TREE MANAGEMENT PLAN

City of Dunkirk, New York

November 2019

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VISION FOR DUNKIRK'S URBAN FOREST

The City of Dunkirk's urban forest will be a collection of healthy tree ecology that ensures canopy continuity, in order to protect, preserve, and improve the aesthetic value of our neighborhoods, the City's air quality, and overall public health that brings vast benefits to the people of Dunkirk.

EXECUTIVE SUMMARY

This plan was developed for the City of Dunkirk by Davey Resource Group (DRG) with a focus on addressing short-term and long-term maintenance needs for inventoried public trees. DRG completed a tree inventory to gain an understanding of the needs of the existing urban forest and to project a recommended maintenance schedule for tree care. Analysis of inventory data and information about the city's existing program and vision for the urban forest were utilized to develop this *Tree Management Plan*. Also included in this plan are economic, environmental, and social benefits provided by the trees in Dunkirk.

Dunkirk has many opportunities to improve its urban forest. Planned tree planting and a systematic approach to tree maintenance will help ensure a cost-effective, proactive program. Investing in this tree management program will promote public safety, improve tree care efficiency, and increase the economic and environmental benefits the community receives from its trees.

State of the Existing Urban Forest

The 2019 inventory took place August through September, which included trees, stumps, and planting sites along public street rights-of-way (ROW), in specified parks, and public facilities. The parks selected for the inventory include: Fourth Street Park, Kosciuszko Park, Memorial Park, New York Avenue Playground, Point Gratiot, Washington Park, and Wright Park. A total of 9,762 sites were recorded during the inventory: 6,479 trees, 73 stumps, and 3,210 planting sites. Analysis of the tree inventory data found the following:

- Two species, *Acer platanoides* (Norway maple) and *A. saccharinum* (silver maple), comprise a large percentage of the inventoried trees (15% and 14%, respectively) and threaten biodiversity.
- The diameter size class distribution of the inventoried tree population is skewed toward mature trees with a deficit of young trees.
- The overall condition of the inventoried tree population is rated Fair.
- Approximately 41% of the inventoried trees had dead and dying parts.
- Overhead utilities interfering with street trees occur among 13% of the population.
- Spotted lantern fly (*Lycorma delicatula*) and Asian longhorned beetle (*Anoplophora glabripennis*) pose the biggest threats to the health of the inventoried population.
- Dunkirk's trees have an estimated structural value of $14.4 million.
- Trees provide approximately $54,176.62 in the following annual benefits:
    - *Air quality*: 4,640 pounds of pollutants removed valued at $31,223.62 per year.
    - *Net total carbon sequestered and avoided*: 61.93 tons valued at $10,562.88 per year.
    - *Stormwater peak flow reductions:* 1.39 million gallons valued at $12,390.13 per year.

Urban Forest Program Needs

Tree Management

Trees provide many environmental and economic benefits that justify the time and money invested in planting and maintenance. Recommended maintenance needs include tree removal, stump removal, tree pruning, young tree training, tree planting, and routine inspections. Maintenance should be prioritized by addressing trees with the highest risk first. The inventory noted Extreme and High Risk trees (<1% and 5% of trees assessed, respectively); these trees should be removed or pruned immediately to promote public safety. Low and Moderate Risk trees should be addressed after all elevated risk tree maintenance has been completed. Trees should be planted to mitigate removals and create canopy.

Dunkirk's urban forest will benefit greatly from a three-year young tree training cycle and a five-year routine pruning cycle. Proactive pruning cycles improve the overall health of the tree population and may eventually reduce program costs. In most cases, pruning cycles will correct defects in trees before they worsen, which will avoid costly problems. Based on inventory data, at least 131 young trees should be structurally pruned each year during the young tree training cycle, and approximately 897 trees should be cleaned each year during the routine pruning cycle.

Funding

Adequate funding will be needed for the city to implement an effective management program that will provide short-term and long-term public benefits, ensure that priority maintenance is performed expediently, and establish proactive maintenance cycles. The estimated total cost for the first year of this five-year program is $357,739. High-priority removal and pruning is costly; since most of this work is scheduled during the first year of the program, the budget is higher for that year. After high-priority work has been completed, the urban forestry program will mostly involve proactive maintenance, which is generally less costly. Budgets for later years are thus projected to be lower. The total will decrease to approximately $220,545 per year by Year 5 of the program. The 5 year program is recommended, but some communities choose a 7 year or 10 year plan. The plans are typically increased in time due to an expansive backlog of deferred tree maintenance coupled with funding constraints.

Community Planting

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

Planting trees is necessary to maintain and increase canopy cover, and to replace trees that have been removed or lost to natural mortality (expected to be 1–3% per year) or other threats (for example, construction, invasive pests, or impacts from weather events such as drought, flooding, ice, snow, storms, and wind). Within the designated inventoried areas, DRG recommends planting at least 75 trees of a variety of species each year (based on a 5 year plan) to offset these losses, increase canopy, maximize benefits, and budgeting.

City-wide tree planting should focus on replacing trees and stumps recommended for removal and establishing new canopy in areas that promote economic growth, such as business districts, recreational areas, trails, parking lots, areas near buildings with insufficient shade, and areas where

there are gaps in the existing canopy. Various tree species should be planted; however, the planting of *Acer platanoides* (Norway maple) and *A. saccharinum* (silver maple) should be limited until the species distribution normalizes. Due to the species distribution and impending threats from emerald ash borer (EAB, *Agrilus planipennis*), all *Fraxinus* species (ash) trees should be removed from the planting list.

Invasive Species

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

Generally, trees do not have significant insect and disease problems if they are healthy and well cared for. However, some degree of insect infestation and disease incidence will always be present, as this is the norm for the natural world. It is only when particularly damaging insects are detected, and the levels of insect populations are extremely high or when particularly virulent diseases are diagnosed that action must be taken. Awareness and early diagnosis are essential to ensuring the health and continuity of street and park trees.

Storm Readiness

Global climate change manifested by increased rainfall and atmospheric instability present a sense of urgency for urban forestry professionals. The main urban forestry concerns for this Dunkirk are severe storms and heavy precipitation events such as summertime microbursts and wintertime heavy snow and ice. Strong winds associated with rapid developing localized weather events due to the proximate Lake Erie plays a significant factor in forecasting tree maintenance workload.

With the recent tree inventory data, the vulnerability of Dunkirk's urban forest from severe weather events can be assessed more accurately. It is well known that certain species of trees are more prone to breaking and splitting in storms (i.e., silver maple and callery pear); trees that are under utility lines and have been poorly pruned in the past are more prone to storm damage; trees in poor condition or with crown, trunk, or root defects can fail in even moderate storms; and trees under stress from insect and disease pressures are also more likely to fail in a storm.

Community Tree Board and Public Outreach

Volunteers and partnerships with community organizations is fundamental for a successful tree management program. One way to garner support and public input is through a tree board. The most recent publication of *Municipal Tree Care and Management in the United States* identified 65% of the 644 municipalities surveyed did have community volunteers involved in their urban forestry program.

A community tree board is a selected group of citizens intended to serve as an advisory board that supports tree management in the municipality. Typically, the City Administrator or his/her designee will delegate or contract responsibility for care and oversight of public trees to a professional forester, arborist, citizen led Tree Advisory Committee, or a combination of these options.

FY 2020 $357,739

- 206 Extreme or High Risk Removals
- 96 Extreme or High Risk Prunes
- 73 Stump Removals
- Routine Pruning Cycle: 1/5 of Public Trees Cleaned
- Young Tree Training Cycle: 131 Trees
- 75 Trees Recommended for Planting and Follow-Up Care
- Newly Found Priority Tree Work (Removal or Pruning): Costs TBD

FY 2021 $310,955

- 50 Moderate Risk Removals
- 280 Moderate Risk Pruning
- Routine Pruning Cycle: 1/5 of Public Trees Cleaned
- Young Tree Training Cycle: 131 Trees
- 75 Trees Recommended for Planting and Follow-Up Care
- Newly Found Priority Tree Work (Removal or Pruning): Costs TBD

FY 2022 $286,205

- 75 Moderate Risk Removals
- 37 Low Risk Removals
- 162 Moderate Risk Pruning
- Rountine Pruning Cycle: 1/5 of Public Trees Cleaned
- Young Tree Training Cycle: 131 Trees
- 75 Trees Recommended for Planting and Follow-Up Care
- Newly Found Priority Tree Work (Removal or Pruning): Costs TBD

FY 2023 $263,501

- 73 Moderate Risk Removals
- 71 Low Risk Removals
- 122 Moderate Risk Pruning
- Routine Pruning Cycle: 1/5 of Public Trees Cleaned
- Young Tree Training Cycle: 131 Trees
- 75 Trees Recommended for Planting and Follow-Up Care
- Newly Found Priority Tree Work (Removal or Pruning): Costs TBD

FY2024 $220,545

- 140 Moderate Risk Removals
- 128 Low Risk Removals
- 75 Moderate Risk Pruning
- Routine Pruning Cycle: 1/5 of Public Trees Cleaned
- Young Tree Training Cycle: 131 Trees
- 75 Trees Recommended for Planting and Follow-Up Care
- Newly Found Priority Tree Work (Removal or Pruning): Costs TBD

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THE DUNKIRK PUBLIC TREE POPULATION

Dunkirk has commissioned an inventory of the public trees in its streets, and parks. The inventory concluded with 9,762 trees, planting sites, and stumps. Data were collected and analyzed, providing information on the species composition, relative size, health, and maintenance recommendations for the urban forest. This report will focus primarily on the inventory completed per the selected city-designated area. The major findings of Dunkirk's tree inventory include the following:

- The inventory of Dunkirk's city streets resulted in 9,762 total sites. Of these, 6,479 (66%) are street trees, 3,210 (33%) are potential planting sites, and 73 (1%) are stumps.
- The genus *Acer* (maple) comprises 42% of the overall street/public space tree population, followed by *Fraxinus* (ash) with 12%; *Picea* (spruce) 6%; *Quercus* (oak) 5%; and *Pinus* (pine) contributing 3%.
- The inventoried street tree population has high percentages of medium-sized trees. Medium-sized trees are 9 to 24 inches DBH and comprise 56% of the street trees. Small trees are 8 inches and less in diameter at breast height (DBH) and represent 21% of the street tree population Finally, 23% of the street trees are large sized, including trees 25 inches and greater DBH.
- There is a total of 3,210 potential planting sites. Of those, 1,753 (20%) are available for small growth habit trees, 809 (25%) for medium growth habit trees, and 648 (20%) for large growth habit trees.
- There are 80 (47%) planting sites identified as having utilities above or immediately adjacent to them. Only small growth habit trees should be planted in these sites.

Public Tree Planting Plan Recommendations

DRG makes the following recommendations for planning and implementing a street tree-planting program in Dunkirk:

- Implement a tree-planting program to fill the vacant planting sites identified by the tree inventory. Remove stumps in a timely fashion and add that vacancy to potential sites in the inventory.
- Focus on increasing tree diversity and putting the "Right Tree in the Right Place." Be selective as to the quality of trees purchased, focus on good morphology.
- Implement a Young Tree Training pruning program for all newly established trees.
- Follow the 10-20-30 rule for planting diversity. No more than 10% same species, 20% of same genera, and 30% for tree family. Develop planting species regimes for neighborhoods.
- Implement an expanded public relations campaign to gain increased citizen interest and city support for the urban forestry program.

Importance of the Urban Forest

The City of Dunkirk is home to more than 11,800 full-time residents who enjoy the beauty and benefits of their urban forest. The Dunkirk's forestry program manages and maintains trees on public property, including trees, stumps, and planting sites in specified parks, public facilities, and along the street rights-of-way (ROW).

Trees are a significant component of Dunkirk's urban environment. The street and public/park space trees are an integral part of the city's infrastructure and should be treated as a community asset. Unlike other infrastructure components, the public tree population, when properly cared for, will increase in value as the trees mature over time.

Trees return overall benefits and value to the community far in excess of the time and money invested in them for planting, pruning, protection, and removal. Their shade and beauty contribute to the community's quality of life and soften the hard appearance of concrete structures and streets, moderating harsh urban conditions. They help stabilize the soil by controlling wind and water erosion. They provide shade and help reduce energy costs in hot climates. Trees also help reduce noise levels, cleanse air of pollutants, produce oxygen, and absorb carbon dioxide. Additionally, they provide economic value, including increased real estate values and improved commerce for local commerce.

The citizens and officials of Dunkirk have recognized these benefits and realized the need to protect this investment with a comprehensive planting plan in order to sustain a healthy and functional urban forest. Such a program begins with an inventory of the public trees and potential planting sites and their present condition. This inventory will provide important information used to identify the needs of Dunkirk's urban forest and help direct the establishment of an effective planting plan.

Approach to Tree Management

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

In August through September 2019, Dunkirk worked with DRG to inventory trees and develop a management plan. This plan considers the diversity, distribution, and general condition of the tree inventory. The following tasks were completed:

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

This plan is divided into 7 sections:

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

- *Section 2: Benefits of the Urban Forest* summarizes the economic, environmental, and social benefits that trees provide to the community. This section presents statistics of an i-Tree Eco benefits analysis conducted for Dunkirk.
- *Section 3: Tree Management Program* utilizes the inventory data to develop a prioritized maintenance schedule and projected budget for the recommended tree maintenance over a five-year period.
- *Section 4: Community Urban Forest Planting Strategies* identifies priority planting areas based on the performed inventory. Also includes review of tree selection and choices.
- *Section 5: Invasive Species Detection and Management* reviews invasive information for New York State found in the performed inventory and Integrated Pest Management Program guidelines. Accompanying appendix includes invasive species control and identification fact sheets.
- *Section 6: Storm Readiness Strategies* provides an overview of storm response and review of inventory for storm-prone species. Storm classification, region-specific storm threats and accompanying appendix are included with this section.
- Section 7: *Community Tree Board and Public Outreach* summary of tree board fundamentals and nuances of public outreach.

SECTION 1: TREE INVENTORY ANALYSIS

In August through September 2019, DRG arborists certified by the International Society of Arboriculture assessed and inventoried trees, stumps, and planting sites along the street ROW, specified parks, and public facilities. A total of 9,479 sites were collected during the inventory: 6,479 trees, 73 stumps, and 3,210 planting sites. Of the 9,479 sites collected, 82% were collected along the street ROW, and the remaining 18% were collected in parks. Figure 1 provides a detailed breakdown of the number and type of sites inventoried.

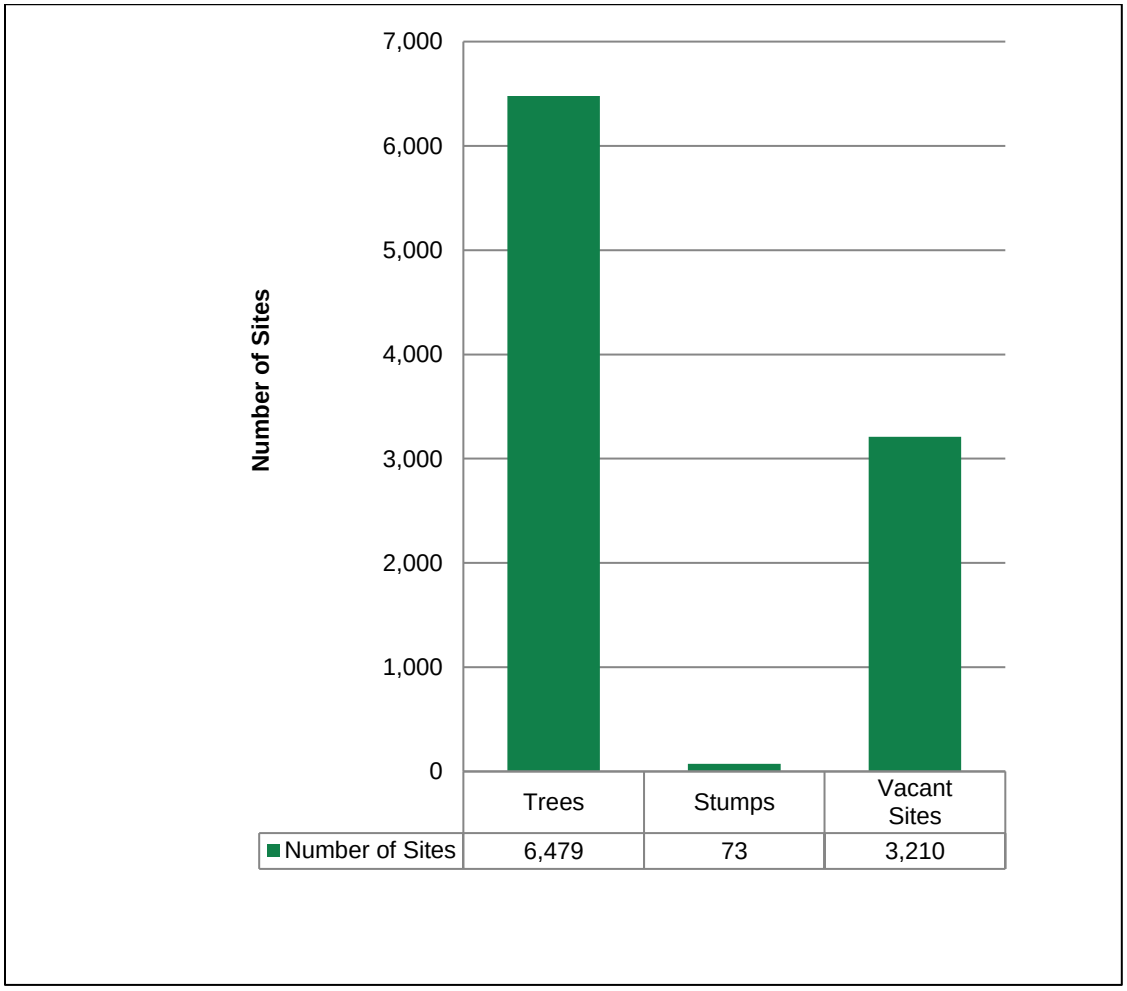


Figure 1. Sites collected during the 2019 inventory.

The city's public street rights-of-way were selected by Dunkirk for the inventory. Seven community parks were selected by Dunkirk for the tree inventory including Fourth Street Park, Kosciuszko Park, Memorial Park, New York Avenue Playground, perimeter trees of Point Gratiot, Washington Park, and Wright Park. A total of 1,701 trees were inventoried within the parks (Table 1).

Table 1. Inventoried Park Trees Within the City of Dunkirk.

Park	Number of Trees Inventoried
Fourth Street Park	13
Kosciuszko Park	1
Memorial Park	110
New York Avenue Playground	11
Point Gratiot	1,030
Washington Park	106
Wright Park	430
Total	1,701

Assessment of Tree Inventory Data

Data analysis and professional judgment are used to make generalizations about the state of the inventoried tree population. Recognizing trends in the data can help guide short-term and long-term management planning. See Appendix A for more information on data collection and site location methods. In this plan, the following criteria and indicators of the inventoried tree population were assessed:

Photograph 1. *Davey's ISA Certified Arborists inventoried trees along street ROW and in community parks to collect information about trees that could be used to assess the state of the urban forest.*

- *Species Diversity*, the variety of species in a specific population, affects the population's ability to withstand threats from invasive pests and diseases. Species diversity also impacts tree maintenance needs and costs, tree planting goals, and canopy continuity.
- *Diameter Size Class Distribution Data*, the statistical distribution of a given tree population's trunk-size class, is used to indicate the relative age of a tree population. The diameter size class distribution affects the valuation of tree-related benefits as well as the projection of maintenance needs and costs, planting goals, and canopy continuity.
- *Condition*, the general health of a tree population, indicates how well trees are performing given their site-specific conditions. General health affects both short-term and long-term maintenance needs and costs as well as canopy continuity.

- *Stocking Level* is the proportion of existing street trees compared to the total number of potential street trees (number of inventoried trees plus the number of potential planting spaces); stocking level can help determine tree planting needs and budgets.
- *Other Observations* include inventory data analysis that provides insight into past maintenance practices and growing conditions; such observations may affect future management decisions.
- *Further Inspection* indicates whether a particular tree requires additional inspection, such as a Level III risk inspection in accordance with *ANSI A300, Part 9* (ANSI 2011), or periodic inspection due to particular conditions that may cause the tree to be a safety risk and, therefore, hazardous.

Species Diversity

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

The composition of a tree population should follow 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%.

Findings

The findings presented in this report represent the select inventory that was performed. It is encouraged to have all the public trees inventoried and managed under the same umbrella of municipal care. Analysis of Dunkirk's tree inventory data indicated that the street and park tree population had relatively good diversity, with 56 genera and 140 species represented.

Figure 2 uses the 10% Rule to compare the percentages of the most common species identified during the inventory to the park and street tree populations. *Acer platanoides* (Norway maple) and *Acer saccharinum* (silver maple) exceed the recommended 10% maximum for a single species in a population, comprising 15% and 14% of the inventoried tree population, respectively. *Fraxinus pennsylvanica* (green ash) and *Acer rubrum* (red maple) are approaching the 10% threshold.

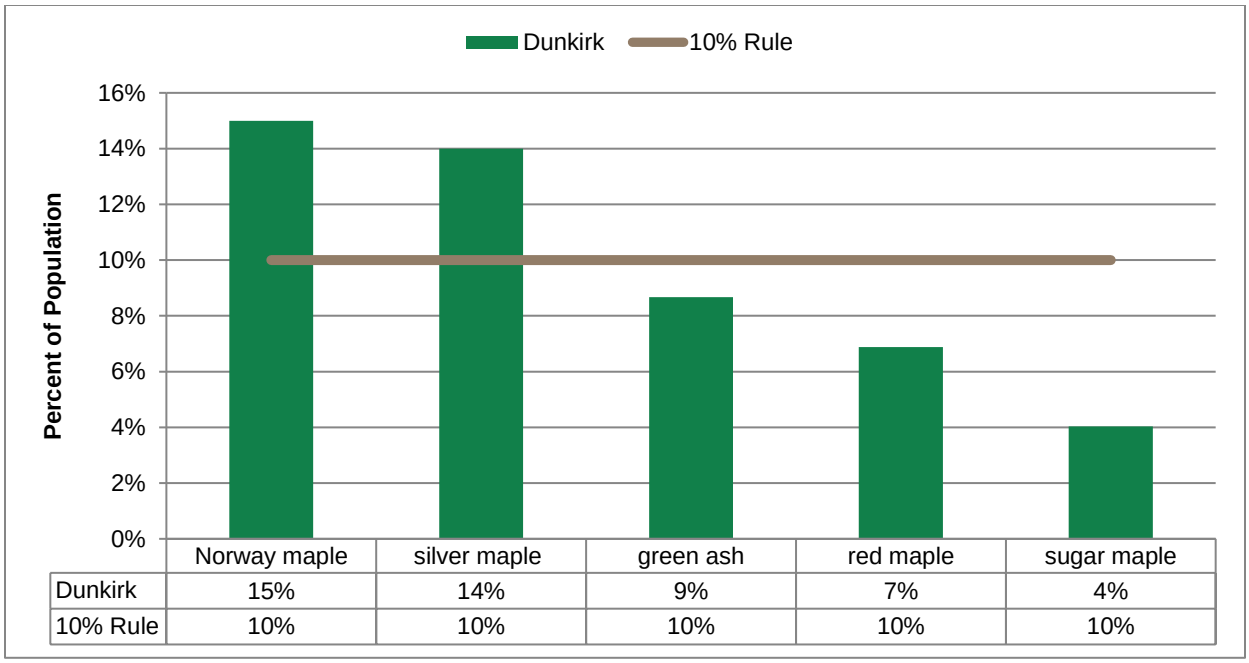


Figure 2. Five most abundant species of the inventoried population compared to the 10% Rule.

