, by state law and local ordinance, the responsibility of the property owner. This situation has created confusion, given the many tree planting programs. More importantly, there is a lack of consistency in providing such care, ranging from close attention to total neglect.

What is the problem?

Most, if not all, newly planted trees are given a tree watering bag by the city or the contractor, and owners are given detailed information on when and how to fill the bags.

Observations by those involved in our programs indicate that most of our newly planted street trees are not being watered consistently, if at all. Among the possible reasons why are:

• a lack of understanding that the owner is responsible, although owners are provided with such information, often multiple times

• insufficient awareness about the importance of watering

• a lack of convenient access to water

• absentee landlords who are not ensuring that the trees are watered

There is not at present a "system" for watering trees. Rather, there are many well-intentioned efforts, with variable success. Paid employees and volunteers are devoting considerable time and effort to a patchwork system: doing some watering, checking that bags are filled, designing outreach to owners, providing reminders, and too often replanting dead trees. What we have now is neither efficient nor effective.

Why is watering important?

Data shows that watering new trees is crucial for survival and growth. A tree that is not properly watered may die. If the tree survives the stress, recovery may take years; the tree may never reach its full potential size and thus may not provide the full potential benefits. In an experiment on field-grown trees, Prof. Edward Gilman observed that the cumulative growth of a cohort of young trees not irrigated during the summer (some of which died) was half that of trees that were irrigated (few of which died).

Researchers have found that successful urban tree programs are characterized by "rigorous and consistent young tree care" (Lara Roman, U.S. Forest Service, Philadelphia).

The planting of a tree represents a substantial investment; replacing trees comes at additional cost. Through the city's Tree Planting Program, the owner has invested on average over $200 per tree, while the city has invested even more in materials and especially labor to prepare the site (including very expensive work such as stump removal or concrete cutting) and to plant the tree. Trees

provided by grants are likewise not "free", but are funded, in the case of state TreeVitalize grants, through tax dollars. Lancaster Tree Tenders and the Lancaster City Alliance have received funds from donors; such support in the future could be at risk if donors see trees failing to thrive or dying. All of these investments are not currently adequately protected; time and money are wasted.

Some funding agencies, including the state TreeVitalize program, are now "beginning to require survival monitoring as a metric of success" (Lara Roman), which could be a factor in reviews of future grant applications.

Lancaster City has set an ambitious goal to increase its tree canopy from 28% to 40%. Trees can make a meaningful contribution to achieving the reduction in storm water runoff required in the EPA consent decree. Reaching these goals requires many enhancements to our tree policies and procedures, and better watering is a critical one.

What is currently being done?

Tree maintenance, including weekly filling of the watering bag, is part of the contract the property owner agrees to prior to planting (via the Tree Planting Program or Lancaster Tree Tenders/Lancaster City Alliance programs). Owners receive our "Street Tree Care Tips" sheet (available in English and Spanish) on how to care for a newly planted tree. Additionally, we send email reminders, include reminders in the Lancaster Tree Tenders e-newsletter, and place door hanger reminders.

In the case of land developments, language in city regulations requires the use of irrigation bags for watering, although the language could be improved.

In all cases owners of trees that die are required to replace them, although the mechanisms for enforcement are cumbersome and not often applied.

How can we fix the problem?

The non-profit Lancaster Tree Tenders and the Lancaster City Shade Tree Commission have resolved to develop a plan for a better system for watering trees for the first few years after planting. The goal of this plan is to improve tree survival and vigor. A draft of the plan is attached below.

Research – Other Communities

As we reached out to other communities for insight, we found they have similar concerns and issues with new street tree plantings. These are particularly acute in Pennsylvania cities, where owners, rather than the municipality, are responsible for street trees. Effective solutions seem to rely a collaborative effort of the municipality, contractor services, property owner commitment, and non-profits in the community. Neighborhood-scale projects with groups and volunteers seem particularly effective. Workforce development is a component of several successful programs.

Some observations from other communities follow. Individuals from these communities were quite willing to discuss their systems with us in phone conversations and emails.

Bethlehem, PA - "When planting street trees under contract, there is a 2 year maintenance and guarantee period required. It makes the initial price higher but it's motivation for the contractor to keep things watered."

Allentown, PA - "We (Public Works) install "Gator Bags" and maintain a watering schedule on all street trees that are planted as a function of a "TreeVitalize" grant or department funds for a

period of one year. The trees are then periodically monitored beyond the first year and pruned (minor) by the city for structure as needed up to the fifth year.

Our Streets Department put together a 500 gallon watering truck with a hydraulic pump that fills the "Gator" bags in about 90 seconds." Having a long hose on a retractable reel and being able to refill the tank quickly (without driving too far to the water source) are important factors. With this system, 200 trees can be watered in a day, provided the trees are located in a compact area.

Philadelphia, PA - "In Philadelphia, the Parks & Recreation Dept. is in charge of street tree planting. We contract out the planting (and pruning and removal) and the contract includes a one year warranty, during which time the contactor is supposed to be watering each new tree once a week. If the tree is dead after one year, the contractor replaces it (we withhold 10% per tree and pay the final amount to the contractor for a healthy tree once the warranty period is over). Based on our workload, we are not typically able to check to make sure the trees are being watered during the year after planting, but rely mostly on the one year inspection and use the 10% warranty retainage as our leverage to make sure the contractors are caring for the trees.

"The Pennsylvania Horticultural Society has a Tree Tenders program where trained volunteers plant street trees as well, and the property owner is responsible for watering those trees after planting. They have a "Tree Checkers" program where the volunteers return during the summer after planting to see how the trees are doing and issue a report card of sorts to the property owner to tell them what they are doing right and what needs improvement. Watering, weeding, trash removal, etc. are included in that.

"We've also worked with community groups who create their own watering programs for street trees. We did a bunch of street tree plantings along commercial corridors in the Germantown neighborhood of Philadelphia, and then the Germantown United CDC contracted with DePaul USA's homeless transition program for watering and maintenance services (the CDC provided the funding).

"We also plant trees in parks, and the watering for those is always a joint effort. At one of our park plantings we have 2 separate Parks & Rec divisions and three partner groups helping to water trees each week, so each group is only watering about once a month. At another park planting we have 2 divisions of Parks & Rec and a local library with their summer kids' program helping to water. For these we use water from nearby hydrants and buildings to fill buckets, and then walk or cart them in a wagon over to the trees. For larger parks we have 100 gallon watering tanks that we fill and then drive around in a pickup truck, then fill the buckets from the tank and walk them to nearby trees. We water our park plantings for two summers following planting."

Pittsburgh, PA - "For areas without access to water, we have used our trucks with a watering tank and met up with volunteers to distribute to needed trees. Years ago we spent several hundred dollars from our Shade Tree Commission for a watering tank and transfer pump. A cheaper water tank is an IBC tote, which we buy from Craigslist for as little as $50."

"We can empty from 4 to 8 tanks in an 8 hour day with a transfer pump. Each tank being 250 gallons, minus 25+/- for spillage = 225/20 gallons = 11 trees per tank, so 44 to 88 trees per 8 hour day." (Note: this sometimes involves filling buckets which are carried to the trees, so the daily capacity is less than in Allentown, where bags are filled directly.)

Baltimore, MD (TreeBaltimore) - "All our contractor planted trees comes with two years of watering and maintenance, and a warranty of 'replacement at the next available planting

season.' This means the contractor may need to replace a tree 3 times in a two year period, this keeps them more honest during maintenance. We also hold back funding. So it costs around $400 for a tree, planting and 2 years of watering/mulching. We pay out the watering and maintenance monies monthly over two years, so that if something goes wrong we withhold funds until it is resolved.

"We also work with several larger non-profits who hire "YouthWorkers" which is a City run program to hire 15-21 year olds during the summer. So the NGO's get grants to fund some staff that drive and coordinate watering trees with watering trucks / YouthWorkers.

"Our contractually planted trees have a very high survival rate of about 95%. Our non-profits are closer to 75-85%, depending on the neighborhood.

"We worked to better the specs of our planting/maintenance contract, so that it is required and enforceable. It didn't used to be this good."

Baltimore, MD (Baltimore Tree Trust) - Tree plantings are neighborhood focused making it a bit easier to maintain the new tree plantings (in a more compact area). They had a truck with water tank donated to them and have permission to use the fire hydrants to refill the tank. The agreement is for ten fills per tree bag each summer. Creating a workforce development program in partnership with other local organizations. Plan is to have approximately six apprenticeship jobs / 40 hours a week / six weeks / pay approximately $12/hour – tasks would include planting and watering. They strongly suggested connecting with local tree experts and businesses – possibly feeder program to employment.