Figure 3 uses the 20% Rule to compare the percentages of the most common genera identified during the inventory to the park and street tree populations. *Acer* (maple) far exceed the recommended 20% maximum for a single genus in a population, comprising 42% of the inventoried tree population, respectively. *Fraxinus* (ash), *Picea* (spruce), *Quercus* (oak), and *Pinus* (pine) are approaching the 20% threshold.

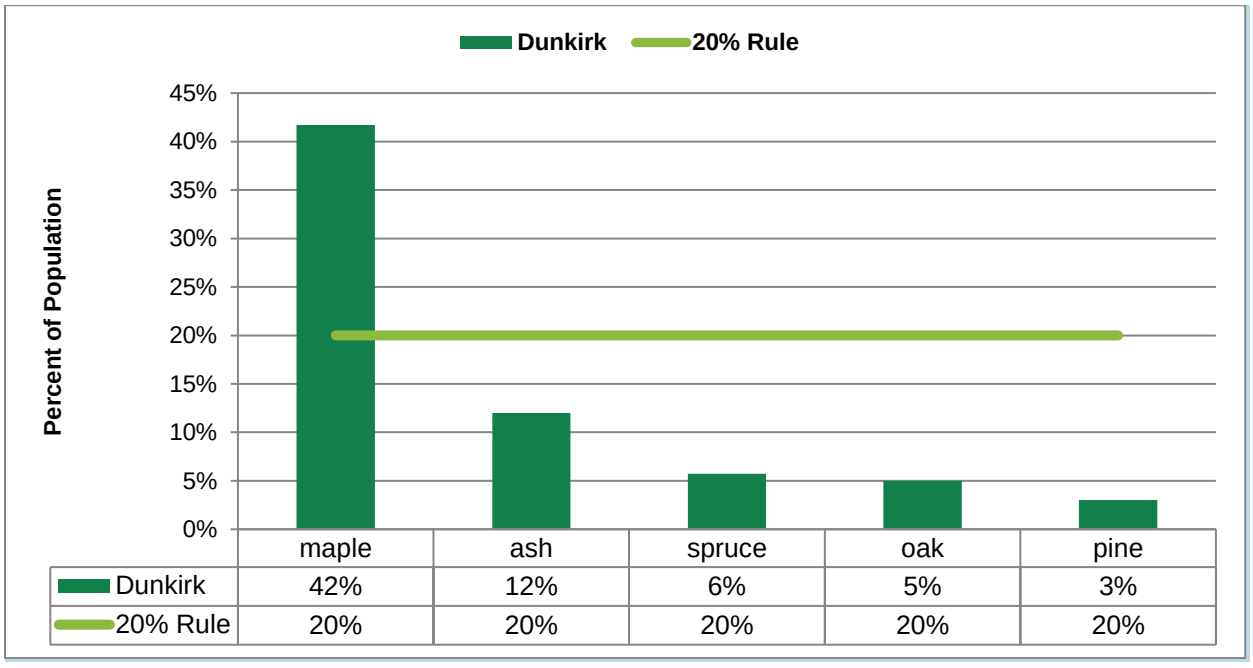


Figure 3. Five most abundant genera of the inventoried population compared to the 20% Rule.

Discussion

Maples dominate the inventory. This is a biodiversity concern because its abundance in the landscape creates a borderline monoculture. Continued diversity of tree species is an important objective that will ensure Dunkirk's urban forest is sustainable and resilient to future invasive pest infestations. Considering the large quantity of maple trees in the city's population, along with its susceptibility to ALB, the planting of maple trees should be limited to minimize the potential for loss in the event that ALB threatens Dunkirk's urban tree population. See Appendix C for a recommended tree species list for planting. Also consider the free online tool i-Tree Species selector at https://species.itreetools.org/.

Diameter Size Class Distribution

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

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

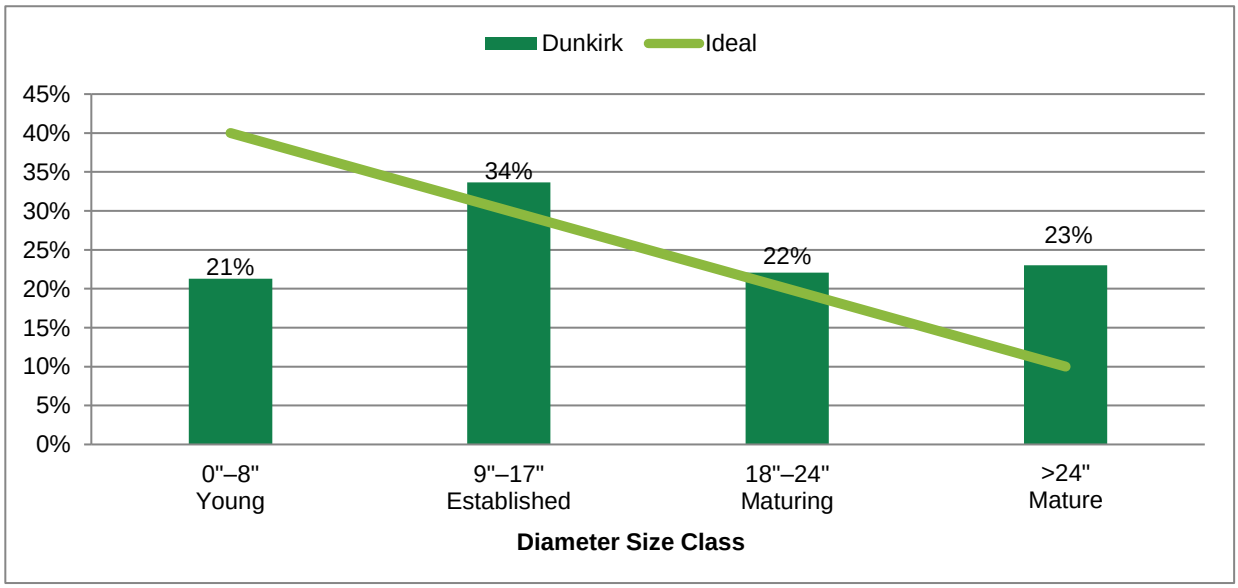


Figure 4. Comparison of diameter size class distribution for inventoried trees to the ideal distribution.

Findings

Figure 4 compares Dunkirk's diameter size class distribution of the inventoried tree population to the ideal proposed by Richards (1983). Dunkirk's trees inventoried in both street and parks do not trend toward the ideal. Young trees fall short of the ideal by nearly 19%, while mature trees exceed the ideal by 13%.

Discussion

Dunkirk has too few young trees, and too many established and mature trees, which indicates a potential concern in the future. It is recommended that Dunkirk support a strong planting and maintenance program to ensure that young, healthy trees are in place to fill in gaps in tree canopy and replace older declining trees. The city must promote tree preservation and proactive tree care to ensure the long-term survival of older trees. See Appendix B for more information on risk assessment and priority maintenance. Additionally, increased tree planting and tree care will allow the distribution to normalize over time. See Appendix C for a recommended tree species list for planting. See Appendix D for planting suggestions and information on species selection.

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.

Condition

DRG assessed the condition of individual trees based on methods defined by the International Society of Arboriculture (ISA). Several factors were considered for each tree, including root characteristics, branch structure, trunk, canopy, foliage condition, and the presence of pests. The condition of each inventoried tree was rated good, Fair, poor, or dead.

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

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

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

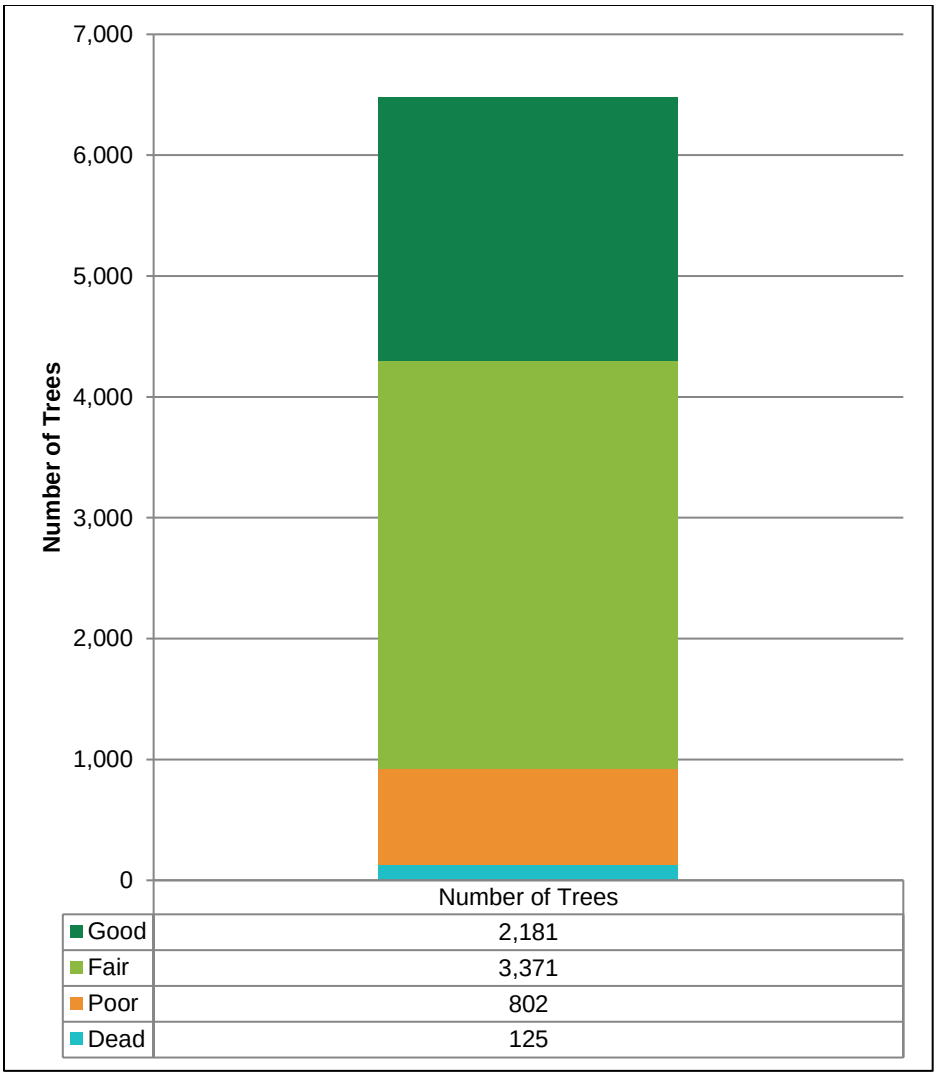


Figure 5. Conditions of inventoried trees.

Findings

Most of the inventoried trees were recorded to be in Fair or good condition, 52% and 34%, respectively (Figure 5). Based on these data, the general health of the overall inventoried tree population is rated Fair. Figure 6 illustrates that most of the established, maturing, and mature trees were rated to be in Fair condition. Only the young trees had a larger cohort of good condition rated trees.

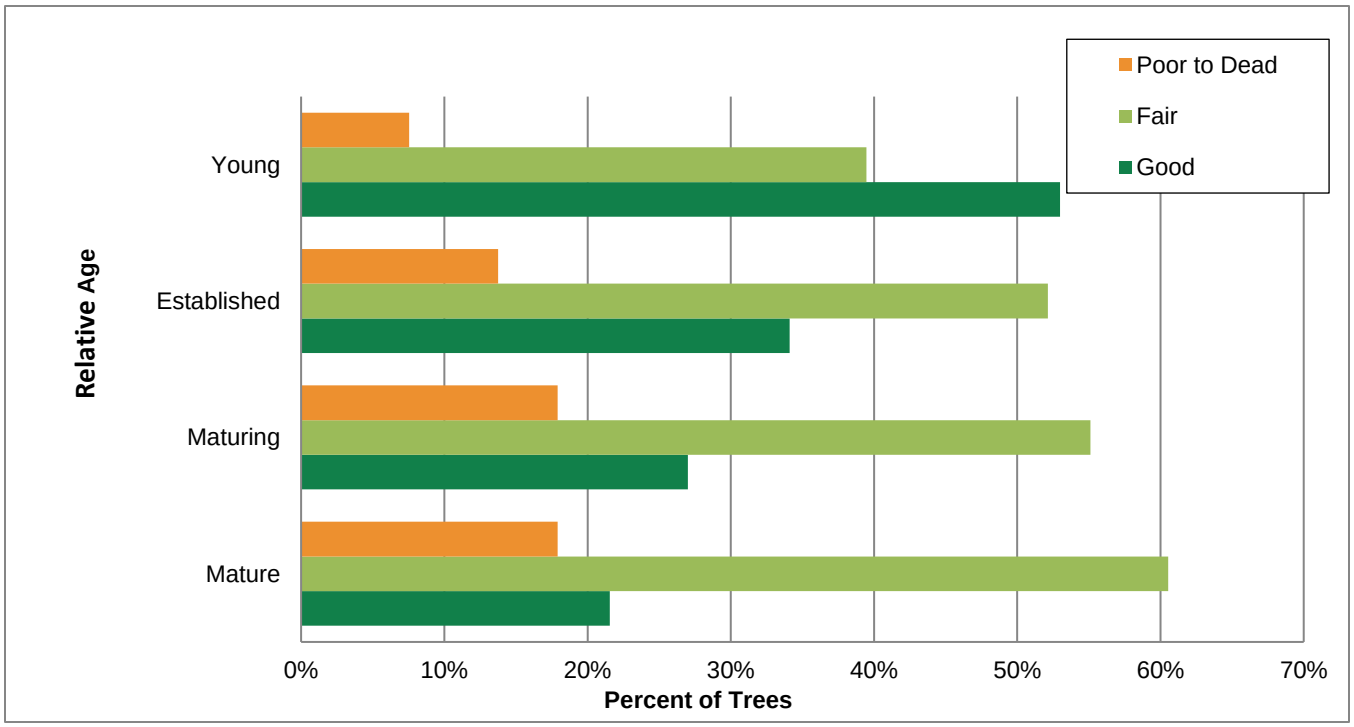


Figure 6. Tree condition by relative age during the 2019 inventory.

Discussion

The condition of Dunkirk's inventoried tree population is rated Fair overall. Data analysis has provided the following insight into maintenance needs and historical maintenance practices:

- The similar trend in condition across street and park trees reveals that growing conditions and/or past management of trees were consistent.
- Dead trees should be removed because of their failed health; these trees will likely not recover, even with increased care. Existing stumps should be removed as soon as possible.
- Younger trees rated in Fair or poor condition may benefit from improvements in structure that may improve their health over time. Pruning should follow *ANSI A300* (Part 1) (ANSI 2008).
- Poor condition ratings among mature trees were generally due to visible signs of decline and stress, including decay, dead limbs, sparse branching, or poor structure. These trees will require corrective pruning, regular inspections, and possible intensive plant health care to improve their vigor. Trees with poor structure and poor condition may require further scrutiny regarding removal.
- Proper tree care practices are needed for the long-term general health of the urban forest. Many of the newly planted trees were improperly mulched or had staking hardware attached to them long after they should have been removed. Following guidelines developed by ISA and those recommended by *ANSI A300* (Part 6) (ANSI 2012) will ensure that tree maintenance practices ultimately improve the health of the urban forest.

Defects

Defects were recorded during the inventory to further describe a tree's health, structure, or location when more detail was required as a qualifier of condition.

Findings

Dead and dying parts, as well as weakly attached branches and codominant stems, were most frequently observed and recorded (41% and 27% of inventoried trees, respectively). Of these 4,397 trees, 573 were recommended for removal, and 236 were rated to be High or Extreme Risk trees.

Table 2. Defects Recorded During the Street and Park Tree Inventory

Defects	Number of Trees	Percent
Dead and dying parts	2,647	41%
Weakly attached branches and codominant stems	1,749	27%
Missing or decayed wood	558	9%
Tree architecture	344	5%
Other	110	2%
Broken and/or hanging branches	108	2%
Cracks	44	1%
Root problems	22	0%
None	895	14%
Total	6,477	100%

Discussion

Unless slated for removal, trees noted as having missing or decayed wood or tree architecture issues should be regularly inspected. Corrective actions should be taken when warranted. If their condition worsens, removal may be required. Of the 559 trees noted for having missing or decayed wood, 154 were recommended for removal. Of the 344 trees noted for tree architecture, only 14 were recommended for removal.

The costs for treating deficient trees must be considered to determine whether removing and replacing the tree is the more viable option.

Infrastructure Conflicts

In an urban setting, space is limited both above and below ground. Trees in this environment may conflict with infrastructure such as overhead utilities. These conflicts were recorded during the inventory. The presence of overhead utility lines above a tree or planting site were noted. Identifying these conflicts are important to consider when planning pruning activities and selecting tree species for planting.

Findings

There were 6,477 trees evaluated for overhead clearance concerns. The majority of the trees inventoried, 69%, did not have an overhead utility conflict (Table 3). When the tree's canopy was 10 feet or less but not in direct contact of a primary, secondary, or phone/cable line, this overhead utilities' clearance notation was recorded.

Table 3. Trees Noted to be Conflicting with Infrastructure

Conflict	Presence	Number of Trees	Percent
Overhead Utilities	Present and Conflicting	869	13%
	Present and Not Conflicting	1,124	17%
	Not Present	4,484	69%
Total		6,477	100%

Of the 869 trees noted as a conflict, there were 8 in dead condition, 117 in poor, 603 in Fair, and 141 rated as good. In terms of utility conflict, prioritize maintenance is based on the potential for risk and condition. Dead trees conflicting with utilities should be considered a removal priority.

Discussion

Chose the right tree for the right place. Planting only small-growing trees within 20 feet of overhead utilities, medium-size trees within 20–40 feet, and large-growing trees outside 40 feet will help improve future tree conditions, minimize future utility line conflicts, and reduce the costs of maintaining trees under utility lines. See Appendix C for Suggested Tree Species and Appendix D Tree Planting.

Further Inspection

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

Findings

DRG recommended 1,139 (18%) trees for further inspection. Of those, 571 trees were recommended for a multi-year annual inspection, 121 trees were recommended for an ANSI Level 3 inspection, and 447 trees were recommended for an insect/disease monitoring interval.

The 808 inventoried ash trees should continue to be monitored for possible symptoms of EAB. If signs of EAB manifest, the tree should be removed, and the site should be inspected for potential replacement. Table 4 below is a list of ash trees and condition noted at the time of inventory.

Table 4. Condition of Ash Trees Noted at Time of Inventory

Ash Species	Dead	Fair	Good	Poor	Total
Fraxinus americana	16	69	23	85	193
Fraxinus nigra	0	15	23	8	46
Fraxinus pennsylvanica	17	205	93	247	562
Fraxinus species	3	1	0	3	7
Grand Total	36	290	139	343	808

Discussion

An ISA Certified Arborist should perform additional inspections of the 1,139 trees, including the above mentioned ash trees. If it is determined that these trees exceed the threshold for acceptable risk, the defective part(s) of the trees should be corrected or removed, or the entire tree may need to be removed.

SECTION 2: BENEFITS OF THE URBAN FOREST

There is a growing understanding and validation of the importance of trees to a community. Scientists and researchers have studied the effects of trees on air quality, stormwater runoff, human behavior, and crime rates. Trees are demonstrably beneficial and positively affect human and public health. The benefits trees provide are commonly divided into three categories—economic, environmental, and social. A total of 6,462 in the inventory trees were used for determining the benefits calculations.

The benefit of utilizing i-Tree Eco is that it provides a better understanding of the structure and function of trees as a resource. It also provides institutions, like Dunkirk, the means to advocate for the necessary funding to manage trees appropriately.

i-Tree Eco Analysis

Both the structural and functional benefits of trees can be assessed when utilizing i-Tree Eco. The functional benefits of trees are associated with their ability to provide pollution reduction and ecosystem services through sequestration. Pollution removed from the city includes carbon (C), ozone (O_3), nitrogen dioxide (NO_2), particulate matter up to the tenth of a micron (PM_{10}), and sulfur dioxide (SO_2). These services are also quantifiable within i-Tree through a process that utilizes tree growth algorithms which are part of a tree benefits model. The city currently receives $54,176.62 annually in ecosystem services from the 6,462 trees in the 2019 tree inventory data set (Figure 7).

Dunkirk's trees benefit the community in the following ways:

- Remove and mitigate air pollutants. The net air quality improvement provided by the sample tree population is valued at approximately $31,23.62 per year with the removal of 4,644 pounds annually, for an average net benefit of $4.83 per tree.
- Provide an annual benefit of roughly $1.08 million ($167.13 per tree) in carbon storage and avoidance through the sequestration of 123,860 pounds of carbon annually.
- Carbon storage in the form of tree biomass of the sample trees amounts to 12,716 pounds each year, which accounts for an estimated annual value of $10,600.
- Oxygen produced by the sample tree population amounts to 330,400 pounds annually.
- Attenuation of 1,387 gallons of stormwater per year, for an average of 0.21 gallon per tree. The total annual value of this benefit is $12,390.13, for an average value of $1.92 per tree.
- At over $14.4 million dollars in replacement cost, the structural value to the sample trees lends insight to the overall value of Dunkirk's urban forest.

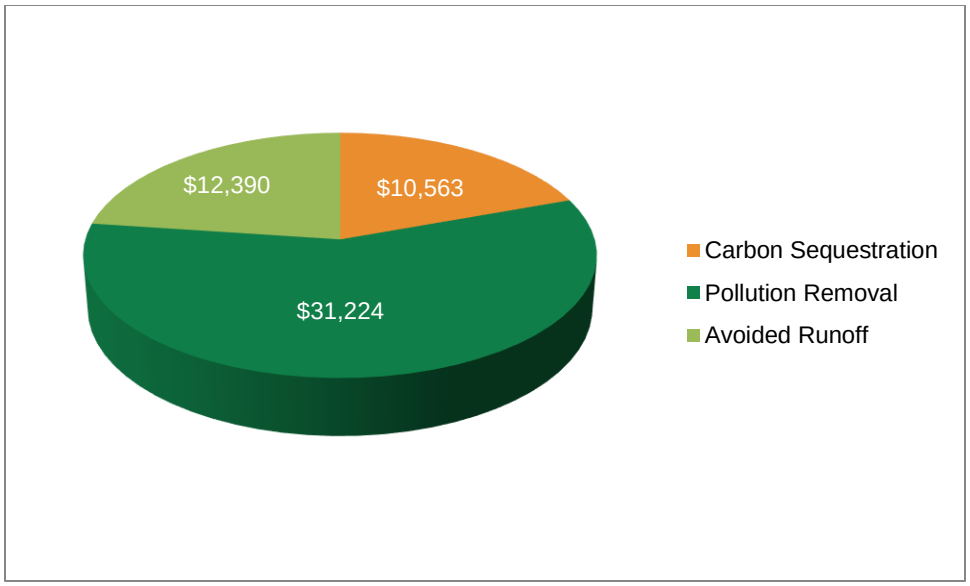
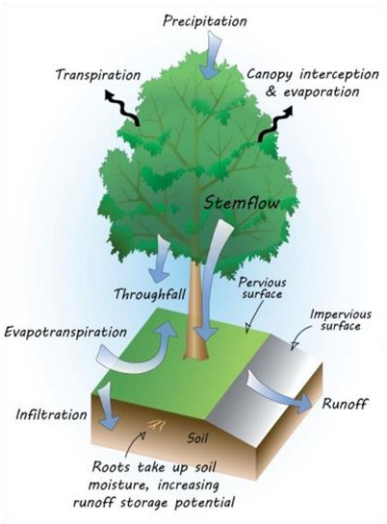


Figure 7. Annual benefits of the sampled trees provided to Dunkirk.

Economic Benefits

i-Tree Eco can be utilized with a complete inventory to simplify the quantification process. When location in the landscape is matched with healthy, high–quality tree species, the benefits can be readily quantified utilizing the Council of Tree and Landscape Appraiser's methodology within the i-Tree Eco tool. The monetary values of trees are based on four characteristics, which are condition, location, species, and trunk area. This information has been complemented with United States Forest Service (USFS) software programs like i-Tree Eco to provide benefit-based assessments of what trees are worth on an economic level (McPherson 2007) and (Nowak et al. 2008).



Reduce Crime

Chicago apartment buildings with high amounts of greenery compared to none saw a 52% reduction in crime (Kuo and Sullivan, 2001a). Areas that have 'medium' amounts of greenery expereince a 42% reduction in crime (Kuo and Sullivan, 2001a).

Reduce Air Pollution

Trees reduce the stress of drivers. They also decrease traffic speeds creating safer streets. Also, psychosocial signs of stress, such as muscle tension and pulse rate decrease within 3 or 4 minutes when a person is surrounded by trees (Wolf 1998a, Kuo and Sullivan, 2001b).

Trees reduce noise levels, clean the air, produce oxygen and absorb carbon dioxide. They also can reduce air pollution by 60% (Cooler, 1996) and reduce rates of asthma in children (Lovasi, 2008).

Reduce Runoff + Erosion

Trees slow down and reduce stormwater runoff. 100 Mature trees can intercept 100,000 gallons of rainfall! Additionally, trees stabilize soil and provide habitat for wildlife (USFS, 2003a).

Improve Health + Wellness

Employees who can see trees experience 23% less sick time and report higher satisfaction with their job (Wolf, 1998a). Recovering hospital patients who had a view of trees required fewer pain relievers, experienced fewer complications, and left sooner than other patients (Ulrich 1984, 1986).

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

Dunkirk's inventoried trees have been quantified utilizing the i-Tree Eco software suite and the assessment provides structural economic benefits.

Trees improve air quality. During photosynthesis, trees remove carbon dioxide (CO_2) from the atmosphere to form carbohydrates that are used in plant structure/function and return oxygen (O_2) back to the atmosphere as a byproduct. Trees, therefore, act as a carbon sink. Urban forests cleanse the air by intercepting and slowing particulate materials and by absorbing pollutant gases on their leaf surfaces. Pollutants partially controlled by trees include nitrogen oxides (NO_x), sulfur dioxide (SO_2), carbon monoxide (CO), CO_2, ozone (O_3), and small particulates less than 10 microns in size (PM_{10}). Coder (1996) found that trees could reduce air pollution by up to 60%. Lovasi et al., (2008) suggested that children who live in communities with an abundance of trees have lower rates of asthma.

Planting trees in strategic areas can augment the function of existing stormwater infrastructure, increasing its capacity, delaying onsets of peak flows, and improving water quality. Because trees act as mini-reservoirs, planting trees can reduce the long-term costs to manage runoff. Leafy tree canopies catch precipitation before it reaches the ground, allowing some water to gently drip and the rest to evaporate. This lessens the initial impact of storms and reduces runoff and erosion. For every 5% of tree cover added to a community, stormwater runoff is reduced by approximately 2% (Coder 1996). Research by the U.S. Department of Agriculture (USDA) Forest Service indicates that 100 mature tree crowns intercept about 100,000 gallons of rainfall per year, reducing runoff and providing cleaner water (USDA Forest Service, 2003(a)). A typical community forest of 10,000 trees will retain approximately 10 million gallons of rainwater per year (USDA Forest Service, 2003(b)).

Social Benefits

Research has shown that trees can lead to reduced crime rates, decreased amounts of human stress, and shorter lengths of hospital stays. Kuo and Sullivan (2001(a)) studied apartment buildings in Chicago and found that buildings with high levels of greenery had 52% fewer crimes than those without any trees, and buildings with medium amounts of greenery had 42% fewer crimes.

Trees create a sense of serenity and add to the overall landscape athletics of a location. Ulrich (1984, 1986) found that hospital patients who were recovering from surgery and 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.

Functional Benefits

The functional benefits of trees are associated with their ability to provide pollution reduction and ecosystem services through sequestration. Pollution removed from the city from the sample trees includes carbon (C), ozone (O_3), nitrogen dioxide (NO_2), particulate matter up to the tenth of a micron (PM_{10}), and sulfur dioxide (SO_2). These services are also quantifiable within i-Tree through a process that utilizes tree growth algorithms which are part of a tree benefits model. The inventoried trees provide numerous functional benefits to the community. These cumulative benefits can be valued at an annual average of approximately $89 per tree for trees surveyed. Trees help reduce local carbon dioxide levels, improve air quality, and mitigate stormwater runoff.

Structural Benefits

The most straightforward way to establish a monetary value for a forest is by establishing a structural value. Generally, this value represents the amount it would cost to replace all of the trees in the urban forest; although in assessing City of Dunkirk's sample tree resource, structural value provides an approximation of the investment in planning, resources, and time that have gone into the establishment and maintenance of the urban forest. The inventory performed has a total structural value of $14,380,468 based on the i-Tree Eco valuation algorithm.

Using i-Tree Eco, Table 5 shows the functional and structural benefits of the top 14 species from the select tree inventory.

Table 5. The Functional and Structural Benefits of the top 14 tree cohorts in the i-Tree Eco Dataset

Species	Trees Number	Carbon Storage		Gross Carbon Sequestration		Avoided Runoff		Pollution Removal		Structural Value
		(ton)	($)	(ton/yr)	($/yr)	(^{3}/yr)	($/yr)	(ton/yr)	($/yr)	($)
Acer saccharinum	909	2,104.89	$358,991.02	13.54	$2,309.82	47,729.77	$3,190.54	0.60	$8,040.28	$3,005,696.48
Acer platanoides 'Crimson King'	650	364.89	$62,232.49	5.22	$890.70	19,681.16	$1,315.60	0.25	$3,315.37	$950,077.84
Fraxinus pennsylvanica	562	247.62	$42,231.66	2.34	$399.33	12,118.10	$810.04	0.15	$2,041.34	$950,937.73
Acer rubrum	446	464.77	$79,267.14	5.35	$911.97	13,849.71	$925.80	0.17	$2,333.04	$1,308,333.29
Acer platanoides 'Crimson King'	346	244.64	$41,723.38	3.06	$521.38	11,696.33	$781.85	0.15	$1,970.30	$653,073.78
Acer saccharum	261	486.77	$83,018.77	3.98	$678.80	8,755.89	$585.29	0.11	$1,474.97	$1,134,713.98
Fraxinus americana	193	213.35	$36,387.60	1.71	$291.75	3,706.30	$247.75	0.05	$624.34	$372,591.84
Picea abies	188	85.03	$14,502.23	1.36	$231.19	6,817.48	$455.72	0.09	$1,148.43	$486,274.97
Pyrus calleryana	182	24.51	$4,180.39	0.68	$115.30	1,154.50	$77.17	0.01	$194.48	$120,972.78
Quercus palustris	172	320.47	$54,656.35	3.63	$618.87	5,846.73	$390.83	0.07	$984.91	$834,103.95
Aesculus hippocastanum	171	294.60	$50,244.15	2.74	$467.92	7,699.58	$514.68	0.10	$1,297.03	$504,378.98
Robinia pseudoacacia	168	84.59	$14,427.60	1.34	$228.88	3,060.78	$204.60	0.04	$515.60	$226,903.03
Gleditsia tricanthos	146	81.83	$13,955.35	1.31	$223.84	1,583.60	$105.86	0.02	$266.76	$282,762.51
Picea pungens	146	26.30	$4,485.16	0.53	$90.87	1,763.73	$117.90	0.02	$297.11	$148,634.21
All Others	1,922	1,313.34	$223,992.09	15.14	$2,582.26	39,890.11	$2,666.50	0.49	$6,719.66	$3,401,013.39
Total	**6,462**	**6,357.60**	**$1,084,295.38**	**61.93**	**$10,562.88**	**185,353.77**	**$12,390.13**	**2.32**	**$31,223.62**	**$14,380,468.76**

Carbon storage and gross carbon sequestration value is calculated based on the price of $133.05 per ton.
Avoided runoff value is calculated by the price $0.067/ft^3. The user-designated weather station reported 35.7 inches of total annual precipitation.
Pollution removal value is calculated based on the prices of $1,468.51 per ton (CO), $43,850.47 per ton ($O_3$), $6,451.28 per ton ($NO_2$), $2,778.17 per ton ($SO_2$), $1,865,723.84 per ton ($PM_{2.5}$).
Structural value is the compensatory value calculated based on the local cost of having to replace a tree with a similar tree.
A value of zero may indicate that ancillary data (pollution, weather, energy, etc.) may not available for this location or that the reported amounts are too small to be shown.

SECTION 3: TREE MANAGEMENT PROGRAM

This tree management program was developed to uphold Dunkirk's comprehensive vision for preserving its urban forest. This five-year program is based on the tree inventory data and designed to reduce risk through prioritized tree removal and pruning. Tree planting to mitigate removals and increase canopy cover and public outreach are important parts of the program as well. This section will review what maintenance concerns were revealed from the tree inventory data.

While implementing a tree care program is an ongoing process, tree work must always be prioritized to reduce public safety risks. DRG recommends completing the work identified during the inventory based on the identified risk rating; however, routinely monitoring the tree population is essential so that Extreme or High Risk trees can be identified and systematically addressed. While regular pruning cycles and tree planting are important, priority work (especially for Extreme or High Risk trees) must take precedence to ensure that risk is expediently managed.

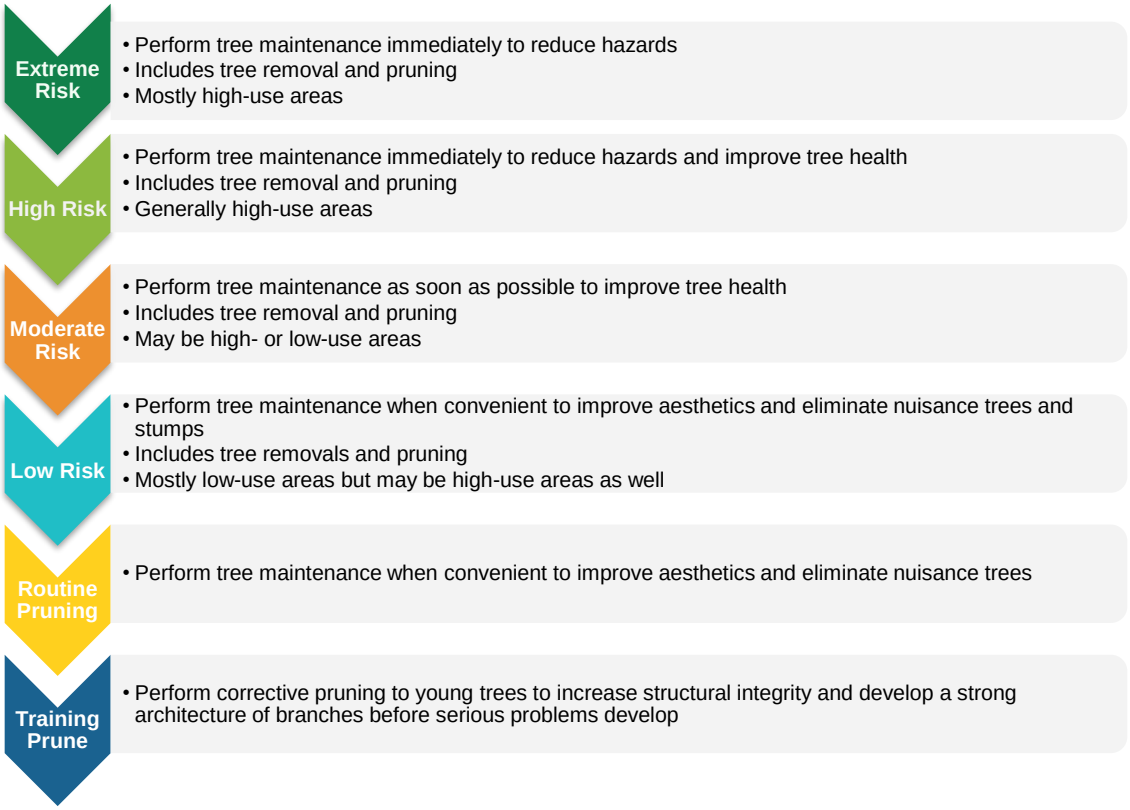
Inspections

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

Trees along the street ROW should be regularly inspected and attended to as needed based on the inspection findings. When trees need additional or new work, they should be added to the maintenance schedule and budgeted as appropriate. Use appropriate computer management software such as TreeKeeper® to update inventory data and work records. In addition to locating potential new hazards, inspections are an opportunity to look for signs and symptoms of pests and diseases. Dunkirk has a population of trees that are susceptible to pests and diseases, such as ash, oak, and maple. For more information, see Section 5 regarding invasive pests and diseases.

Priority and Proactive Maintenance

In this plan, the recommended tree maintenance work was divided into either priority or proactive maintenance. Priority maintenance includes tree/stump removals and pruning of trees with an assessed risk rating of Extreme and High Risk. Proactive tree maintenance includes pruning of trees with an assessed risk of Moderate or low risk and trees that are young. Tree planting, inspections, and community outreach are also considered proactive maintenance.



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, weather conditions, vandalism, root disturbances, and from physical injury due to vehicles. DRG recommends 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. Diseased and nuisance trees also warrant removal.

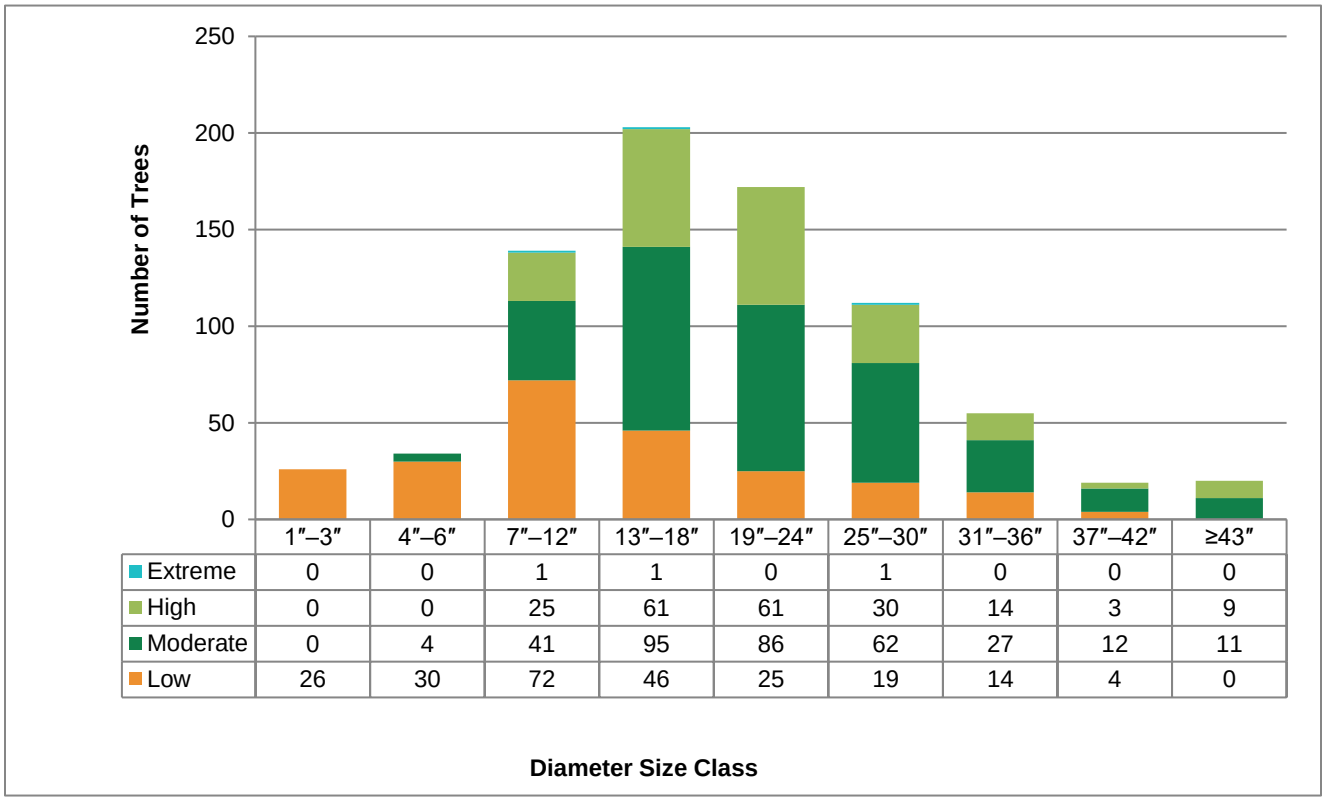
Even though large short-term expenditures may be required, it is important to secure the funding needed to complete priority tree removals. Expedient removal reduces risk and promotes public safety.

Findings

Figure 8 presents tree removals by risk rating and diameter size class.The inventory identified 3 Extreme Risk trees, 203 high risk trees, 338 Moderate Risk trees, and 236 low risk trees that are recommended for removal. The diameter size classes for high risk trees ranged between 13–30 inches diameter at breast height (DBH). These trees should be removed immediately based on their assigned risk. Extreme and High Risk removals and pruning can be performed concurrently.

Most Moderate Risk trees were smaller than 31 inches DBH. These trees should be removed as soon as possible after all Extreme and High Risk removals and pruning have been this removal begins in year 3 of the plan and ends in year 5. Low Risk removals pose little threat; these trees are generally small or poorly formed trees that need to be removed before they create larger concerns in the future. Healthy trees growing in poor locations or undesirable species are also included in this category. All low risk trees should be removed by end of year 5 of this plan after all High and Moderate Risk removals and pruning have been completed.

The inventory identified 73 stumps recommended for removal. Almost all these stumps were larger than 7 inches in diameter. Stump removals should occur when convenient, but typically are cleared within the first year of the program. This not only improves community aesthetics, but also adds an additional planting site to the program.



	1″–3″	4″–6″	7″–12″	13″–18″	19″–24″	25″–30″	31″–36″	37″–42″	≥43″
Extreme	0	0	1	1	0	1	0	0	0
High	0	0	25	61	61	30	14	3	9
Moderate	0	4	41	95	86	62	27	12	11
Low	26	30	72	46	25	19	14	4	0

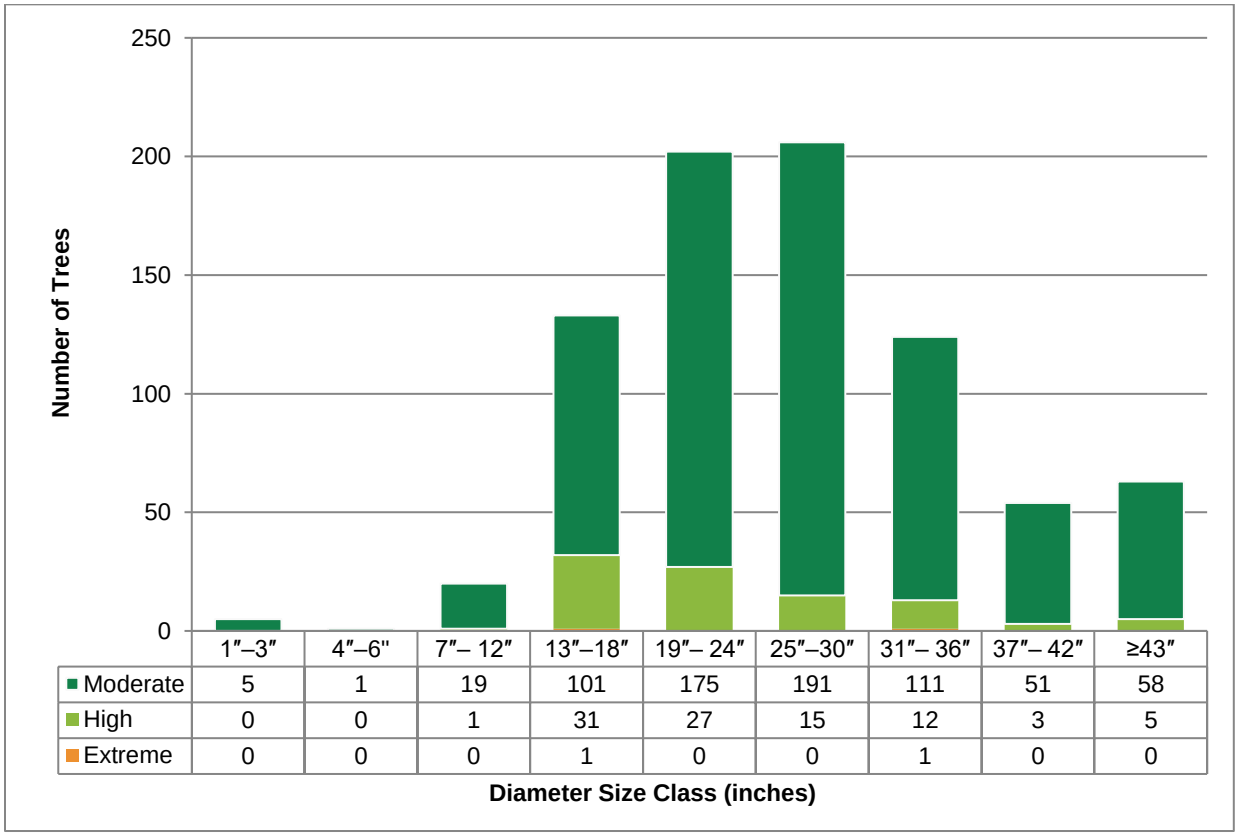
Figure 8. Tree removals by risk rating and diameter size class.

Discussion

Updating the tree inventory data can streamline workload management and lend insight into setting accurate budgets and staffing levels by moving from a reactionary program to a more predicable proactive design. This plan is set for a 5-year rotational program and designed to clear any backlog of maintenance first, prioritized based on risk assessment levels. As workflow is originated, completed, and closed out, inventory updates should be made electronically and can be recorded using TreeKeeper® or similar computer software.

Tree Pruning

Extreme, High, and Moderate Risk pruning generally requires 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. In these cases, pruning the branch or branches can correct the problem and reduce risk associated with the tree. Figure 9 presents the number of Extreme, High, and Moderate Risk trees recommended for pruning by size class.



	1″–3″	4″–6″	7″– 12″	13″–18″	19″– 24″	25″–30″	31″– 36″	37″– 42″	≥43″
Moderate	5	1	19	101	175	191	111	51	58
High	0	0	1	31	27	15	12	3	5
Extreme	0	0	0	1	0	0	1	0	0

Figure 9. Extreme, High and Moderate Risk pruning by diameter size class.

Findings

The inventory identified 2 Extreme Risk trees, 95 high risk trees, and 712 Moderate Risk trees recommended for pruning. High Risk trees ranged in diameter size classes from 1-3 inches DBH to ≥ 43inches DBH.

Discussion

Pruning should be performed concurrently with other Extreme and High Risk removals. Moderate and Low Risk trees recommended for pruning should be included in a proactive, routine pruning cycle after all the higher risk trees are addressed. Figure 10 represents the relationship between years between pruning and tree condition.