Wilmington, DE - "Watering city trees is indeed a challenge. We have always utilized a mix of contractor services, homeowner-commitment, and in-house. Ideally the homeowner can commit to the care of the tree. We have also considered a youth employment program during the summer months, with some great examples from Keep Indianapolis Beautiful.

We typically use gator bags and ask homeowners to water spring planted trees once a week until temperatures drop below 40. We've had good luck with planting smaller stock or root bag/bareroot trees, which tend to establish quicker."

Cambridge, MA - One component of the city's watering program is a bicycle pulling a trailer with a small tank.

How do trees get planted in Lancaster?

In Lancaster City, street trees are planted as part of several different programs and projects.

• The City's Tree Planting Program, with requests by individual property owners who pay for the tree

• Lancaster Tree Tenders in collaboration with the Lancaster City Alliance, with requests by individual property owners or neighborhood groups. Most often, the cost of the tree is covered (in part or fully) by grants and donations.

• City planting projects, often as part of major street reconstruction. The cost of the trees is part of the overall project budget, often supported by grants.

• Land development projects, in which the owner/developer pays for and installs the required new trees.

Although the processes differ in detail, the city arborist (and in some cases the Shade Tree Commission) plays a critical role in site review and species selection. The city arborist crew may be involved in site preparation and planting, or sometimes volunteers participate. Especially for larger projects, the work may be performed by contractors.

Who should be part of discussion?

Possible suggestions are:

• City – arborist; personnel from relevant Bureaus in the Departments 0f Public Works, Community Planning and Economic Development, and Neighborhood Engagement; members of the Shade Tree Commission

• Community groups – Lancaster City Alliance, Lancaster Tree Tenders, neighborhood groups

• Others – Alliance for the Chesapeake Bay, Chesapeake Bay Foundation, PA Department of Conservation and Natural Resources' TreeVitalize program, US Forest Service

An early discussion should be how the plan would be reviewed by those involved for their evaluation, approval, and buy-in and financial support, followed by necessary policy changes (by the city, particularly, as well as by Lancaster Tree Tenders and other groups that provide trees and their care).

Financial Argument For Support Of Watering Plan

Assumptions:

• Through various programs, 250 street trees are planted per year. With recent efforts, that number has been increasing.

• Although owners purchase the trees in theory, in practice city funds are often used, via grants, Shade Tree Commission funds, or contracts for large-scale streetscape projects. The average cost for a tree through the city's contract is about $205.

• The average cost for the city to plant a tree is $500. This is an estimate from the city arborist. In fact, when concrete must be cut or a stump removed, the cost can be considerably greater.

• We do not know the average cost for trees or installation provided by contractors for streetscape projects, but we assume they would be no less than those listed above, and potentially more.

• Based on studies in other cities, the average tree mortality in each of the first two years (largely from insufficient watering) is 10% per year.

• If trees are not properly watered, but do survive, their growth may well be reduced, and they may not reach their full potential. Thus, the gain in ecosystem services will be delayed and perhaps permanently reduced. A large mature shade tree may provide $1000 or more in annual ecosystem services. We do not include any reduction in this value in the calculations that follow, but it should not be ignored.

• Each year, various groups do outreach to owners of new trees to encourage them to water the trees. Outreach includes mailings, notices left at the door, phone calls, emails, personal visits, etc. Some of these are conducted by paid staff of the City or of other organizations, while others are conducted by volunteers. There are costs for staff labor, printing, postage, etc. Time and money could be spent on other activities. We cannot estimate these costs in the calculations that follow,

but they should not be ignored. These costs would be significantly reduced if there was a water system in place.

• Trees provided by contractors usually have a one-year guarantee. However, the guarantee does not apply when the cause of tree death is lack of watering.

• When a tree dies, there is a setback in the gain of ecosystem benefits since the replacement will be delayed in reaching a particular stage and size.

Model

- 25 trees die in a year
- Cost of those trees - $5,125
- Cost of planting those trees - $12,500
- Removing the dead tree is an additional cost
- These are, at minimum, the wasted investments.