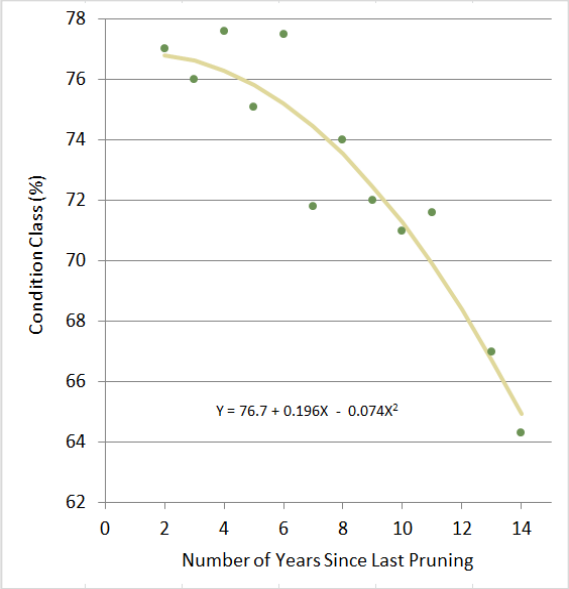


Figure 10. Relationship between average tree condition class and the number of years since the most recent pruning (adapted from Miller

Pruning Cycles

The goals of pruning cycles are to visit, assess, and prune trees on a regular schedule to improve health and reduce risk. DRG recommends that pruning cycles begin after all Extreme and High Risk trees are corrected through removal or high risk priority pruning. However, due to the long-term benefits of pruning cycles, DRG recommends that the cycles be implemented as soon as possible.

To ensure that all trees receive the type of pruning they need to mature with better structure and lower associated risk, two pruning cycles are recommended: the young tree training cycle (YTT Cycle) and the routine pruning cycle (RP Cycle). The cycles differ in the type of pruning, the general age of the target tree, and cycle time.

The recommended number of trees in the pruning cycles will need to be modified to reflect changes in the tree population as trees are planted, age, and leave the inventory. Newly planted trees will enter the YTT Cycle once they become established (2-3 years after planting with proper after planting care). As young trees reach maturity, they will be shifted from the YTT Cycle into the RP Cycle. When a tree reaches the end of its useful life, it should be removed and eliminated from the RP Cycle. The stump should be removed, and the site added to the potential planting site inventory.

Research has shown that a proactive program that includes a routine pruning cycle will improve the overall health of a tree population (Miller and Sylvester 1981). Proactive tree maintenance has many advantages over on-demand maintenance, the most significant of which is reduced risk. In a proactive program, trees are regularly assessed and pruned, which helps detect and eliminate most defects before they escalate to a hazardous situation with an unacceptable level of risk. Other advantages of a proactive program include increased environmental and economic benefits from trees, more predictable budgets and projectable workloads, and reduced long-term tree maintenance costs.

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 five years is optimal for urban trees.

Young Tree Training Cycle

Trees included in the YTT Cycle are generally less than 8 inches DBH. These younger trees sometimes have branch structures that can lead to potential problems as the tree ages. Potential structural problems include codominant leaders, multiple limbs attaching at the same point on the trunk, or crossing/interfering limbs. If these problems are not corrected, they may worsen as the tree grows, increasing risk and creating potential liability.

YTT Pruning is performed to improve tree form or structure; the recommended length of a YTT Cycle is three years because young trees tend to grow at faster rates (on average) than more mature trees. The YTT Cycle differs from the RP Cycle in that these trees generally can be pruned from the ground with a pole pruner or pruning shear. The objective is to increase structural integrity by pruning for one dominant leader.

YTT Pruning is species-specific, since many trees such as *Betula nigra* (river birch) may naturally have more than one leader. For such trees, YTT Pruning is performed to develop a strong structural architecture of branches so that future growth will lead to a healthy, structurally sound tree. Increased scrutiny when selecting a young tree to plant can aid in reducing the amount of YTT.

DRG recommends that Dunkirk implement a three-year YTT Cycle to begin after all Extreme and High Risk trees are removed or pruned. The YTT Cycle will include existing young trees. During the inventory, 355 trees smaller than 7 inches DBH were inventoried and recommended for young tree training. Since the number of existing young trees is relatively small, and the benefit of beginning the YTT Cycle is substantial, DRG recommends that an average of 131 trees be structurally pruned each year over 3 years, beginning in Year One of the management program.

If trees are planted, they will need to enter the YTT Cycle after establishment, typically a few years after planting.

In future years, the number of trees in the YTT Cycle will be based on tree planting efforts and growth rates of young trees. The city should strive to prune approximately one-third of its young trees each year.

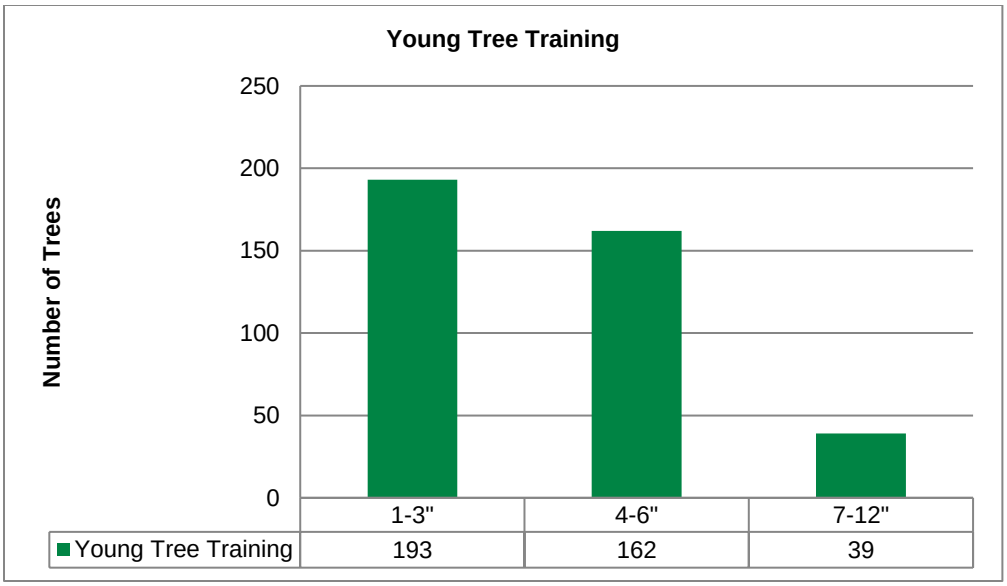


Figure 11. Trees recommended for the YTT Cycle by diameter size class.

Routine Pruning Cycle

The RP Cycle includes established, maturing, and mature trees (greater than 8 inches DBH) that need cleaning, crown raising, and reducing to remove deadwood and improve structure. Over time, routine pruning can reduce reactive maintenance, and provide defensible budgets for this risk management program. Included in this cycle are Moderate and Low Risk trees that require pruning and pose some risk but have a smaller size of defect and/or less potential for target impact. The defects found within these trees can usually be remediated during the RP Cycle.

The length of the RP Cycle is based on the size of the tree population and what was assumed to be a reasonable number of trees for a program to prune per year in this 5-year program. Generally, the RP Cycle recommended for a tree population is five years but may extend to seven years if the population is large.

Figure 12. Trees recommended for the RP Cycle by diameter size class.

DRG recommends that the city establish a five-year RP Cycle in which approximately one-fifth of the tree population is to be pruned each year. The 2019 tree inventory identified approximately 4,496 trees that should be pruned over a five-year RP Cycle. An average of 897 trees should be pruned each year over the course of the cycle. DRG recommends that the RP Cycle begin in Year One of this five-year plan.

The inventory found that most trees (69%) on the street ROW or park needed routine pruning. Figure 12 shows that a variety of tree sizes will require pruning; however, most of the trees that require routine pruning were smaller than 24 inches DBH.

Budget Table

The budget table is an estimate of workload and costs based on the extent of the inventory performed. The overarching theme of the tree management program is to alleviate public risk through the certified arborist's risk assessment which was performed during the field inventory portion of this study. In this fashion, the highest costs are associated in the first few years as the backlog of highest risk is eliminated first, then onto the lower risk categories. Eventually the program moves from reactive to proactive, creating steady, more predictable costs into the routine and young tree training cycles.

Table 6. Estimated Costs for Five-Year Tree Management Program

Estimated Costs for Each Activity			Year 1 - 2020		Year 2 - 2021		Year 3 - 2022		Year 4 - 2023		Year 5 - 2024		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	
Extreme Risk Removals	1-3"	$28	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	4-6"	$58	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	7-12"	$138	1	$138	0	$0	0	$0	0	$0	0	$0	$138
	13-18"	$314	1	$314	0	$0	0	$0	0	$0	0	$0	$314
	19-24"	$605	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	25-30"	$825	1	$825	0	$0	0	$0	0	$0	0	$0	$825
	31-36"	$1,045	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	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)			**3**	**$1,276**	**Tre**	$0	0	$0	0	$0	0	$0	**$1,276**
High Risk Removals	1-3"	$28	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	4-6"	$58	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	7-12"	$138	25	$3,438	0	$0	0	$0	0	$0	0	$0	$3,438
	13-18"	$314	61	$19,124	0	$0	0	$0	0	$0	0	$0	$19,124
	19-24"	$605	61	$36,905	0	$0	0	$0	0	$0	0	$0	$36,905
	25-30"	$825	30	$24,750	0	$0	0	$0	0	$0	0	$0	$24,750
	31-36"	$1,045	14	$14,630	0	$0	0	$0	0	$0	0	$0	$14,630
	37-42"	$1,485	3	$4,455	0	$0	0	$0	0	$0	0	$0	$4,455
	43"+	$2,035	9	$18,315	0	$0	0	$0	0	$0	0	$0	$18,315
Activity Total(s)			**203**	**$121,616**	0	$0	0	$0	0	$0	0	$0	**$121,616**
Moderate Risk Removals	1-3"	$28	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	4-6"	$58	0	$0	0	$0	0	$0	0	$0	4	$230	$230
	7-12"	$138	0	$0	0	$0	0	$0	0	$0	41	$5,638	$5,638
	13-18"	$314	0	$0	0	$0	0	$0	0	$0	95	$29,783	$29,783
	19-24"	$605	0	$0	0	$0	43	$26,015	43	$26,015	0	$0	$52,030
	25-30"	$825	0	$0	0	$0	32	$26,400	30	$24,750	0	$0	$51,150
	31-36"	$1,045	0	$0	27	$28,215	0	$0	0	$0	0	$0	$28,215
	37-42"	$1,485	0	$0	12	$17,820	0	$0	0	$0	0	$0	$17,820
	43"+	$2,035	0	$0	11	$22,385	0	$0	0	$0	0	$0	$22,385
Activity Total(s)			0	$0	**50**	**$68,420**	**75**	**$52,415**	**73**	**$50,765**	**140**	**$35,650**	**$207,250**
Low Risk Removals	1-3"	$28	0	$0	0	$0	0	$0	0	$0	26	$715	$715
	4-6"	$58	0	$0	0	$0	0	$0	0	$0	30	$1,725	$1,725
	7-12"	$138	0	$0	0	$0	0	$0	0	$0	72	$9,900	$9,900
	13-18"	$314	0	$0	0	$0	0	$0	46	$14,421	0	$0	$14,421
	19-24"	$605	0	$0	0	$0	0	$0	25	$15,125	0	$0	$15,125
	25-30"	$825	0	$0	0	$0	19	$15,675	0	$0	0	$0	$15,675
	31-36"	$1,045	0	$0	0	$0	14	$14,630	0	$0	0	$0	$14,630
	37-42"	$1,485	0	$0	0	$0	4	$5,940	0	$0	0	$0	$5,940
	43"+	$2,035	0	$0	0	$0	0	$0	0	$0	0	$0	$0
Activity Total(s)			0	$0	0	$0	**37**	**$36,245**	**71**	**$29,546**	**128**	**$12,340**	**$78,131**
Stump Removals	1-3"	$18	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	4-6"	$28	11	$303	0	$0	0	$0	0	$0	0	$0	$303
	7-12"	$44	20	$880	0	$0	0	$0	0	$0	0	$0	$880
	13-18"	$72	15	$1,073	0	$0	0	$0	0	$0	0	$0	$1,073
	19-24"	$94	12	$1,122	0	$0	0	$0	0	$0	0	$0	$1,122
	25-30"	$110	10	$1,100	0	$0	0	$0	0	$0	0	$0	$1,100
	31-36"	$138	2	$275	0	$0	0	$0	0	$0	0	$0	$275
	37-42"	$160	2	$319	0	$0	0	$0	0	$0	0	$0	$319
	43"+	$182	1	$182	0	$0	0	$0	0	$0	0	$0	$182
Activity Total(s)			**73**	**$5,253**	0	$0	0	$0	0	$0	0	$0	**$5,253**
Extreme 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	1	$120	0	$0	0	$0	0	$0	0	$0	$120
	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	1	$305	0	$0	0	$0	0	$0	0	$0	$305
	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)			**2**	**$425**	0	$0	0	$0	0	$0	0	$0	**$425**
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	1	$75	0	$0	0	$0	0	$0	0	$0	$75
	13-18"	$120	31	$3,720	0	$0	0	$0	0	$0	0	$0	$3,720
	19-24"	$170	27	$4,590	0	$0	0	$0	0	$0	0	$0	$4,590
	25-30"	$225	15	$3,375	0	$0	0	$0	0	$0	0	$0	$3,375
	31-36"	$305	12	$3,660	0	$0	0	$0	0	$0	0	$0	$3,660
	37-42"	$380	3	$1,140	0	$0	0	$0	0	$0	0	$0	$1,140
	43"+	$590	5	$2,950	0	$0	0	$0	0	$0	0	$0	$2,950
Activity Total(s)			**94**	**$19,510**	0	$0	0	$0	0	$0	0	$0	**$19,510**

Estimated Costs for Each Activity			Year 1 - 2020		Year 2 - 2021		Year 3 - 2022		Year 4 - 2023		Year 5 - 2024		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	
Moderate Risk Pruning	1-3"	$20	0	$0	0	$0	0	$0	0	$0	5	$100	$100
	4-6"	$30	0	$0	0	$0	0	$0	0	$0	1	$30	$30
	7-12"	$75	0	$0	0	$0	0	$0	0	$0	19	$1,425	$1,425
	13-18"	$120	0	$0	0	$0	0	$0	51	$6,120	50	$6,000	$12,120
	19-24"	$170	0	$0	72	$12,240	71	$12,070	71	$12,070	0	$0	$36,380
	25-30"	$225	0	$0	100	$22,500	91	$20,475	0	$0	0	$0	$42,975
	31-36"	$305	56	$17,080	55	$16,775	0	$0	0	$0	0	$0	$33,855
	37-42"	$380	26	$9,880	25	$9,500	0	$0	0	$0	0	$0	$19,380
	43"+	$590	30	$17,700	28	$16,520	0	$0	0	$0	0	$0	$34,220
Activity Total(s)			**112**	**$44,660**	**280**	**$77,535**	**162**	**$32,545**	**122**	**$18,190**	**75**	**$7,555**	**$180,485**
Routine Pruning (5-year cycle)	1-3"	$20	47	$936	47	$936	47	$936	47	$936	47	$936	$4,680
	4-6"	$30	65	$1,944	65	$1,944	65	$1,944	65	$1,944	65	$1,944	$9,720
	7-12"	$75	219	$16,410	219	$16,410	219	$16,410	219	$16,410	219	$16,410	$82,050
	13-18"	$120	243	$29,208	243	$29,208	243	$29,208	243	$29,208	243	$29,208	$146,040
	19-24"	$170	157	$26,656	157	$26,656	157	$26,656	157	$26,656	157	$26,656	$133,280
	25-30"	$225	85	$19,125	85	$19,125	85	$19,125	85	$19,125	85	$19,125	$95,625
	31-36"	$305	44	$13,359	44	$13,359	44	$13,359	44	$13,359	44	$13,359	$66,795
	37-42"	$380	22	$8,512	22	$8,512	22	$8,512	22	$8,512	22	$8,512	$42,560
	43"+	$590	15	$8,968	15	$8,968	15	$8,968	15	$8,968	15	$8,968	$44,840
Activity Total(s)			**897**	**$125,118**	**897**	**$125,118**	**897**	**$125,118**	**897**	**$125,118**	**897**	**$125,118**	**$625,590**
Young Tree Training Pruning (3-year cycle)	1-3"	$20	64	$1,287	64	$1,287	64	$1,287	64	$1,287	64	$1,287	$6,433
	4-8"	$30	54	$1,620	54	$1,620	54	$1,620	54	$1,620	54	$1,620	$8,100
	7-12"	$75	13	$975	13	$975	13	$975	13	$975	13	$975	$4,875
Activity Total(s)			**131**	**$3,882**	**131**	**$3,882**	**131**	**$3,882**	**131**	**$3,882**	**131**	**$3,882**	**$19,408**
Replacement Tree Planting and Maintenance	Purchasing	$170	75	$12,750	75	$12,750	75	$12,750	75	$12,750	75	$12,750	$63,750
	Planting	$110	75	$8,250	75	$8,250	75	$8,250	75	$8,250	75	$8,250	$41,250
	Mulching	$100	75	$7,500	75	$7,500	75	$7,500	75	$7,500	75	$7,500	$37,500
	Watering	$100	75	$7,500	75	$7,500	75	$7,500	75	$7,500	75	$7,500	$37,500
Activity Total(s)			**300**	**$36,000**	**300**	**$36,000**	**300**	**$36,000**	**300**	**$36,000**	**300**	**$36,000**	**$180,000**
Activity Grand Total			**1,815**		**1,658**		**1,602**		**1,594**		**1,671**		
Cost Grand Total				**$357,739**		**$310,955**		**$286,205**		**$263,501**		**$220,545**	**$1,438,944**

SECTION 4: COMMUNITY URBAN FOREST PLANTING STRATEGIES

Planting trees is a valuable goal as long as tree species are carefully selected and correctly planted. When planting trees, choose higher quality specimens and plant with purpose. Without proactive planning and follow-up tree care, a new tree may become a future problem instead of a benefit to the community. Watering and proper soil amendments are necessary after planting requirements. This section provides a description of planting sites recorded during the Dunkirk tree inventory. See Appendix A for definitions and methodology of data collection, Appendix C is a list of suggested tree species, and Appendix D is a tree planting guide. Appendix C also provides a list of herbaceous layer restoration plantings for parks and waterfronts. The suggested species have been categorized by mature height classes (small, medium, and large) that match the potential planting site size designations.

A "tree" is defined as a perennial woody plant that may grow more than 20 feet tall. Characteristically, it has one main stem, although many species may grow as multi-stemmed. A "street tree" is further defined as a tree growing within the public ROW that was planted by the city or its residents. A "park/public space tree" is defined as a tree growing in an area designated as a park/public space or growing on city owned property such as municipal building lots or other facilities. At times, when the ROW data and park/public space boundaries seemed incorrect or offset, experience reading obvious and subtle ROW and property boundary indicators was relied upon.

During the tree inventory field work, potential planting sites are located by street and address in addition to the trees in place. Planting sites are defined as areas suitable for tree planting within the existing ROW. The size of each site is designated as small (4–8 feet), medium (8–12 feet), or large (12 feet and greater), depending primarily on the growing space available and the presence of overhead wires. Small sites are spaced 20 feet on center, medium sites are 30 feet on center, and large sites are 40 feet on center. Sites are also restricted by certain external influences. Criteria for these planting restrictions are no planting of a tree within 35 feet of any intersection, within 15 feet of any fire hydrant, within 10 feet of any driveway, sign, water box, telephone pole, storm drain, or manhole. The overall landscape and any existing planting scheme are also taken into account for the spacing and sizes of recommended planting sites.

The shortest dimension (width in feet) of each growing space type is recorded. The growing space size can be a limiting factor of the growth and natural habit of trees, and dictates which species are suitable for any given site. The presence of all overhead utility lines is noted in the inventory. These include, but are not limited to, power, telephone, and cable lines. Where any types of overhead utility wires exist, planting sites are recorded as small, regardless of the available growing space.

The size of the site refers to the mature size of a tree suitable to be planted in that particular site. Selecting trees from this list will help to ensure that appropriately sized trees are planted in a site suitable to sustain the tree's natural habit. The suggested species list also contains a select number of species not recommended for planting along streets, but appropriate for planting in parks and public spaces.

Findings

Street Right-Of-Way Stocking Level

Stocking is a traditional forestry term used to measure the density and distribution of trees. For an urban/community forest, stocking level is used to estimate the total number of sites along the street ROW that could contain trees. Park trees and similar public property trees are typically excluded from this measurement as this is ROW only. For forested stand management, refer to *The Woodlot Management Handbook* by Stewart Hilts and Peter Mitchell (2009).

Stocking level is the ratio of street ROW spaces occupied by trees to the total street ROW spaces suitable for trees. For example, a street ROW tree inventory of 1,000 total sites with 750 existing trees and 250 planting sites would have a stocking level of 75%.

For an urban area, the apex of planting would be a street ROW stocking level of at least 90% so that no more than 10% of the potential planting sites along the street ROW are vacant. Street ROW stocking levels may be estimated using information about the community, tree inventory data, and common street tree planting practices. Inventory data that contain the number of existing trees and planting sites along the street ROW will increase the accuracy of the projection. Street ROW stocking levels can be estimated using only the number of trees present and the number of street miles in the community. When the estimated stocking level is determined using theoretical assumptions, the actual number of planting sites may be significantly less than estimated due to unknown growing space constraints, including inadequate growing space size, proximity of private trees, and utility conflicts.

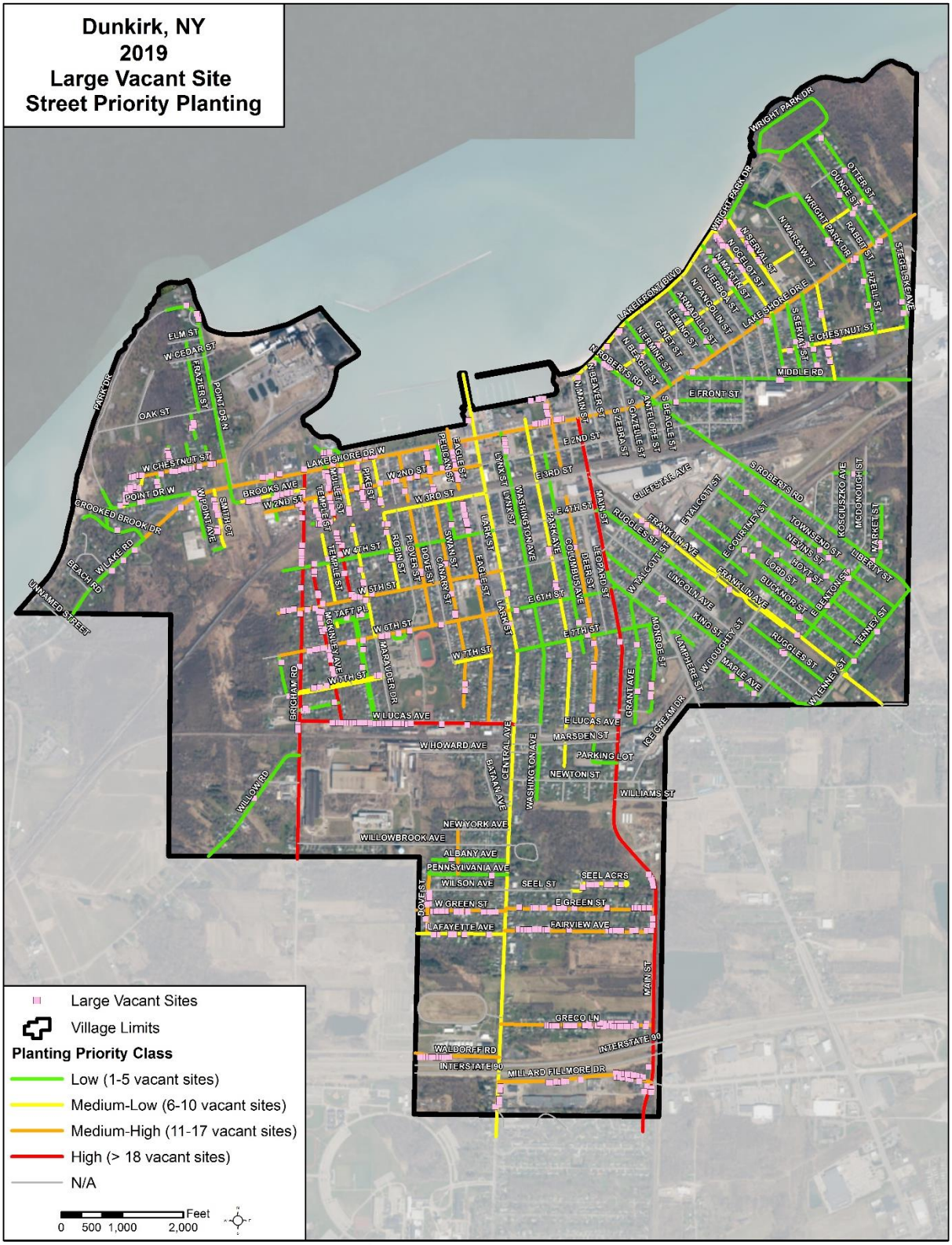
For this analysis, the inventory field collection did include planting sites, but only in the selected areas. This will only determine the stocking level for the ROW sites. Stocking levels for parks will vary with the theme of the greenspace design (woodlot management / park design). For tree density in city parks, the overseeing department would turn to public interest and overall comprehensive park plans.

The tree inventory found a total of 3,210 vacant planting sites distributed within the selected areas of the inventory (Table 7). Of the inventoried sites, 648 were potential planting sites for large-size trees (8-foot-wide and greater growing space size); 809 were potential sites for medium-size trees (6- to 7-foot-wide growing space sizes); 1,753 were potential sites for small-size trees (4- to 5-foot-wide growing space sizes); and 73 sites were occupied by stumps. Of the 73 stumps, 45 were in large sites, 23 in medium sites, and 7 in small planting sites. Overall, the small plantings sites made up approximately 54.6% of all inventoried sites.

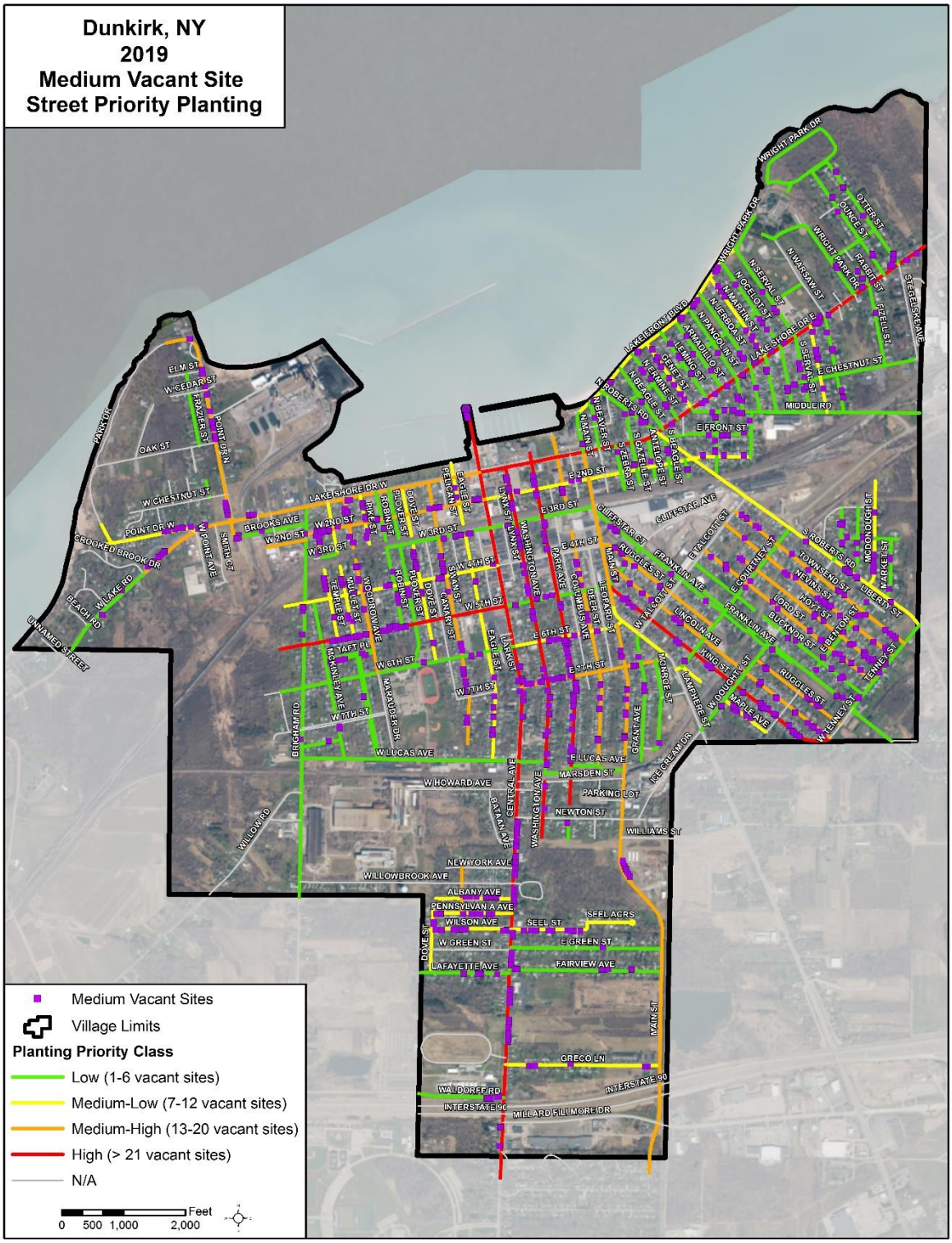
Table 7. Vacant Planting Sites

Planting Site Size	Total	Percent
Large (8 ft +)	648	20.2%
Medium (6-7 ft.)	809	25.2%
Small (4-5 ft.)	1,753	54.6%
Total	3,210	100%

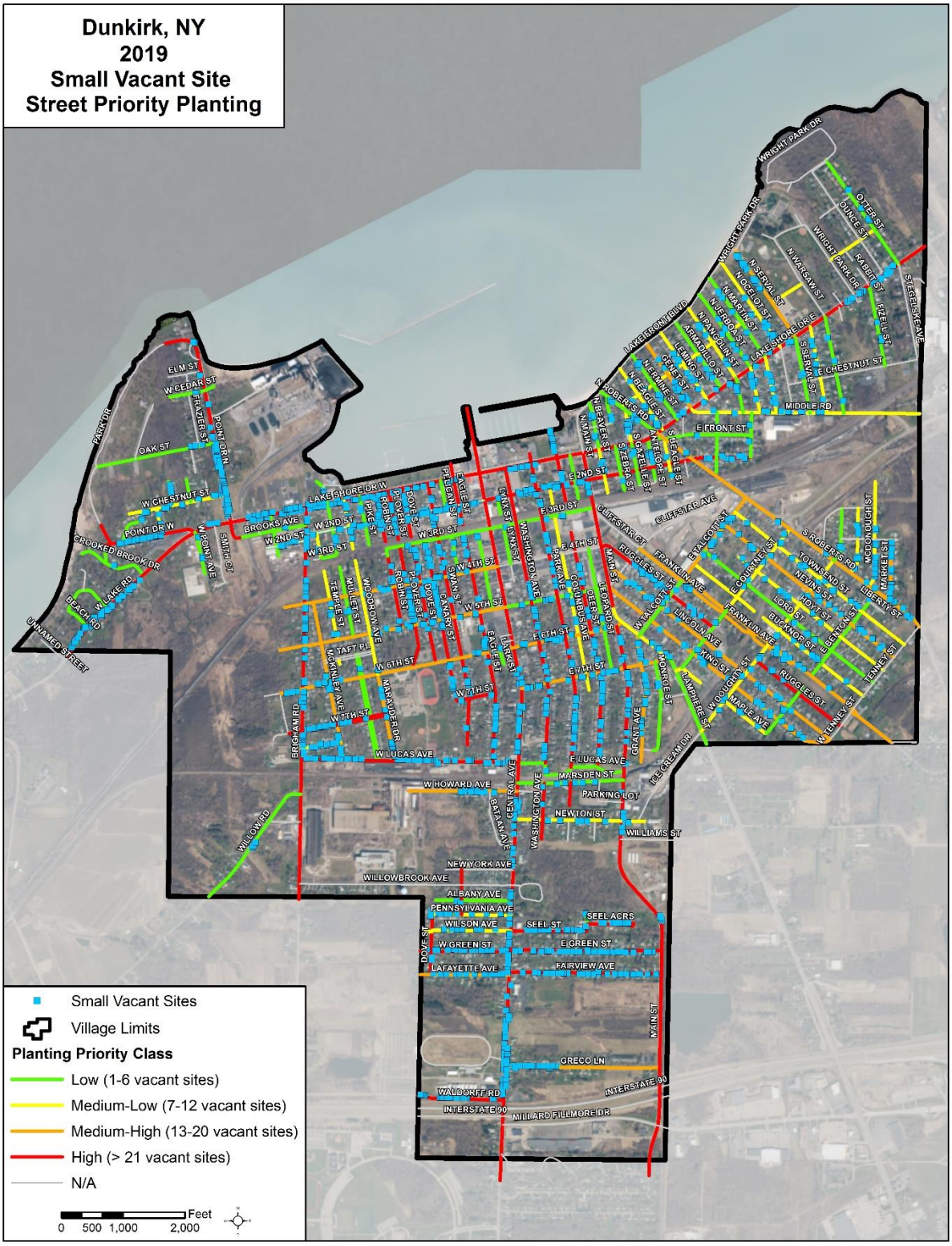
Maps 1, 2, and 3 convey the priority planting zones per the ROW for each site size. Priority is based upon the amount of planting sites recorded during the inventory field collection process. ROWs which are highlighted are the areas where data collection occurred per the scope of work of the inventory, roads not identified were not part of the requested inventory locations.



Map 1. Dunkirk Vacant Large Planting Sites by Priority for Selected Inventory.



Map 2. Dunkirk Medium Vacant Planting Sites by Priority for Selected Inventory.



Map 3. Dunkirk Vacant Small Planting Sites by Priority for Selected Inventory.

Discussion

Fully stocking the street ROW with trees is an excellent goal. The priority for Dunkirk should be to fill the currently vacant planting sites with trees that are appropriate for the site size and avoiding utility conflicts. The city should consider improving its street ROW population's stocking level of 65% and work toward achieving the ideal of 90% or better. Generally, this entails a planned program of planting, care, and maintenance for the city's street trees. Inadequate tree planting and maintenance budgets, along with tree mortality, will result in lower stocking levels. Working to attain a fully stocked street ROW is important to promote canopy continuity and environmental sustainability. Also consider calculations of trees per capita as another important way to determine the density of a city's urban forest. The more residents and greater housing density a city possess, the greater the need for trees to provide benefits.

Keep in mind larger trees provide the greatest return to the public benefits. If a site can handle a larger tree, select a larger species. See Appendices C and D for species recommendations and tree planting guidance. A study by Geiger (2003) found that cities that were using small trees to reduce initial planting costs found a short-term savings, but over the long term found themselves with fewer benefits as the trees aged. While large vacant planting sites currently only make up 20% of the total number of vacant sites, Dunkirk should take advantage of the available planting sites when possible (additionally, 45 existing stumps were large sites).

Planting sites containing stumps can be thought of as an additional 73 possible planting sites if these stumps were ground. Sites with stumps of the smallest DBH would be of priority for planting, as these sites would be least costly to prepare. However, be mindful of the original failure. Evaluate the site to determine probable cause of tree mortality. External negative site factors can include lack of watering, poor soil, utility conflicts (pruning), and vandalism.

While Dunkirk can expand tree canopy on city rights-of-way and publicly owned lands, fully realizing potential tree canopy coverage (on public and private land) will require the cooperation of business owners and private residents. Generally, this may be accomplished through a variety of strategies designed specifically for Dunkirk. Such strategies may include education, outreach, workshops, volunteer opportunities, new policies, and cost-share programs.

Planting beyond the right-of-way is being implemented in parts of New York (Wegener 2014). According to the New York State Attorney General, "an incidental benefit to a private individual or entity does not invalidate an expenditure of public funds if a public purpose is primarily served by that expenditure (Murphy v. Erie Co., 28 N.Y.2d 80, 88 (1971)." This effectively states that public funds can be used to plant trees beyond the right-of-way as there is a public benefit from the growth of the trees.

Improving Growing Space

Capital improvement projects present great opportunities to transition city ROW's into larger planting sites. Creating larger growing sites for trees in the municipal ROW can be the single most beneficial management practice to improve the survival rate of planted and developing trees. Increasing planting space can also reduce the amount of tree-related infrastructure conflicts, as the trees will be planted further from curbs and sidewalks. However, species selection for these areas is very important as the presence of utility lines can mean clearance issues in the future. Depending

on the site, there are several methods available to increase the growing space for newly planted trees.

- Planting trees 4 feet behind a curb with no sidewalk, or 4 feet behind an existing sidewalk, can be a low-cost alternative to more construction intensive methods. Using this method will result in less damage to the sidewalk and give the trees roots room to grow into the open soil.
- Re-routing the sidewalk around an area to create designated large tree-growing spaces is a relatively cost-effective method to increase growing spaces. This method can also be applied to existing tree locations, where a tree's roots have already come in conflict with the sidewalk.
- A landscape bump-out, or curb extension, is a vegetative area that protrudes into the parking lane of a street, to provide a growing space for plants or trees. These spaces can be used quite effectively by municipalities to beautify a streetscape, provide greater storm water retention, along with the added benefit of slowing car speeds at the bump-out location.
- Suspended pavement over noncompacted soil, or the implementation of structural cells, can greatly reduce the conflict between tree roots and infrastructure, as well as provide an ideal urban growing environment for the tree. The development of these type of planting sites can be costly and are typically taken on during larger capital improvement projects, due to their construction intensive nature.

Tree Species Selection

Selecting a limited number of species could simplify decision-making processes; however, careful deliberation and selection of a wide variety of species is more beneficial and can save money. Planting a variety of species can decrease the impact of species-specific pests and diseases by limiting the number of susceptible trees in a population. This reduces time and money spent to mitigate pest- or disease-related problems. A wide variety of tree species can help limit the impacts from physical events, as different tree species react differently to stress. Species diversity helps withstand drought, ice, flooding, strong storms, and wind.

Dunkirk is located in USDA Hardiness Zone 6b, which is identified as a climatic region with average annual minimum temperatures between -5°F and 0°F. Tree species selected for planting in Dunkirk should be appropriate for this zone.

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

The Right Tree in the Right Place is a mantra for tree planting used by the Arbor Day Foundation and many utility companies nationwide. Trees come in many different shapes and sizes, and often change dramatically over their lifetimes. Some grow tall, some grow wide, and some have extensive root systems. Before selecting a tree for planting, make sure it is the right tree—know how tall, wide, and deep it will be at maturity. Equally important to selecting the right tree is

choosing the right spot to plant it. Blocking an unsightly view or creating some shade may be a priority, but it is important to consider how a tree may impact existing utility lines and hardscape as it grows taller, wider, and deeper. If the tree at maturity, will reach overhead lines, or conflict with sidewalks and curbs, it is best to choose another tree or a different location. Taking the time to consider location before planting can prevent power disturbances and improper utility pruning practices.

Too much of a single tree species can lead to significant canopy losses. Low species diversity (large number of trees of the same species) can lead to severe losses in the event of species-specific epidemics, such as the devastating results of emerald ash borer (*Agrilus planipennis*). Since *Fraxinus* (ash) species comprises 12.5% of Dunkirk's tree population, consider replacing trees that may be affected (see Invasive Species Detection and Management Strategy). The ideal distribution for a tree population should follow the 10-20-30 rule for species diversity: a single species should represent no more than 10% of the population, a single genus no more than 20%, and a single family no more than 30% of the population. The genus *Acer* (maple) currently makes up 30% of the public tree population in Dunkirk. Other genera should be planted on public property to create more diversity.

SECTION 5: INVASIVE SPECIES DETECTION AND MANAGEMENT STRATEGY

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

Generally, trees do not have significant insect and disease problems if they are healthy and well cared for. Some degree of insect infestation and disease incidence will always be present, as this is normal environmental conditions. When particularly damaging insects are detected, or the levels of insect populations are extremely high, or when particularly virulent diseases are diagnosed then action must be taken. Awareness and early diagnosis are essential to ensure the health and continuity of street and park trees.

This section provides different management strategies for dealing with invasive species. Included are sections on how to effectively monitor, increase public education, handle debris, approach reforestation, work with stakeholders, and utilize wood. Appendix E contains additional invasive species reference materials. The array of insects and diseases that can threaten the health of forest and urban trees and their treatments are too numerous to completely encompass within the scope of this document. However, a basic discussion on the fundamentals of an integrated pest management program, and specifically monitoring, is covered in this section.

A qualified arborist will be able to make sure that the municipality's trees are properly diagnosed and that a beneficial and realistic action plan is developed. The inventory data were analyzed to provide a general estimate of the percentage of trees susceptible to some of the known pests in New York. It is important to note that the figure only presents data collected from the inventory. Trees throughout Dunkirk, including those on public and private property, may be susceptible to these invasive pests.

An integral part of tree management is maintaining awareness of invasive insects and diseases in the area and knowing how to best manage them. Depending on the tree diversity within Dunkirk's urban forest, an invasive insect or disease has the potential to dramatically impact the tree population. Many pests target a single species or an entire genus. Integrated Pest Management is a process that involves common sense and sound solutions for treating and controlling pests. These solutions incorporate basic steps: identifying the problem, understanding pest biology, monitoring trees, and determining action thresholds. The practice of integrated pest management can vary depending on the site and based on each individual tree.

Fundamentals of an Integrated Pest Management Program:

Identification: The proper identification of trees and their existing and potentially harmful pests is necessary to successfully manage a pest outbreak or occurrence. Additionally, understanding each pest's life cycle is important for a positive diagnosis. Knowledge of beneficial and incidental (non-threatening) organisms also plays an important role in the identification and diagnostic process.

Monitoring: Proactive, regular monitoring for potential threats is perhaps the most important part of an integrated pest management program. Monitoring for pest activity can be done using a variety of techniques, including visual inspection, and, in some cases, use of specialized traps. Regular contact with state and local plant health care officials can help to focus monitoring efforts and increase awareness of emerging threats. In most cases, New York's State Forester, Cornell University extension services, New York Department of Natural Resources, or United States Department of Agriculture's state office can provide support for suspicions of potential pest infestations.

Understanding the Economic Threshold Level: The economic threshold is the level in which the costs involved in managing a pest infestation overshadow the value that a tree or plant is providing. In an urban situation, the economic value of a tree can be tied to the benefits that a tree provides. These benefits include, but are not limited to, aesthetic, environmental, and cultural benefits. This concept, on a general level, amounts to determining whether a tree is worth the costs of mitigating against a pest problem compared to its value to the community.

Selecting the Correct Treatment: Once a pest problem has been properly diagnosed and the decision has been made to treat the problem, selection of the correct treatment is the next step. Selecting treatment is a decision that requires a solid understanding of all the options, chemical or otherwise, for pest management material.

Proper Timing of Management Strategies: Once an appropriate treatment has been selected, it is important to carefully plan the timing and implementation to maximize effectiveness.

Recordkeeping: To facilitate future pest management decisions, accurate records should be kept concerning information on pests, treatments, locations, timing, weather conditions, and any other useful information.

Evaluation: A successful integrated pest management program must be evaluated based on experience, successes, and failures in order to focus efforts and resources for the future.

Findings:

The trees included in the inventory were evaluated for known existing pests and diseases in the state. Figure 13 is a chart revealing the susceptibility of the inventoried trees in relation to the pest measured for the region.

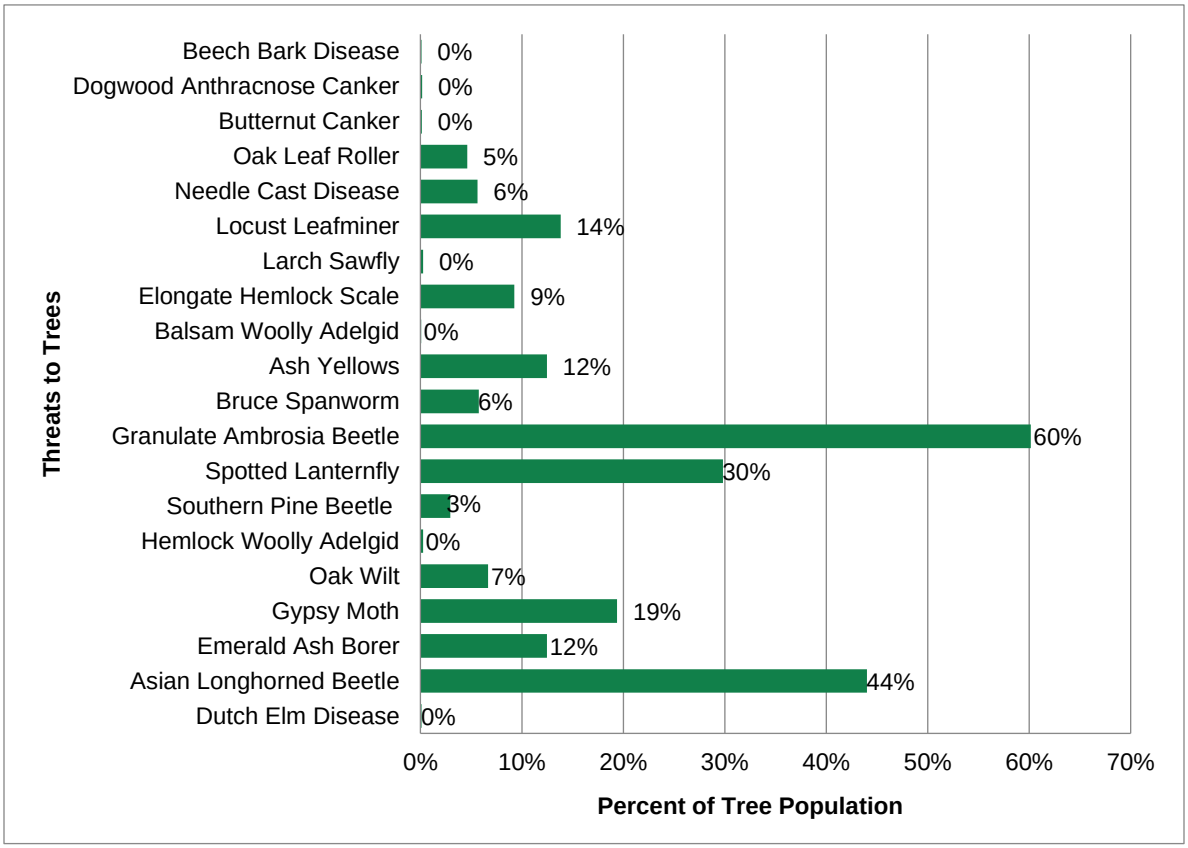
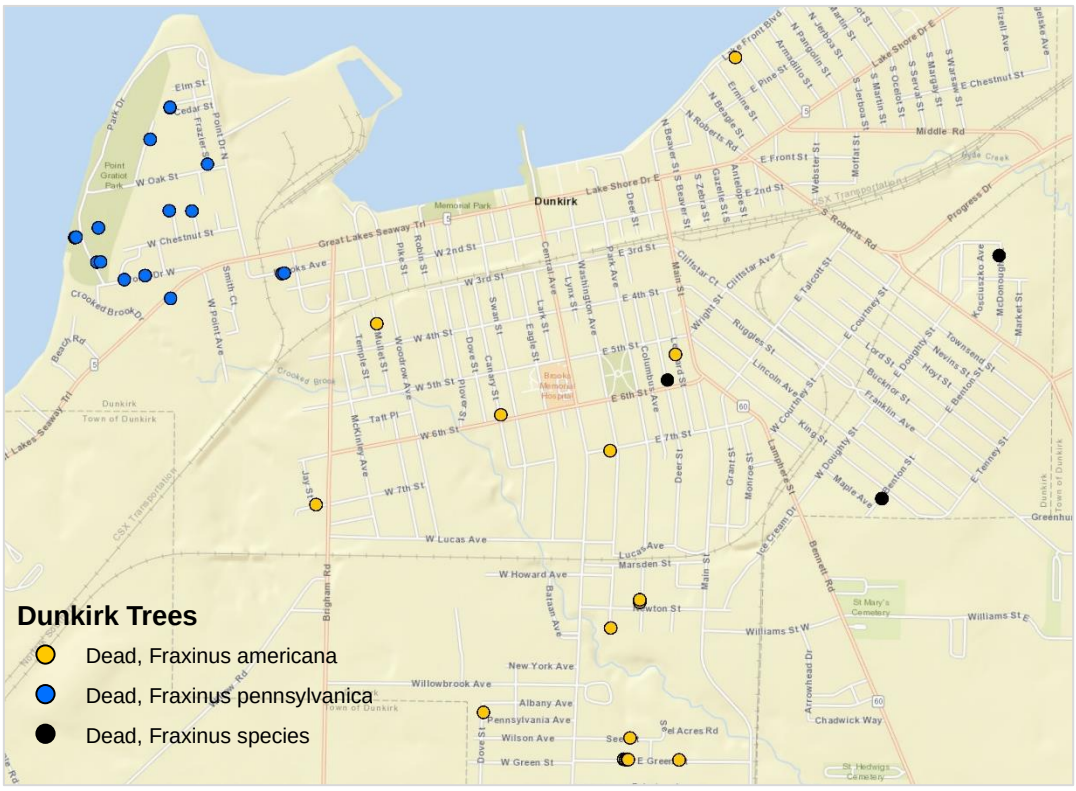


Figure 13. Potential impact of insect and disease threats noted during the 2019 inventory.