APPENDIX D: FIVE-YEAR COST ESTIMATE

Estimated Costs for Each Activity			Year 1		Year 2		Year 3		Year 4		Year 5		Five-Year Cost
Activity	Diameter	Cost/Tree	# of Trees	Total Cost	# of Trees	Total Cost	# of Trees	Total Cost	# of Trees	Total Cost	# of Trees	Total Cost	
"Dead" Condition	1-3"	$28	0	$0	0	$0	22	$616	0	$0	0	$0	$616
Removals - Highest	4-6"	$58	0	$0	0	$0	4	$232	0	$0	0	$0	$232
Priority	7-12"	$138	0	$0	14	$1,932	0	$0	0	$0	0	$0	$1,932
	13-18"	$314	0	$0	12	$3,768	0	$0	0	$0	0	$0	$3,768
	19-24"	$605	5	$3,025	0	$0	0	$0	0	$0	0	$0	$3,025
	25-30"	$825	3	$2,475	0	$0	0	$0	0	$0	0	$0	$2,475
	31-36"	$1,045	1	$1,045	0	$0	0	$0	0	$0	0	$0	$1,045
	37-42"	$1,485	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	43"+	$2,035	0	$0	0	$0	0	$0	0	$0	0	$0	$0
Activity Total(s)			9	$6,545	26	$5,700	26	$848	0	$0	0	$0	$13,093
"Poor" Condition	1-3"	$28	0	$0	0	$0	0	$0	16	$448	15	$420	$868
Removals - Moderate	4-6"	$58	0	$0	0	$0	0	$0	13	$754	10	$580	$1,334
Priority	7-12"	$138	0	$0	0	$0	31	$4,278	30	$4,140	30	$4,140	$12,558
	13-18"	$314	0	$0	43	$13,502	40	$12,560	0	$0	0	$0	$26,062
	19-24"	$605	0	$0	33	$19,965	30	$18,150	0	$0	0	$0	$38,115
	25-30"	$825	30	$24,750	10	$8,250	0	$0	0	$0	0	$0	$33,000
	31-36"	$1,045	23	$24,035	0	$0	0	$0	0	$0	0	$0	$24,035
	37-42"	$1,485	1	$1,485	0	$0	0	$0	0	$0	0	$0	$1,485
	43"+	$2,035	2	$4,070	0	$0	0	$0	0	$0	0	$0	$4,070
Activity Total(s)			56	$54,340	86	$41,717	101	$34,988	59	$5,342	55	$5,140	$141,527
"Removed" Condition	1-3"	$18	0	$0	0	$0	0	$0	0	$0	48	$864	$864
Stump Removals	4-6"	$28	0	$0	0	$0	0	$0	35	$980	0	$0	$980
	7-12"	$44	0	$0	25	$1,100	25	$1,100	25	$1,100	23	$1,012	$4,312
	13-18"	$72	0	$0	46	$3,312	30	$2,160	30	$2,160	30	$2,160	$9,792
	19-24"	$94	0	$0	25	$2,350	25	$2,350	25	$2,350	24	$2,256	$9,306
	25-30"	$110	25	$2,750	25	$2,750	17	$1,870	0	$0	0	$0	$7,370
	31-36"	$138	28	$3,864	0	$0	0	$0	0	$0	0	$0	$3,864
	37-42"	$160	17	$2,720	0	$0	0	$0	0	$0	0	$0	$2,720
	43"+	$182	1	$182	0	$0	0	$0	0	$0	0	$0	$182
Activity Total(s)			71	$9,516	121	$9,512	97	$7,480	115	$6,590	125	$6,292	$39,390
High Risk Pruning	1-3"	$20	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	4-6"	$30	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	7-12"	$75	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	13-18"	$120	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	19-24"	$170	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	25-30"	$225	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	31-36"	$305	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	37-42"	$380	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	43"+	$590	0	$0	0	$0	0	$0	0	$0	0	$0	$0
Activity Total(s)			0	$0	0	$0	0	$0	0	$0	0	$0	$0
Routine Pruning	1-3"	$20	0	$0	0	$0	0	$0	0	$0	0	$0	$0
(5-year cycle)	4-6"	$30	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	7-12"	$75	315	$23,625	315	$23,625	315	$23,625	315	$23,625	305	$22,875	$117,375
	13-18"	$120	301	$36,120	301	$36,120	301	$36,120	301	$36,120	301	$36,120	$180,600
	19-24"	$170	240	$40,800	240	$40,800	240	$40,800	240	$40,800	240	$40,800	$204,000
	25-30"	$225	125	$28,125	125	$28,125	125	$28,125	125	$28,125	123	$27,675	$140,175
	31-36"	$305	70	$21,350	70	$21,350	70	$21,350	70	$21,350	70	$21,350	$106,750
	37-42"	$380	40	$15,200	40	$15,200	40	$15,200	40	$15,200	21	$7,980	$68,780
	43"+	$590	20	$11,800	20	$11,800	20	$11,800	20	$11,800	13	$7,670	$54,870
Activity Total(s)			1111	$177,020	1111	$177,020	1111	$177,020	1111	$177,020	1073	$164,470	$872,550
Young Tree Training	1-3"	$20	520	$10,400	520	$10,400	516	$10,320	0	$0	0	$0	$31,120
Pruning (3-year cycle)	4-8"	$30	489	$14,670	489	$14,670	489	$14,670	0	$0	0	$0	$44,010
Activity Total(s)			1009	$25,070	1009	$25,070	1005	$24,990	0	$0	0	$0	$75,130
			2256	272491	2353	259019	2340	245326	1285	188952	1253	175902	1141690
Replacement Tree	Purchasing	$200	200	$40,000	200	$40,000	200	$40,000	200	$40,000	200	$40,000	$200,000
Planting	Planting	$450	200	$90,000	200	$90,000	200	$90,000	200	$90,000	200	$90,000	$450,000
Activity Total(s)			400	$130,000	400	$130,000	400	$130,000	400	$130,000	400	$130,000	$650,000
Replacement Young	Mulching,												
Tree Maintenance	staking, etc	$12	200	$2,400	200	$2,400	200	$2,400	200	$2,400	200	$2,400	$12,000
	Watering			$0	200	$0	200	$0	200	$0	200	$0	$0
Activity Total(s)			200	$2,400	400	$2,400	400	$2,400	400	$2,400	400	$2,400	$12,000
Activity Grand Total			2856		3153		3140		2085		2053		
Cost Grand Total				$404,891		$391,419		$377,726		$321,352		$308,302	$1,803,690
Total without tree purchase cost				$362,491		$349,019		$335,326		$278,952		$265,902	$1,591,690