Greatest threats are from granulate ambrosia beetle, ALB, and spotted lanternfly (SLF). The ambrosia beetle has the potential to affect over 3,800 trees in the inventory as it can operate within a wide range of tree species. ALB has less hosts, but the inventory notes over 2,800 trees with potential susceptibility. The SLF is newer to the region, but has the ability to infest a wide variety of species; it has been found in neighoring Erie County as of September 2019. SLF is of growing concern for grape growers in New York State, but its main host is the invasive tree-of-heaven (*Ailanthus altissima*). There were only 4 *Ailanthus* noted in the inventory; removing these trees would reduce the potential infestation as well as public education of SLF.

EAB is another concern which has decimated ash trees in the infestation zones. Whole host removal of ash trees appears to be the most cost-effective tool. There were 808 ash trees inventoried along Dunkirk's street ROW and parks. Some ash trees inventoried showed signs of EAB. Private ash trees were not evaluated within the scope of this management plan, but the unknown number of private trees that were not part of this inventory may be a future concern for spreading the pest. Map 3 shows ash trees in dead condition within the Dunkirk inventoried trees. Dead trees should be removed.



Map 4. Location of Dead Ash Trees in Dunkirk.

Discussion

Dunkirk 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.

Photograph 2. *Hangers will help make private homeowners aware of the management options available for invasive species.*

Public education is a key role in early pest identification. When an educated public is aware of a concern and on the lookout for potential infestations, treatment options and preservation work can be accomplished proactively. Their assistance and cooperation will be vital in detecting, managing trees on private property, and expediting reforestation that will occur after removals of infected trees are complete. A well-informed community is more likely to cooperate with the city's requests. The city should provide information about treatment options so that their trees can last for years to come. It will be important for the city to inform the public about reforestation, the important benefits trees provide to neighborhoods, and how trees increase real estate value. This can help fund and promote neighborhood tree plantings.

The following are examples of ways the city can inform the public about these issues:

- News releases
- City newsletter articles
- Radio programs
- Post information about invasive species on the city's website
- Display information packets at public buildings
- Postcard mailings to infected tree owners
- Door hangers explaining maintenance options
- Presentations to community groups
- Tie ribbons place tags on the trees with information about specific infestations.

Photograph 3. *Posting information about EAB on ash trees around the city could encourage private homeowners to become more proactive in managing their ash trees.*

SECTION 6: STORM READINESS STRATEGIES

The City of Dunkirk, New York lies in a climate zone that exhibits four distinct seasons. This creates the potential for rapid changes in temperature, humidity, and barometric pressure, and sets the stage for severe weather events, such as tornadoes, thunderstorms, hurricanes, hail, high winds, ice, and snow. The main urban forestry concerns for this city are the threats of winter storms, including ice storms.

The Köppen climate classification rates Dunkirk as Dfa. Dfa is characterized as a humid continental climate and is directly influenced by the city's proximity to Lake Erie. The record low temperature for Dunkirk is -28°F, with an average January low of 20°F. The record high is 99°F, with an 80°F average high for July. Dunkirk receives above national average annual precipitation at 38" but is well above national average snowfall of 72". The snowfall is significantly above the national average of 28" per year.

Global climate change manifested by increased rainfall and atmospheric instability present a sense of urgency for urban forestry professionals. The main urban forestry concerns for this Dunkirk are severe storms and heavy precipitation events such as summertime microbursts and wintertime heavy snow and ice. Strong winds associated with rapid developing localized weather events due to the proximate Lake Erie plays a significant factor in forecasting tree maintenance workload.

The National Weather Service's Storm Prediction Center reports from 1952 through 2017, 26 tornadoes have touched down in Chautauqua County. The threat of tornadoes, and the resulting damage that occurs, is relatively low in Dunkirk. Nationally, western New York is classified as a low risk for tornadoes based on the number of confirmed touch downs, but with the changing climate the region is experiencing more frequent and severe non-tornado weather events and challenging winter storms. The closest tornado in this data set was an F2 size which touched down near Van Buren Point in November 2011.

Readiness

Severe weather can create catastrophic damage and significant volumes debris that requires processing. Therefore, proactive cities have developed emergency response and recovery plans. Traditionally, these plans address serious public safety and health issues, but commonly overlook trees and woody debris in the mitigation efforts.

When catastrophic disasters, such as tornadoes, ice storms, and severe straight-line winds, strike a metropolitan center, thousands to millions of cubic yards of debris are produced. Trees and vegetation can account for approximately 30% of this debris volume. Debris transportation, storage, and processing may be considered with support from Chautauqua County Emergency Services (http://www.chautcofire.org/). This department also maintains the Chautauqua County Multi-Jurisdictional Hazard Mitigation Plan. The plan has a community profile of Dunkirk on page 3 of Appendix A, part 1 (http://www.chautcofire.org/2016MitigationPlan.html). The Cornell Cooperative Extension offers the Extension Disaster Education Network (EDEN) which is designed to link, *"... extension educators, emergency managers, and community officials to enhance resilience and reduce the impact of disasters in New York communities."* (http://emergencypreparedness.cce.cornell.edu/Pages/default.aspx)

Beyond the task of collecting and disposing of this debris, there are additional urban forest management considerations, including increased threat to life, hindrance to life-saving efforts,

power outages, and personal and public property damage. The impacts of these additional tree-related considerations are not always quantifiable but can overwhelm municipal services and slow down the recovery process. A comprehensive urban forest management plan reduces storm hazards through proper planting and preventive maintenance. However, when disasters occur, an emergency plan as an addendum to this plan can provide solid data, facts, and protocols to ensure service continuity and timely recovery and restoration.

During and after a storm emergency and depending on the severity of the storm and the damage sustained, municipal urban forestry staff calls upon parks, streets, and maintenance employees to address the community's needs. The municipal utilities department is staffed and equipped to address water and electric infrastructure damage. Contractors are also used to supplement municipal staff when available. All these personnel resources have trucks and equipment to manage and mitigate tree-related storm damage.

More Frequent and Severe Storms

As a result of sea level changes, increases in the frequency and severity of storms are occurring throughout the East Coast and Great Lakes. Largest concerns are early fall storms (ice events) where leaves are still on the trees, or late spring storms with heavy lake effect snows. Recent (2019-2018) fast developing thunderstorms across Lake Erie with direct line winds, often associated with downbursts and smaller microbursts are also a growing concern. These impacts the urban forest in several ways:

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

Funding and Budget for Urban Forest Emergencies

While the scope of this plan does not permit detailed budgeting estimates, municipalities are strongly encouraged to analyze past storm events and provide for enough regular funding and contingency funding to support an adequate response for various levels of storm damage. Storm and emergency response will require funding for staff overtime, contractual services, and equipment rental.

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

Historically, FEMA funding for storm damage mitigation reimbursements has been made available in New York. Most recently, over $9.6 million in public assistance grants were provided in the state after a severe winter storm occurred in January 2014. In order to receive FEMA funding, it is critical to be prepared and fully document all losses and money spent. Most damage assessments through FEMA must be done immediately after the disaster event. The calculated dollar amount is then sent to the County Emergency Management Director. FEMA has a public assistance program that is open to municipal departments and non-profit hospitals. These grants can be applied for to assist with a variety damages, including debris removal and emergency protective measures.

Findings

Dunkirk's Tree Inventory Characteristics Related to Storm Damage Risks

With the recent tree inventory data, the vulnerability of Dunkirk's urban forest from severe weather events can be assessed more accurately. It is well known that certain species of trees are more prone to breaking and splitting in storms (i.e., silver maple and callery pear); trees that are under utility lines and have been poorly pruned in the past are more prone to storm damage; trees in poor condition or with crown, trunk, or root defects can fail in even moderate storms; and trees under stress from insect and disease pressures are also more likely to fail in a storm.

Therefore, it is beneficial to examine the urban forest data to do a generalized vulnerability assessment of Dunkirk in terms of its urban forest resource. The following is a discussion of the findings.

Tree Condition

The Dunkirk tree inventory collected data on 6,479 total trees with condition ratings. Dunkirk is recommended to remove the dead trees and remove or prune the poor trees to avoid road blockage along their important routes. Certainly, the deferred maintenance of the dead and poor rated trees should be a removal priority and replaced with healthy trees of substantial caliber. Approximately 10% of the inventory are poor rated trees, with >1% being dead.

In addition to health of a tree, maturity has shown to be a factor during storms. Mature trees that may fail during a storm can create a higher risk of causing damage and creating excessive debris. Mature trees that have been around recent construction pose an increased risk due to potential for stress and damage to the tree's root system

Storm-Prone Species Frequency

The fast-growing, weak-wooded species have the highest potential to create the largest amount of debris after storms. These trees are more prone to storm damage and should be monitored closely for defects and disease. Hauer, *et al* describes Siberian elm, honeylocust, Bradford (callery) pear, common hackberry, pin oak, sycamore, green ash, and tulip tree as part of the 254 major trees species susceptible to ice damage during a survey in Illinois. Larger diameter trees with broader crowns incurred the most ice damage, with larger DBH trees showing increased removal rates among the species mentioned. Sisinni, *et al* published a study based on ice prone species from a storm event data collected from 1991 in Rochester, New York. They also had similar findings to Hauer, with green ash, silver maple, London planetree, callery (Bradford) pear, Norway maple, honeylocust, red maple, and littleleaf linden as the top species susceptible to ice storm damage.

Table 8 is a combined species list of those studies, their corresponding amounts found in the Dunkirk inventory, and tree condition(s). Outright removal of these trees is not imperative but consider suitable replacements when they are eventually replaced in the inventory. If the indicated species represents a tree in good condition, closer inspection through the lens of storm readiness may reveal an increase in maintenance needs. As an example, review Table 8 for differences between silver maple and green ash. Although silver maples outnumber the green ash, nearly half of the green ash are in poor condition. If prioritizing workload based on storm prone species alone, the city would concentrate on the green ash.

Table 8. Storm Prone Species Noted in the Dunkirk Inventory

Common Name	Scientific Name	Identified during Inventory	Good	Fair	Poor	Dead
silver maple	*Acer saccharinum*	909	199	612	92	6
green ash	*Fraxinus pennsylvanica*	562	93	205	247	17
red maple	*Acer rubrum*	446	95	308	41	2
Norway maple	*Acer platanoides*	346	117	190	37	2
Bradford (callery) pear	*Pyrus calleryana*	182	96	78	5	3
pin oak	*Quercus palustris*	172	66	104	2	
black locust	*Robinia pseudoacacia*	168	115	39	13	1
honeylocust	*Gleditsia triacanthos*	145	44	100		1
littleleaf linden	*Tilia cordata*	74	25	45	3	1
sycamore	*Platanus occidentalis*	26	24	2		
tulip tree	*Liriodendron tulipifera*	18	14	4		
Siberian Elm	*Ulmus pumila*	6		5	1	

London plane tree	*Platanus hybrida*	4		4		
common hackberry	*Celtis occidentalis*	2		2		

Discussion

With this Storm Preparedness plan, and other urban forest management resources available to Dunkirk, such as the tree inventory, TreeKeeper® software and the urban forest management plan, the city is fairly well prepared to handle the severe weather events that inevitably will impact Dunkirk's trees. With only minor adjustments in its approach to storm response, Dunkirk should be able to manage future events and be better prepared to seek reimbursement for the large expenses that sometimes accompany large storm events. Be sure all staff are signed up for the emergency alert system (see www.alert.ny.gov). Chautauqua county also has an incident management network (EOC) and is located at https://chautcofire.disasterlan.org/.

Recommendations for Improving Storm Response and Recovery Program and Actions

- Continue to update Dunkirk's street and park tree inventories utilizing the software already in place. Current data will provide much needed information that will help to reduce future storm damage.
- Utilize Homeland Security office to provide quick notification to New York Department of Homeland Security (IDHS) and FEMA if reimbursement from disaster funds is anticipated. Develop a clear system of record keeping that will provide required information so that reimbursement is achieved where allowed. This step can save Dunkirk several thousands of dollars in costs for cleanup of storm debris from future storm events.
- Complete the Tree Emergency Plan Worksheet and distribute appropriately. Annually review the Worksheet and update information as needed.
- Address high risk trees and EAB-infested trees promptly to remove them from the population to reduce preventable damage.
- Remove low risk but storm-prone species from the population when their service lives are over and replace with more resilient species.
- Communicate to all appropriate Dunkirk staff and partners the procedures for prioritizing and managing urban forest damage after storms per the three storm categories.
- Provide staff training, particularly on tree risk and working with potential electrical hazards.
- Commit to providing the citizens timely messaging about Dunkirk's response and recovery activities and about tree damage and correction topics. Prepare public relations materials ahead of time so that they are easily accessible when the storm strikes.

Training

The Dunkirk staff should receive safety and technical training through in-the-field and classroom methods. To ensure safe and effective work, staff should receive regular and updated training sessions for first-aid, CPR, chainsaw use, tree risk assessment, and minimum approach distances

for energized electric lines. These topics should be considered as basic minimum training opportunities.

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

Public Relations

Communication is critical to surviving disasters, especially when dealing with the public and those who have been impacted by the storm event. If information is not actively managed during tree emergencies, disorganization will complicate recovery work. Public relations should be coordinated through the EOC or the mayor's office.

Recommendations for General Public Relations

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

More information on public relations after a storm event and messaging templates are found in Appendix F. Dunkirk can use these templates for press releases, printed handouts, and posting on the Dunkirk's website and social media outlets. The press releases can be customized with the Dunkirk's logo, contact information, and quotes from local leaders. Local, state and federal partner links are provided below to assist Dunkirk. DRG encourages the city to establish contact to verify emergency procedures within Dunkirk are cohesive to other regional plans.

Partner Information

Chautauqua County – Water Emergency Team

http://www.chautcofire.org/ccwet.html

Department of New York Homeland Security and Emergency Services

http://www.dhses.ny.gov/oct/

New York State / Disaster Preparedness Commission

http://www.dhses.ny.gov/oem/disaster-prep/

New York State Park Police

https://parks.ny.gov/employment/park-police/contact-us.aspx

Ready.gov – personal concerns for hurricanes

https://www.ready.gov/hurricanes

Disaster Relief Grants

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

FEMA Disaster Management Toolkit

Debris Management Guide -- https://www.fema.gov/pdf/government/grant/pa/demagde.pdf

United States Coast Guard – Buffalo Station

https://www.atlanticarea.uscg.mil/Our-Organization/District-9/Ninth-District-Units/Sector-Buffalo/Units/Buffalo/

United States Coast Guard – Erie Station (Sector Buffalo)

https://www.atlanticarea.uscg.mil/Our-Organization/District-9/Ninth-District-Units/Sector-Buffalo/Units/Erie/

United Way Disaster Relief

http://www.uwwp.org/disaster-fund.shtml

SECTION 7: COMMUNITY TREE BOARD AND PUBLIC OUTREACH

Volunteers and partnerships with community organizations is fundamental for a successful tree management program. One way to garner support and public input is through a tree board. The most recent publication of *Municipal Tree Care and Management in the United States* identified 65% of the 644 municipalities surveyed did have community volunteers involved in their urban forestry program.

All municipalities with a population over 1 million had some form of volunteer involvement, as the population decreased, so did the percentage of volunteers. For the demographics of Dunkirk, 61% of the cities surveyed did have some of common volunteering activities. In terms of which municipalities had a tree board, 48% responded their city had a tree board which helped their community carry out tree management activities. The largest portion of the volunteers help with tree planting and watering, a smaller percentage (18%) serve as policy/management advisors.

A community tree board is a selected group of citizens intended to serve as an advisory board that supports tree management in the municipality. Typically, the City Administrator or his/her designee will delegate or contract responsibility for care and oversight of public trees to a professional forester, arborist, citizen led Tree Advisory Committee, or a combination of these options.

A Tree Advisory Committee will typically meet the following requirements:

Tree Advisory Committee

A. **Creation:** The City's Board of Aldermen, with support of the Mayor, has the authority to create a Tree Advisory Committee for the city. Members should reflect the diverse citizen interests in the city and may include homeowners, tree professionals, business owners, and city staff.

B. **Duties:** The Tree Advisory Committee shall be an advisory committee to the Public Works Department concerning tree related topics in the city.

C. **Compensation:** Members of the Tree Advisory Committee shall serve without compensation.

D. **Structure:** The Tree Advisory Committee may set rules of procedure for its meeting as it deems appropriate. The City Public Works Director or designee will be the staff liaison to the board. Members serve at the discretion of the Mayor and board of Aldermen.

Means of Public Outreach

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

- Tree inventory data can be used to justify necessary priority and proactive tree maintenance activities as well as tree planting and preservation initiatives.
- Species data can be used to guide tree species selection for planting projects with the goals of improving species diversity and limiting the introduction of invasive pests and diseases.

- Information in this plan can be used to advise citizens about threats to urban trees (such as granulate ambrosia beetle, emerald ash borer, and gypsy moth).

Dunkirk's data are instrumental in helping to provide tangible and meaningful outreach about the urban forest. There are various avenues for outreach. Maps can be created and posted on websites, in parks, or in business areas. Public service announcements can be developed. Articles can be written and programs about trees and the benefits they provide can be developed. Arbor Day and Earth Day celebrations can become community traditions. Engage existing volunteer groups to host tree plantings and maintenance events.

Educational contests can be created to increase awareness of the importance of trees. One proven way of engaging the public is through a tree-centered photography contest. In one example, the city selected photos from the contest and used them in their Urban Forest Master Plan. Winning photos were also publicly displayed at city hall and public libraries.

Signs can be hung from trees to highlight the contributions trees make to the community. Trees provide oxygen we need to breathe, shade to cool our neighborhoods, and canopies to aid in stormwater control. Using the free software of the i-Tree suite of tools (itreetools.org), help educate the citizens. The i-Tree MyTree tool allows users to look at the individual benefits for any tree of their choosing.

Photograph 3. *An 11"x 17" weatherproof vinyl tree tag form used to publicly display per tree benefits.*

CONCLUSIONS

Every hour of every day, public trees in Dunkirk are supporting and improving the quality of life. The city's trees provide an annual benefit of $54,176.62. When properly maintained, trees provide numerous environmental, economic, and social benefits that far exceed the time and money invested in planting, pruning, protection, and removal.

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 and 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. The city should prepare and implement an EAB Management Plan as soon as possible.

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

Inventory and Plan Updates

DRG recommends that the inventory and management plan be updated using an appropriate computer software program so that the city can sustain its program and accurately project future program and budget needs:

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

- Perform routine inspections of public trees as needed. Windshield surveys (inspections performed from a vehicle) in line with ANSI A300 (Part 9) (ANSI 2011) will help city staff stay apprised of changing conditions. Update the tree maintenance schedule and the budget as needed so that identified tree work may be efficiently performed. Schedule and prioritize work based on risk.
- If the recommended work cannot be completed as suggested in this plan, modify maintenance schedules and budgets accordingly.
- Update the inventory database using TreeKeeper® as work is performed. Add new tree work to the schedule when work is identified through inspections or a citizen call process.
- Re-inventory the street ROW, and update all data fields in five years, or a portion of the population (1/5) every year over the course of five years.
- Revise the *Tree Management Plan* after five years when the re-inventory has been completed.

Evaluating and Updating This Plan

This *Public Tree Planting Plan* is initially intended to provide planting guidelines for the next ten years. In order to measure the effectiveness of the implementation of the program in achieving the stated goals, a method for evaluation should be followed. Specific accomplishments can be measured in comparison to the plan's goals and recommendations. These include:

- Annually comparing the number of trees planted to the desired number of plantings and the number of removals per year.
- Beginning in Year 3, establishing a training pruning program and evaluating the number of trees pruned annually to match the goal of a five-year program.
- At the end of each year, comparing the city's annual urban forestry budget for planting and training pruning to that projected in this Plan.

REFERENCES

American National Standards Institute. 2008. *ANSI A300 (Part 1)–2008, American National Standard for Tree Care Operations—Tree, Shrub, and Other Woody Plant Management—Standard Practices (Pruning)*. Londonderry: Tree Care Industry Association, Inc.

———. 2011. *ANSI A300 (Part 9)–2011, American National Standard for Tree Care Operations—Tree, Shrub, and Other Woody Plant Management Standard Practices (Tree Risk Assessment a. Tree Structure Assessment).* Londonderry: Tree Care Industry Association, Inc.

———. 2012. *ANSI A300 (Part 6)–2012, American National Standard for Tree Care Operations—Tree, Shrub, and Other Woody Plant Management Standard Practices (Transplanting).* Londonderry: Tree Care Industry Association, Inc.

Casey Trees. 2008. *Tree Space Design: Growing the Tree Out of the Box.* Washington, D.C.: Casey Trees.

Coder, K. D. 1996. "Identified Benefits of Community Trees and Forests." University of Georgia Cooperative Extension Service, Forest Resources Publication FOR96-39.

Geiger, J. 2003. "The case for large trees vs. small trees." *Urban Forest Research*, Fall 2003. Center for Urban Forest Research, Pacific Southwest Research Station, USDA Forest Service, Davis, CA. www.fs.fed.us/psw/programs/cufr/newsletter.stml.

Heisler, G. M. 1986. "Energy Savings with Trees." *J. Arbor* 12(5):113–125. Prepared by Ryan Bell and Jennie Wheeler.

Karnosky, D. F. 1979. "Dutch Elm Disease: A Review of the History, Environmental Implications, Control, and Research Needs." *Environ Cons* 6(04): 311–322.

Kuo, F., and W. Sullivan. 2001a. "Environment and Crime in the Inner City: Does Vegetation Reduce Crime?" *Environment and Behavior* 33(3): 343–367.

———. 2001b. Aggression and Violence in the Inner City - Effects of Environment via Mental Fatigue. *Environment and Behavior* 33(4): 543–571.

Lovasi, G. S., J. W. Quinn, K. M. Neckerman, M. S. Perzanowski, and A. Rundle. 2008. "Children living in areas with more street trees have lower prevalence of asthma." *J. Epidemiol Community Health* 62:647–9.

McPherson, E. G., R.A. Rowntree. 1989. "Using structural measures to compare twenty-two US street tree populations." *Landscape J.* 8(1):13–23.

Miller, R. W., and W. A. Sylvester. 1981. "An Economic Evaluation of the Pruning Cycle." *J. Arbor* 7(4):109–112.

North Carolina State University. 2012. "Americans are Planting Trees of Strength." http://www.treesofstrength.org/benefits.htm. Accessed May 12, 2012.

Nowak, D. J., E. J. Greenfield, R. E. Hoehn, and E. Lapoint. 2013. "Carbon storage and sequestration by trees in urban and community areas of the United States." *Environmental Pollution* 178(July):229-236. doi:10.1016.

Ohio Department of Natural Resources. 2012. *Position Statement: Master Street Tree Planting Plans*. http://ohiodnr.com/LinkClick.aspx?fileticket=uq3ki%2FMX51w%3D&tabid=5443. Accessed April 3, 2012.

Pokorny, J.D., J.G. O'Brien, R.J. Hauer, G.R. Johnson, J.S. Albers, M. MacKenzie, T.T. Dunlap, and B.J. Spears. 1992. *Urban Tree Risk Management: A Community Guide to Program Design and Implementation*. U.S. Forest Service, Northeastern Area State and Private Forestry. NA-TP-03-03. St. Paul, MN: USDA Forest Service.

Richards, N. A. 1983. "Diversity and Stability in a Street Tree Population." *Urban Ecology* 7(2):159–171.

Smiley, E. T., N. Matheny, and S. Lilly. 2011. *Best Management Practices: Tree Risk Assessment*. Champaign: International Society of Arboriculture.

Stamen, R.S. "Understanding and Preventing Arboriculture Lawsuits." Presented at the Georgia Urban Forest Council Annual Meeting, Madison, Georgia, November 2–3, 2011.

Ulrich, R. 1984. "View through Window May Influence Recovery from Surgery." *Science* 224(4647): 420–421.

———. 1986. "Human Responses to Vegetation and Landscapes." *Landscape and Urban Planning* 13:29–44.

Ulrich R.S., R.F. Simmons, B.D. Losito, E. Fiority, M.A. Miles and M. Zeison. 1991. "Stress Recovery During Exposure to Natural and Urban Environments." *J. Envir Psych* 11(3): 201-230.

USDA Forest Service. 2003a. "Benefits of Urban Trees. Urban and Community Forestry: Improving Our Quality of Life." *Forestry Report* R8-FR 71.

———. 2003b. *Is All Your Rain Going Down the Drain? Look to Bioretainment—Trees are a Solution.* Davis, CA: Center for Urban Forest Research, Pacific Southwest Research Station.

Wolf, K. L. 1998a. "Urban Nature Benefits: Psycho-Social Dimensions of People and Plants." *University of Washington, College of Forest Resources Fact Sheet*. 1(November).

———. 1998b. "Trees in Business Districts: Positive Effects on Consumer Behavior!" *University of Washington College of Forest Resources Fact Sheet.* 5(November).

———. 1999. "Grow for the Gold." *TreeLink Washington DNR Community Forestry Program.* 14(spring).

———. 2000. "Community Image: Roadside Settings and Public Perceptions." *University of Washington College of Forest Resources Factsheet.* 32(August).

———. 2003. "Public Response to the Urban Forest in Inner-City Business Districts." *J. Arbor* 29(3):117–126.

———. 2007. "City Trees and Property Values." *Arborist News* (August):34-36.

———. 2009. "Trees & Urban Streets: Research on Traffic Safety & Livable Communities." http://www.naturewithin.info/urban.html. Accessed November 10, 2011.

APPENDIX A
DATA COLLECTION AND SITE LOCATION METHODS

Data Collection Methods

DRG collected tree inventory data using a system that utilizes a customized program loaded onto pen-based field computers equipped with geographic information system (GIS) and global positioning system (GPS) receivers. The knowledge and professional judgment of DRG's arborists ensure the high quality of inventory data.

Data fields are defined in the glossary of the management plan. At each site, the following data fields were collected:

• Address	• Notes
• Condition	• Overhead Utilities
• Date of Inventory	• Primary Maintenance
• Defects	• Residual Risk
• Further Inspection	• Risk Rating
• Growspace	• Species
• Multi-stem	• Tree Size*

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

Maintenance needs are based on *Best Management Practices: Tree Risk Assessment* (International Society of Arboriculture [ISA] 2011).

The data collected were provided in an ESRI® shapefile, Access™ database, and Microsoft Excel™ spreadsheet on a CD-ROM that accompanies this plan.

Site Location Methods

Equipment and Base Maps

Inventory arborists use CF-19 Panasonic Toughbook® unit(s) with integral GPS receiver(s).

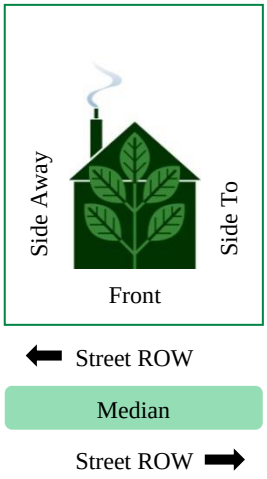
Base map layers were loaded onto these unit(s) to help locate sites during the inventory. The table below lists the base map layers, utilized along with source and format information for each layer.

Base Map Layers Utilized for Inventory

Imagery/Data Source	Date	Projection
Shapefiles NY GIS Clearinghouse ~*~ Parcel Data Chautauqua County GIS	2018-2019	NAD 1983 StatePlane New York West; Feet
1ft Aerial Imagery NY GIS Clearinghouse	2016	NAD 1983 StatePlane New York West; Feet

Street ROW Site Location

Individual street ROW sites (trees, stumps, or planting sites) were located using a methodology that identifies sites by *address number*, *street name*, *side*, *site number*, or *block side*. This methodology was developed by DRG to help ensure consistent assignment of location.



Side values for street ROW sites.

Address Number and Street Name

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

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

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

Side Value and Site Number

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

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

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

Block Side

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

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

Park and/or Public Space Site Location

Park and/or public space site locations were collected using the same methodology as street ROW sites; however, the *on street*, *from street*, and *to street* would be the park and/or public space's name (not street names).

Site Location Examples

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

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

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

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

Corner Lot A

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

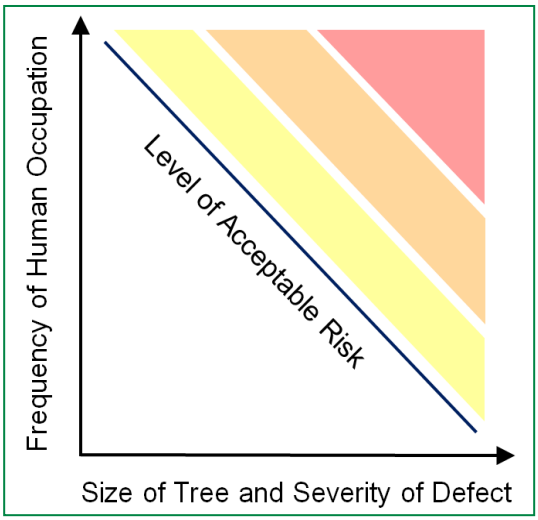
Corner Lot B

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

APPENDIX B
RISK ASSESSMENT/PRIORITY AND PROACTIVE MMAINTENANCE

Risk Assessment

Every tree has an inherent risk of tree failure or defective tree part failure. During the inventory, DRG performed a Level 2 qualitative risk assessment for each tree and assigned a risk rating based on the ANSI A300 (Part 9), and the companion publication *Best Management Practices: Tree Risk Assessment* (ISA 2011). Trees can have multiple failure modes with various risk ratings. One risk rating per tree will be assigned during the inventory. The failure mode having the greatest risk will serve as the overall tree risk rating. The specified time period for the risk assessment is one year.



- **Likelihood of Failure**—Identifies the most likely failure and rates the likelihood that the structural defect(s) will result in failure based on observed, current conditions.
  - Improbable—The tree or branch is not likely to fail during normal weather conditions and may not fail in many severe weather conditions within the specified time period.
  - Possible—Failure could occur but is unlikely during normal weather conditions within the specified time period.
  - Probable—Failure may be expected under normal weather conditions within the specified time period.
- **Likelihood of Impacting a Target**—The rate of occupancy of targets within the target zone and any factors that could affect the failed tree as it falls towards the target.
  - Very low—The chance of the failed tree or branch impacting the target is remote.
    - Rarely used sites
    - Examples include rarely used trails or trailheads
    - Instances where target areas provide protection
  - Low—It is not likely that the failed tree or branch will impact the target.
    - Occasional use area fully exposed to tree
    - Frequently used area partially exposed to tree
    - Constant use area that is well protected
  - Medium—The failed tree or branch may or may not impact the target.
    - Frequently used areas that are partially exposed to the tree on one side
    - Constantly occupied area partially protected from the tree
  - High—The failed tree or branch will most likely impact the target.
    - Fixed target is fully exposed to the tree or tree part

- **Categorizing Likelihood of Tree Failure Impacting a Target**—The likelihood for failure and the likelihood of impacting a target are combined in the matrix below to determine the likelihood of tree failure impacting a target.

Likelihood of Failure	Likelihood of Impacting Target			
	Very Low	Low	Medium	High
Imminent	Unlikely	Somewhat likely	Likely	Very Likely
Probable	Unlikely	Unlikely	Somewhat likely	Likely
Possible	Unlikely	Unlikely	Unlikely	Somewhat likely
Improbable	Unlikely	Unlikely	Unlikely	Unlikely

- **Consequence of Failure**—The consequences of tree failure are based on the categorization of target and potential harm that may occur. Consequences can vary depending upon size of defect, distance of fall for tree or limb, and any other factors that may protect a target from harm. Target values are subjective and should be assessed from the client's perspective.
  - Negligible—Consequences involve low value damage and do not involve personal injury.
    - Small branch striking a fence
    - Medium-sized branch striking a shrub bed
    - Large tree part striking structure and causing monetary damage
    - Disruption of power to landscape lights
  - Minor—Consequences involve low to moderate property damage, small disruptions to traffic or communication utility, or very minor injury.
    - Small branch striking a house roof from a high height
    - Medium-sized branch striking a deck from a moderate height
    - Large tree part striking a structure, causing moderate monetary damage
    - Short-term disruption of power at service drop to house
    - Temporary disruption of traffic on neighborhood street
  - Significant—Consequences involve property damage of moderate to high value, considerable disruption, or personal injury.
    - Medium-sized part striking a vehicle from a moderate or high height
    - Large tree part striking a structure resulting in high monetary damage
    - Disruption of distribution of primary or secondary voltage power lines, including individual services and street-lighting circuits
    - Disruption of traffic on a secondary street
  - Severe—Consequences involve serious potential injury or death, damage to high-value property, or disruption of important activities.
    - Injury to a person that may result in hospitalization
    - Medium-sized part striking an occupied vehicle
    - Large tree part striking an occupied house
    - Serious disruption of high-voltage distribution and transmission power line disruption of arterial traffic or motorways

- **Risk Rating**—The overall risk rating of the tree will be determined based on combining the likelihood of tree failure impacting a target and the consequence of failure in the matrix below.

Likelihood of Failure	Consequences			
	Negligible	Minor	Significant	Severe
Very likely	Low	Moderate	High	Extreme
Likely	Low	Moderate	High	High
Somewhat likely	Low	Low	Moderate	Moderate
Unlikely	Low	Low	Low	Low

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

Tree risk assessors will identify the tree failure mode having the greatest risk, and report that as the tree risk rating. Generally, trees with the highest qualitative risk ratings should receive corrective treatment first. The following risk ratings will be assigned:

- None—Used for planting and stump sites only.
- Low—The low risk category applies when consequences are "negligible" and likelihood is "unlikely"; or consequences are "minor" and likelihood is "somewhat likely." Some trees with this level of risk may benefit from mitigation or maintenance measures, but immediate action is not usually required.
- Moderate—The Moderate Risk category applies when consequences are "minor" and likelihood is "very likely" or "likely"; or likelihood is "somewhat likely" and consequences are "significant" or "severe." In populations of trees, Moderate Risk trees represent a lower priority than High or Extreme Risk trees.
- High—The high risk category applies when consequences are "significant" and likelihood is "very likely" or "likely," or consequences are "severe" and likelihood is "likely." In a population of trees, the priority of high risk trees is second only to Extreme Risk trees.
- Extreme—The Extreme Risk category applies in situations where tree failure is imminent and there is a high likelihood of impacting the target, and the consequences of the failure are "severe." In some cases, this may mean immediate restriction of access to the target zone area to avoid injury to people.

Trees with elevated (Extreme or High) risk levels are usually recommended for removal or pruning to eliminate the defects that warranted their risk rating. However, in some situations, risk may be reduced by adding support (cabling or bracing) or by moving the target away from the tree. DRG recommends only removal or pruning to alleviate risk. But in special situations, such as a memorial tree or a tree in a historic area, Manchester may decide that cabling, bracing, or moving the target may be the best option for reducing risk.

Determination of acceptable risk ultimately lies with city managers. Since there are inherent risks associated with trees, the location of a tree is an important factor in the determination and acceptability of risk for any given tree. The level of risk associated with a tree increases as the frequency of human occupation increases in the vicinity of the tree. For example, a tree located next to a heavily traveled street will have a higher level of risk than a similar tree in an open field.

Priority Maintenance

Identifying and ranking the maintenance needs of a tree population enables tree work to be assigned priority based on observed risk. Once prioritized, tree work can be systematically addressed to eliminate the greatest risk and liability first (Stamen 2011).

Risk is a graduated scale that measures potential tree-related hazardous conditions. A tree is considered hazardous when its potential risks exceed an acceptable level. Managing trees for risk reduction provides many benefits, including:

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

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

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

Proactive Maintenance

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

APPENDIX C
SUGGESTED TREE AND PLANT SPECIES

Proper landscaping and tree planting are critical components of the atmosphere, livability, and ecological quality of a community's urban forest. The tree species listed below have been evaluated for factors such as size, disease and pest resistance, seed or fruit set, and availability. The following list is offered to assist all relevant community personnel in selecting appropriate tree species. These trees have been selected because of their aesthetic and functional characteristics and their ability to thrive in the soil and climate conditions throughout Zone 6 on the USDA Plant Hardiness Zone Map.

Deciduous Trees

Large Trees: Greater than 45 Feet in Height at Maturity

Scientific Name	Common Name	Cultivar
Acer rubrum	red maple	Red Sunset®
Acer saccharum	sugar maple	'Legacy'
*Aesculus flava**	yellow buckeye	
*Betula alleghaniensis**	yellow birch	
*Betula lenta**	sweet birch	
Betula nigra	river birch	Heritage®
Carpinus betulus	European hornbeam	'Franz Fontaine'
*Carya illinoensis**	pecan	
*Carya lacinata**	shellbark hickory	
*Carya ovata**	shagbark hickory	
*Castanea mollissima**	Chinese chestnut	
Celtis laevigata	sugar hackberry	
Celtis occidentalis	common hackberry	'Prairie Pride'
Cercidiphyllum japonicum	Katsura tree	'Aureum'
*Diospyros virginiana**	common persimmon	
*Fagus grandifolia**	American beech	
*Fagus sylvatica**	European beech	(Numerous exist)
Ginkgo biloba	ginkgo	(Choose male trees only)
Gleditsia triacanthos inermis	thornless honeylocust	'Shademaster'
Gymnocladus dioica	Kentucky coffeetree	Prairie Titan®
*Juglans nigra**	black walnut	
*Larix decidua**	European larch	
Liquidambar styraciflua	American sweetgum	'Rotundiloba'
*Liriodendron tulipifera**	tuliptree	'Fastigiatum'
*Magnolia acuminata**	cucumbertree magnolia	(Numerous exist)
*Magnolia macrophylla**	bigleaf magnolia	
Metasequoia glyptostroboides	dawn redwood	'Emerald Feathers'
Nyssa sylvatica	black tupelo	
*Platanus occidentalis**	American sycamore	
Platanus × acerifolia	London planetree	'Yarwood'
Quercus alba	white oak	

Large Trees: Greater than 45 Feet in Height at Maturity (Continued)

Scientific Name	Common Name	Cultivar
Quercus bicolor	swamp white oak	
Quercus coccinea	scarlet oak	
Quercus lyrata	overcup oak	
Quercus macrocarpa	bur oak	
Quercus montana	chestnut oak	
Quercus muehlenbergii	chinkapin oak	
Quercus palustris	pin oak	
Quercus imbricaria	shingle oak	
Quercus phellos	willow oak	
Quercus robur	English oak	Heritage®
Quercus rubra	northern red oak	'Splendens'
Quercus shumardii	Shumard oak	
Styphnolobium japonicum	Japanese pagodatree	'Regent'
Taxodium distichum	common baldcypress	'Shawnee Brave'
Tilia americana	American linden	'Redmond'
Tilia cordata	littleleaf linden	'Greenspire'
Tilia × euchlora	Crimean linden	
Tilia tomentosa	silver linden	'Sterling'
Ulmus parvifolia	Chinese elm	Allée®
Zelkova serrata	Japanese zelkova	'Green Vase'

Medium Trees: 31 to 45 Feet in Height at Maturity

Scientific Name	Common Name	Cultivar
Aesculus × carnea	red horsechestnut	
Alnus cordata	Italian alder	
*Asimina triloba**	pawpaw	
Cladrastis kentukea	American yellowwood	'Rosea'
Corylus colurna	Turkish filbert	
Eucommia ulmoides	hardy rubber tree	
Koelreuteria paniculata	goldenraintree	
Ostrya virginiana	American hophornbeam	
Parrotia persica	Persian parrotia	'Vanessa'
Phellodendron amurense	amur corktree	'Macho'
Pistacia chinensis	Chinese pistache	
Prunus maackii	amur chokecherry	'Amber Beauty'
Prunus sargentii	Sargent cherry	
*Pterocarya fraxinifolia**	Caucasian wingnut	
Quercus acutissima	sawtooth oak	
Quercus cerris	European turkey oak	
*Sassafras albidum**	sassafras	

Small Trees: 15 to 30 Feet in Height at Maturity

Scientific Name	Common Name	Cultivar
Acer buergerianum	trident maple	Streetwise®
Acer campestre	hedge maple	Queen Elizabeth™
Acer cappadocicum	coliseum maple	'Aureum'
Acer ginnala	amur maple	Red Rhapsody™
Acer griseum	paperbark maple	
Acer nigrum	black maple	
*Acer pensylvanicum**	striped maple	
Acer triflorum	three-flower maple	
*Aesculus pavia**	red buckeye	
Amelanchier arborea	downy serviceberry	(Numerous exist)
Amelanchier laevis	Allegheny serviceberry	
*Carpinus caroliniana**	American hornbeam	
Cercis canadensis	eastern redbud	'Forest Pansy'
Chionanthus virginicus	white fringetree	
Cornus alternifolia	pagoda dogwood	
Cornus kousa	Kousa dogwood	(Numerous exist)
Cornus mas	corneliancherry dogwood	'Spring Sun'
Corylus avellana	European filbert	'Contorta'
*Cotinus coggygria**	common smoketree	'Flame'
*Cotinus obovata**	American smoketree	
*Crataegus phaenopyrum**	Washington hawthorn	Princeton Sentry™
Crataegus viridis	green hawthorn	'Winter King'
*Franklinia alatamaha**	Franklinia	
*Halesia tetraptera**	Carolina silverbell	'Arnold Pink'
Laburnum × watereri	goldenchain tree	
Maackia amurensis	amur maackia	
*Magnolia × soulangiana**	saucer magnolia	'Alexandrina'
*Magnolia stellata**	star magnolia	'Centennial'
*Magnolia tripetala**	umbrella magnolia	
*Magnolia virginiana**	sweetbay magnolia	Moonglow®
Malus spp.	flowering crabapple	(Disease resistant only)
Oxydendrum arboreum	sourwood	'Mt. Charm'
Prunus subhirtella	Higan cherry	'Pendula'
Prunus virginiana	common chokecherry	'Schubert'
*Staphylea trifolia**	American bladdernut	
Stewartia ovata	mountain stewartia	
*Styrax japonicus**	Japanese snowbell	'Emerald Pagoda'
Syringa reticulata	Japanese tree lilac	'Ivory Silk'

Note: * denotes species that are **not** recommended for use as street trees.

Coniferous and Evergreen Trees

Large Trees: Greater than 45 Feet in Height at Maturity

Scientific Name	Common Name	Cultivar
Abies balsamea	balsam fir	
Abies concolor	white fir	'Violacea'
Cedrus libani	cedar-of-Lebanon	
Chamaecyparis nootkatensis	Nootka falsecypress	'Pendula'
Cryptomeria japonica	Japanese cryptomeria	'Sekkan-sugi'
× *Cupressocyparis leylandii*	Leyland cypress	
Ilex opaca	American holly	
Picea omorika	Serbian spruce	
Picea orientalis	Oriental spruce	
Pinus densiflora	Japanese red pine	
Pinus strobus	eastern white pine	
Pinus sylvestris	Scotch pine	
Pinus taeda	loblolly pine	
Pinus virginiana	Virginia pine	
Psedotsuga menziesii	Douglas-fir	
Thuja plicata	western arborvitae	(Numerous exist)
Tsuga canadensis	eastern hemlock	

Medium Trees: 31 to 45 Feet in Height at Maturity

Scientific Name	Common Name	Cultivar
Chamaecyparis thyoides	atlantic whitecedar	(Numerous exist)
Juniperus virginiana	eastern redcedar	
Pinus bungeana	lacebark pine	
Pinus flexilis	limber pine	
Pinus parviflora	Japanese white pine	
Thuja occidentalis	eastern arborvitae	(Numerous exist)

Small Trees: 15 to 30 Feet in Height at Maturity

Scientific Name	Common Name	Cultivar
Ilex × *attenuata*	Foster's holly	
Pinus aristata	bristlecone pine	
Pinus mugo mugo	mugo pine	

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. Also consider Dirr's new book, *The Tree Book – Superior Selection for Landscapes, Streetscapes, and Gardens*, with Keith Warren from 2019. The USDA's i-Tree suite of tools has a species selection component: i-Tree Species tool can be found https://species.itreetools.org/

For restoration purposes there are several seed companies which sell custom or pre-designed mixes. One such company to review is Ernst Seeds https://www.ernstseed.com/

On the following pages are planting recommendations for restoration efforts.