APPENDIX E: IMPORTANT TREE RESOURCES

City of Lancaster Department of Public Works (DPW) and Department of Community Planning and Economic Development (CPED)

Physical location
City Hall
120 North Duke Street
Lancaster, PA 17602

Mailing Address
City of Lancaster
120 North Duke Street
PO Box 1599
Lancaster, PA 17608-1599

Email: info@cityoflancasterpa.com

DPW Phone: (717) 291-4711

CPED Phone: (717) 291-4759

Website: https://www.cityoflancasterpa.com/city-gov/

City of Lancaster Tree Program https://www.cityoflancasterpa.com/services/trees/

Partner Organizations

Alliance for the Chesapeake Bay https://www.allianceforthebay.org/ Alliance for the Chesapeake Bay has been instrumental in helping to protect and restore the Chesapeake watershed for over 45 years, with a focus on local forests, streams, and rivers.

Davey Tree/Davey Resource Group https://www.davey.com/davey-resource-group/ Davey Tree was founded in 1880 with a commitment to provide scientifically-based horticultural and environmental services.

Lancaster Conservancy https://www.lancasterconservancy.org/ The Lancaster County Conservancy finds, funds, preserves and maintains natural lands in Lancaster and York Counties for the community and visitors to the region to enjoy them.

Lancaster Tree Tenders https://www.lancastertreetenders.org/ Lancaster Tree Tenders is a volunteer driven initiative of the City of Lancaster, Alliance for the Chesapeake Bay and Lancaster City Alliance that aims to increase and enhance Lancaster's urban forest by engaging and empowering neighborhoods to plant and care for trees.

Penn State Extension https://extension.psu.edu/ Penn State Extension is an educational organization dedicated to delivering science-based information to people, businesses, and communities.

Pennsylvania Department of Conservation and Natural Resources Community Tree Management provides information on a variety of tree education and training programs, TreeVitalize grant program, and the Community Tree Map. https://www.dcnr.pa.gov/Communities/CommunityTreeManagement/Pages/default.aspx

Pennsylvania Horticulture Society https://phsonline.org/ PHS was founded in 1827 to use horticulture to advance the health and well-being of the Greater Philadelphia region.

Tree City USA https://www.arborday.org/programs/treecityusa/ Since 1976. Tree City USA, a program of the Arbor Day Foundation, has provided the framework necessary for communities to manage and expand their public trees.