Herbaceous perennials for native restoration

Scientific Name	Common Name
Elymus riparius	Riverbank Wild Rye
Elymus candensis	Nodding Wild Rye
Elymus virginicus	Virginia Wild Rye
Andropogon geradii	Big Bluestem
Scripus atrovirens	Dark Green Bulrush
Carex crinite	Fringed Sedge
Carex frankii	Frank's Sedge
Glyceria grandis	American Manna Grass
Scripus cyperinus	Woolgrass
Aster umbellatus	Flat Topped White Aster
Hibiscus mosheutos	Crimson-Eyed Rose Mallow
Actionmeris alternifolia	Wingstem
Asclepias incarnata	Swamp Milkweed
Eupatorium perfoliatum	Common Boneset
Verbena hastata	Blue Vervain
Eupatorium fistulosum	Hollow Joe Pye
Mimulus ringens	Monkey Flower
Lobelia cardinalis	Cardinal Flower

Woody shrubs for native restoration

Scientific Name	Common Name
Aronia melanocarpa	Black chokecherry
Cephalanthus occidentalis	Buttonbush
Cornus amomum	Silky dogwood
Cornus sericea	Red-osier dogwood
Physocarpus opulifolius	Ninebark
Salix discolor	Pussy willow
Sambucus canadensis	Elderberry
Ilex verticillate	Winterberry
Rosa palustris	Swamp rose

DRG's Premium Obligate Wetland Mix for restoration

Scientific Name	Common Name
Acornus americanus	Sweetflag
Alisma subcordatum	Water plantain
Cephalanthus occidentalis	Buttonbush
Iris versicolor	Blueflag
Nuphar advena	Yellow pond lily
Peltandra virginica	Arrow arum
Pontederia cordata	Pickerelweed
Rosa palustris	Swamp rose
Sagittaria latifolia	Arrowhead
Schoenoplectus tabernaemontani	Softstem bulrush
Sparganium americanum	American burreed
Sparganium eurycarpum	Broadfruit burreed
Hibiscus moscheutos	Swamp rose mallow

APPENDIX D
TREE PLANTING GUIDE

Tree Planting

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

When planting trees, it is important to be cognizant of the following:

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

Tree Species Selection

Selecting a limited number of species could simplify decision-making processes; however, careful deliberation and selection of a wide variety of species is more beneficial and can save money. Planting a variety of species can decrease the impact of species-specific pests and diseases by limiting the number of susceptible trees in a population. This reduces time and money spent to mitigate pest- or disease-related problems. A wide variety of tree species can help limit the impacts from physical events, as different tree species react differently to stress. Species diversity helps withstand drought, ice, flooding, strong storms, and wind.

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

The Right Tree in the Right Place is a mantra for tree planting used by the Arbor Day Foundation and many utility companies nationwide. Trees come in many different shapes and sizes, and often change dramatically over their lifetimes. Some grow tall, some grow wide, and some have extensive root systems. Before selecting a tree for planting, make sure it is the right tree—know how tall, wide, and deep it will be at maturity. Equally important to selecting the right tree is choosing the right spot to plant it. Blocking an unsightly view or creating some shade may be a priority, but it is important to consider how a tree may impact existing utility lines as it grows taller, wider, and deeper. If the tree's canopy, at maturity, will reach overhead lines, it is best to choose another tree or a different location. Taking the time to consider location before planting can prevent power disturbances and improper utility pruning practices.

A major consideration for street trees is the amount of litter dropped by mature trees. Trees such as *Acer saccharinum* (silver maple) have weak wood and typically drop many small branches during a growing season. Others, such as *Liquidambar styraciflua* (American sweetgum), drop

high volumes of fruit. In certain species, such as *Ginkgo biloba* (ginkgo), female trees produce large odorous fruit; male ginkgo trees, however, do not produce fruit. Furthermore, a few species of trees, including *Crataegus* spp. (hawthorn) and *Gleditsia triacanthos* (honeylocust), may have substantial thorns. These species should be avoided in high-traffic areas.

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

Tips for Planting Trees

To ensure a successful tree planting effort, the following measures should be taken:

- Handle trees with care. Trees are living organisms and are perishable. Protect trees from damage during transport and when loading and unloading. Use care not to break branches, and do not lift trees by the trunk.
- If trees are stored prior to planting, keep the roots moist.
- Dig the planting hole according to the climate. Generally, the planting hole is two to three times wider and not quite as deep as the root ball. The root flair is at or just above ground level.
- Fill the hole with native soil unless it is undesirable, in which case soil amendments should be added as appropriate for local conditions. Gently tamp and add water during filling to reduce large air pockets and ensure a consistent medium of soil, oxygen, and water.
- Stake the tree as necessary to prevent it from shifting too much in the wind.
- Add a thin layer (1–2 inches) of mulch to help prevent weeds and keep the soil moist around the tree. Do not allow mulch to touch the trunk.
- There is no substitute for purchasing high-quality trees. All trees should be inspected to ensure that they meet the size and proportion guidelines set out in the American Standard for Nursery Stock (ANSI Z60.1). Some of the characteristics of healthy nursery trees include free of bark injuries and wounds, healthy root systems, balanced branch distribution, proper taper, and good vigor.
- Initially, watering is the key to survival; new trees typically require at least 60 days of watering to establish. Determine how often trees should be irrigated based on time of planting, drought status, species selection, and site condition.
- Mulch should be applied to the grow space around a newly planted tree (or even a more mature tree) to ensure that no weeds grow, that the tree is protected from mechanical damage, and that the grow space is moist. Mulch should be applied in a thin layer, generally 1 to 2 inches, and the growing area should be covered. Mulch should not touch the tree trunk or be piled up around the tree.

Newly Planted and Young Tree Maintenance

Caring for trees is just as important as planting them. Once a tree is planted, it must receive maintenance for several years.

Watering

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

Mulching

Mulch can be applied to the grow space around a newly planted tree (or even a more mature tree) to ensure that no weeds grow, that the tree is protected from mechanical damage, and that the grow space is moist. Mulch should be applied in a thin layer, generally 1 to 2 inches, and the growing area should be covered. Mulch should not touch the tree trunk or be piled up around the tree.

Lifelong Tree Care

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

The municipality should employ qualified arborists to provide most of the routine tree care. An arborist can determine the type of pruning necessary to maintain or improve the health, appearance, and safety of trees. These techniques may include: eliminating branches that rub against each other; removing limbs that interfere with wires and buildings or that obstruct streets, sidewalks, or signage; removing dead, damaged, or weak limbs that pose a hazard or may lead to decay; removing diseased or insect-infested limbs; creating better structure to reduce wind resistance and minimize the potential for storm damage; and removing branches—or thinning—to increase light penetration.

An arborist can help decide whether a tree should be removed and, if so, to what extent removal is needed. Additionally, an arborist can perform—and provide advice on—tree maintenance when disasters such as storms or droughts occur. Storm-damaged trees can often be dangerous to remove or trim. An arborist can assist in advising or performing the job in a safe manner while reducing further risk of damage to property. The arborist can also help with cabling or bracing for added support to branches with weak attachment, aeration to improve root growth, and installation of lightning protection systems.

Plant health care, a preventive maintenance process that keeps trees in good health, helps a tree better defend itself against insects, disease, and site problems. Arborists can help determine proper plant health so that the municipal tree population will remain healthy and provide benefits to the community for as long as possible.

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

APPENDIX E
INVASIVE PESTS AND DISEASES

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

Although some invasive species naturally enter the United States via wind, ocean currents, and other means, most invasive species enter the country with some help from human activities. Their introduction to the U.S. is a byproduct of cultivation, commerce, tourism, and travel. Many species enter the United States each year in baggage, cargo, contaminants of commodities, or mail.

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

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

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

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

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

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

Asian Longhorned Beetle

The Asian longhorned beetle (ALB, *Anoplophora glabripennis*) is an exotic pest that threatens a wide variety of hardwood trees in North America. The beetle was introduced in Chicago, New Jersey, and New York City, and is believed to have been introduced in the United States from wood pallets and other wood-packing material accompanying cargo shipments from Asia. ALB is a serious threat to America's hardwood tree species.

Adult Asian longhorned beetle

Photograph courtesy of New Bedford Guide 2011

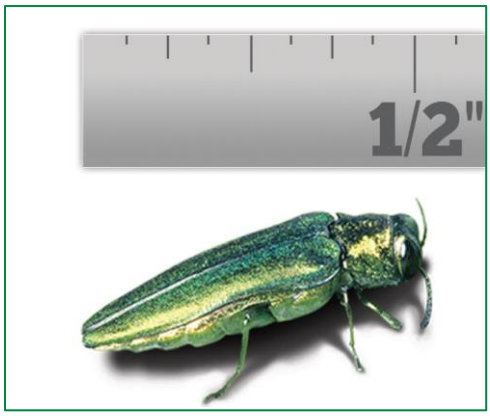
ALB is a serious threat to a large number of America's hardwood tree species. Like EAB, this invasive pest arrived from Asia within the last few decades. However, unlike EAB, ALB targets many common species (maple, birch, horse chestnut, poplar, willow, elm, and ash) and is, for the most part, untreatable.

Because it is untreatable, if found, the USDA institutes an immediate removal of host trees and a strict quarantine to stop the spread of this devastating pest. Proper identification and destruction of host trees is the only acceptable control practice. The management of ALB is under state and federal regulations. Eradication is possible, but the impact of the process can be devastating to a community. First found in Brooklyn in 1996, ALB has since been detected in Worcester, Massachusetts, southwest Ohio, and Central Long Island. The most important thing is early detection, which requires vigilant monitoring. This is why educating the public and city staff is so important.

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

Emerald Ash Borer

Emerald ash borer *(EAB) (Agrilus planipennis*) is responsible for the death or decline of tens of millions of ash trees in 14 states in the American Midwest and Northeast. Native to Asia, EAB has been found in China, Japan, Korea, Mongolia, eastern Russia, and Taiwan. It likely arrived in the United States hidden in wood-packing materials commonly used to ship consumer goods, auto parts, and other products. The first official United States identification of EAB was in southeastern Michigan in 2002. The EAB-preferred host tree species are in the genus *Fraxinus* (ash).



Close-up of the emerald ash borer

Photograph courtesy of APHIS (2011)

Emerald ash borer (*Agrilus planipennis*) is a small insect native to Asia. In North America, the borer is an invasive species that is highly destructive to ash trees in its introduced range. The potential damage of EAB rivals that of chestnut blight and Dutch elm disease. Chestnut blight is a fungus that was introduced in North America around 1900 and by 1940 it wiped out most of the mature American chestnut population. Dutch elm disease is a fungus spread by the elm bark beetle. Since its discovery in the United States in 1928, it has killed millions of elm trees. EAB is thought to have been introduced into the United States and Canada in the 1990s but was not positively identified in North America until 2002 in Canton, Michigan. It has now been confirmed in 14 states and has killed at least 50 to 100 million ash trees so far and threatens another 7.5 billion ash trees throughout North America. The EAB is a serious pest and is known to attack all native ash trees, including black, blue, green and white ash. The state is committed to early detection and thoughtful management of this pest.

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.

EAB adults grow to 5/8 inch in length (Photo courtesy of www.wisconsin.gov).

EAB larvae (Photo courtesy of www.emeraldashborer.info).

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.

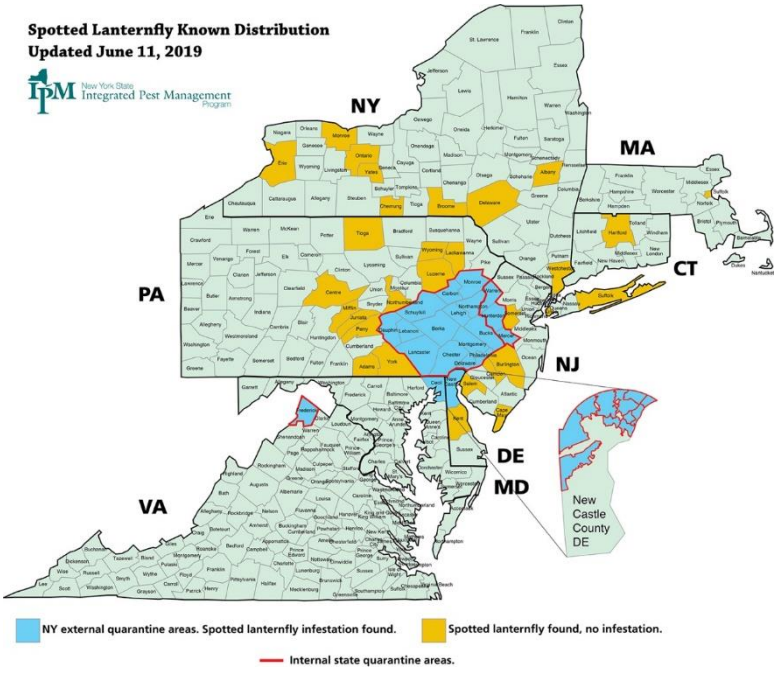
The GMs prefer approximately 150 primary hosts but feed on more than 300 species of trees and shrubs. Some trees are found in these common genera: *Betula* (birch), *Juniperus* (cedar), *Larix* (larch), *Populus* (aspen, cottonwood, poplar), *Quercus* (oak), and *Salix* (willow).

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

Photograph courtesy of APHIS (2011b)

Spotted Lanternfly

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



Spotted Lanternfly Detections in New England as of June 2019. Map by New York State Integrated Pest Management Program
https://nysipm.cornell.edu/environment/invasive-species-exotic-pests/spotted-lanternfly/spotted-lanternfly-ipm/introduction-native-range-and-current-range-us/

In December 2018, a single dead adult was found in Boston, Massachusetts after being discovered in a shipment of poinsettias from Pennsylvania. Currently, this has been the only insect found in Massachusetts. The spotted lanternfly will lay its eggs on plant surfaces, firewood, cars, and other non-host material, which can easily be transported. It can alos be transported along rail lines, whereas Dunkirk has an active rail line. An adult SLF was found in Buffalo in the last several months. Dunkirk's residents should be educated about the spotted lanternfly, because early dection can help prevent an infestation.

Spotted laternfly prefers the host tree-of-heaven, but it feeds on a wide range of fruit, ornamental and woody trees, and agricultural crops (such as apples, peaches, grapes, and hops). While the science of the spotted laternfly is still unfolding, removing tree-of-heaven may help slow its spread.

Hemlock Woolly Adelgid

The hemlock woolly adelgid (HWA, *Adelges tsugae*) was first described in western North America in 1924 and first reported in the eastern United States in 1951 near Richmond, Virginia.

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

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

Hemlock woolly adelgids on a branch

Photograph courtesy of USDA Forest Service (2011a)

Sirex Woodwasp

Sirex woodwasp (*Sirex noctillio*) has been the most common species of exotic woodwasp detected at United States ports-of-entry associated with solid wood-packing materials. Recent detections of sirex woodwasp outside of port areas in the United States have raised concerns because this insect has the potential to cause significant mortality of pines. Awareness of the symptoms and signs of a sirex woodwasp infestation increases the chance of early detection, thus increasing the rapid response needed to contain and manage this exotic forest pest.

Close-up of female Sirex Woodwasp

Photograph courtesy of USDA (2005)

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

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

Southern Pine Beetle

The southern pine beetle (SPB, *Dendroctonus frontalis*) is the most destructive insect pest of pine in the southern United States. It attacks and kills all species of southern yellow pines including *P. strobus* (eastern white pine). Trees are killed when beetles construct winding, S-shaped egg galleries underneath the bark. These galleries effectively girdle the tree and destroy the conductive tissues that transport food throughout the tree. Furthermore, the beetles carry blue staining fungi on their bodies that clog the water conductive tissues (wood), which transport water within the tree. Signs of attack on the outside of the tree are pitch tubes and boring dust, known as frass, caused by beetles entering the tree.

Adult southern pine beetles

Photograph courtesy of Forest Encyclopedia Network (2012)

Adult SPBs reach an ultimate length of only 1/8 inch, similar in size to a grain of rice. They are short-legged, cylindrical, and brown to black in color. Eggs are small, oval-shaped, shiny, opaque, and pearly white.

Dutch Elm Disease

Considered by many to be one of the most destructive, invasive diseases of shade trees in the United States, Dutch elm disease (DED) was first found in Ohio in 1930; by 1933, the disease was present in several East Coast cities. By 1959, it had killed thousands of elms. Today, DED covers about two-thirds of the eastern United States, including Illinois, and annually kills many of the remaining and newly planted elms. The disease is caused by a fungus that attacks the vascular system of elm trees blocking the flow of water and nutrients, resulting in rapid leaf yellowing, tree decline, and death.

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

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

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

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

Oak Wilt

Oak wilt was first identified in 1944 and is caused by the fungus *Ceratocystis fagacearum*. While considered an invasive and aggressive disease, its status as an exotic pest is debated since the fungus has not been reported in any other part of the world. This disease affects the oak genus and is most devastating to those in the red oak subgenus, such as *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.

Oak wilt symptoms on red and white oak leaves

Photograph courtesy of USDA Forest Service (2011a)

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

References

———. 2011a. Beetle Detectives EAB. APHIS 81-35-016.

———. 2011b. Hungry Pests-Gypsy Moth. http://www.aphis.usda.gov/hungrypests/GypsyMoth.shtml. Accessed December 29, 2011.

———. 2002. Plant Protection and Quarantine. Pine Shoot Beetle Fact Sheet.

APHIS. Plant Health, Plant Pest Program Information. www.aphis.usda.gov/plant_health/plant_pest_info. Accessed April 24, 2012.

Atkinson, T.H., J.L. Foltz, R.C. Wilkinson, and R.F. Mizell. 2011. Granulate Ambrosia Beetle, Xylosandrus crassiusculus (Motschulsky) (Insecta: Coleoptera: Curculionidae: Scolytinae). The University of Florida, IFAS Extension, Publication: #EENY131.

Forest Encyclopedia Network. *Southern Pine Beetle*. http://www.forestencyclopedia.net/p/p2901. Accessed March 23, 2012.

Indiana Department of Natural Resources. Entomology and Plant Pathology. Sudden Oak Death. http://www.in.gov/dnr/entomolo/4532.htm. Accessed July 20, 2012.

Katovich, S. USDA Forest Service, Bugwood.org. *Dutch elm disease.* September 7, 2005. Invasives.org, http://www.invasive.org/browse/detail.cfm?imgnum=1398053 (October 21, 2011.)

New Bedford Guide. 2011. *Volunteers Needed for Asian Longhorned Beetle Survey*. http://www.newbedfordguide.com/volunteers-needed-for-asian-longhorned-beetle-survey/2011/03/30. Accessed April 3, 2012.

Rabaglia, R. 2003. *Xylosandrus mutilatas.* 2003. http://www.invasivespecies.net/database/species/ecology.asp?si=963&fr=1&sts=. Accessed April 2015.

Rexrode, C.O. and D. Brown. 1983. *Forest Insect and Disease Leaflet, #29-Oak Wilt*. USDA Forest Service.

Thomas, M.C. November 4, 2002. Bugwood, http://www.forestryimages.org/browse/detail.cfm?imgnum=1460068 (April 7, 2015).

University of Georgia. Center for Invasive Species and Ecosystem Health. www.bugwood.org. Accessed April 24, 2012.

USDA Forest Service. 2011a.. *Forest Health Protection—Hemlock Woolly Adelgid*. http://na.fs.fed.us/fhp/hwa/. Accessed December 29, 2011.

———. 2011b. (Revised). *Pest Alert-Thousand Cankers Disease*. Northeastern Area State and Private Forestry. NA–PR–02–10.

USDA National Agricultural Library. National Invasive Species Information Center. www.invasivespeciesinfo.gov/microbes. Accessed April 24, 2012.

USDA Northeastern Areas Forest Service. Forest Health Protection. www.na.fs.fed.us/fhp. Accessed April 24, 2012.

USDA Northeastern Areas Forest Service, State and Private Forestry, Forest Health Protection. 1993. Pest Alert Common Pine Shoot Beetle. NA-TP-05-93.

APPENDIX F
STORM RESPONSE CATEGORIES FOR THE URBAN FOREST

Storm Emergency Categories in the Urban Forest

Storm severity and resulting damage in the urban forest will vary; the degrees of response and resources need to respond will vary as well. For planning purposes, severe weather can generally be classified into three classes: Class I, II, and III. The following descriptions of these classes and the responses are offered for city consideration and adoption as part of an official emergency response plan.

Class I – Minor Storm Event

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

Damage reports and service requests are made to the government department directly by citizens and from staff inspections. Damage is corrected, and debris is disposed by municipal staff and contractors on site or following customary procedures.

Generally, Class I storms require no outside assistance for parks or streets personnel, and only limited (if any) assistance from contractors or others. Storm damage remediation and clean-up are achieved by municipal staff and/or contractors, requires no additional funding or special equipment, and is completed quickly.

Class I – Storm Mitigation Procedures

- Municipal urban forestry staff receive calls/reports from citizens and partnering agencies.
- Municipal urban forestry staff inspect and determine appropriate mitigation; utility company is called as required.
- Municipal urban forestry staff and/or contractors immediately resolve damage and dispose of debris.
- Municipal urban forestry staff perform a final inspection, complete a work order, and/or otherwise note the occurrence in the tree inventory database.

Class II – Large Storm Event

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

Class II storms exceed the normal staff and resources of the municipality and/or contractors alone. Damage mitigation for these storms will usually require the assistance of outside contractors and from other government departments. The assistance will come in the forms of additional staff and equipment, communication assistance, public safety measures, electrical hazard reduction, and customer service.

Class II Storm Mitigation Procedures

- Municipal urban forestry staff assess damage and immediately communicate with police and fire to determine the extent of the damage.
- The informal EOC should be convened to receive calls/reports and to coordinate mitigation response.
- Municipal urban forestry staff inspect damage, determine mitigation levels and needs, and set work priorities.
- Municipal urban forestry staff designate personnel and equipment resources under the guidance of the EOC leader.
- Municipal urban forestry staff and contractual staff resolve damage, process debris on site where appropriate, or transport debris to storage site.
- Municipal urban forestry staff make final inspection and update the tree inventory database.
- Debris is processed appropriately.
- Municipal urban forestry staff should communicate with the citizens about its response activities and status using the city's website and social media platforms.

Class III – Catastrophic Storm Event

Class III storms will be rare but can occur. Generally, these will result from snowstorms and widespread ice storms. Damage will be severe and widespread on both public and private property.

A "State of Emergency" will likely be called during and after a Class III storm event. A full EOC should be convened by city officials. Other local, state, and federal emergency management agencies will become involved, as well as department of transportations, and natural gas and electric utility providers. It will become necessary to identify municipal funding that can be used to finance additional contractual services, equipment, and staff overtime for the mitigation efforts.

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

The second priority of streets and highways to be cleared of debris are those that provide access to components of the public and private utility systems that are vital to the restoration of essential utility services, such as electrical power stations and substations, municipal water and sanitary sewer pumping stations, and communication stations and towers. The last priority of roadways to be cleared are residential streets and alleys/access ways.

No debris is intended to be removed during the initial emergency road-clearing operations. Rather, debris is to be moved to the side of the roadway that will allow for a minimum of one lane of traffic in each direction and not create conflict with future utility restoration efforts by others.

Class III - Storm Mitigation Procedures

- Municipal urban forestry staff assesses damage and immediately communicates with the EOC and the designated municipal staff leader to determine the extent of the damage. County and State Emergency Management agencies may also be in the communication channels.
- Municipal urban forestry staff secures additional regional tree debris disposal site(s) as needed.
- Municipal urban forestry staff inspects tree-related damage, determines mitigation levels and needs, and sets work priorities.
- Municipal, county, DOT and other agencies combine sufficient and appropriate personnel and equipment resources under the guidance of the municipality to mitigate tree-related situations.
- Municipality, allied agencies, and contractual staff resolve damage, process debris on site where appropriate, or transport debris to storage site.
- Municipal urban forestry staff make final inspection and update the tree inventory database.
- Debris is processed appropriately.
- Municipal urban forestry staff assist EOC team members and municipal leaders with completion of required state and FEMA forms.
- Municipal urban forestry staff should communicate with the citizens about its response activities and status, and advice for the treatment of private trees that have been damaged using the municipal website, and social media platforms.

Partners

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

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

1. **Utility Agencies**

   Electric distribution lines are the responsibility of the corresponding utility and are a key partner during a storm emergency. Only electrical provider staff are qualified to work around energized lines. They have the resources to mobilize quick and appropriate responses to emergency situations involving trees and utilities. During a widespread storm event, the municipality will likely also need to communicate and coordinate with the county public utility service agency or the state power agency. Where whole trees or limbs are down or resting on energized lines, rescue and clean-up efforts cannot proceed until power lines have been addressed by the trained personnel of these agencies. Prioritization of where utility agencies respond first generally are: three-phase aerial electric lines; single-phase aerial electric lines; secondary electric lines; and then service (or residential) drops.

2. **State Department of Transportations (DOTs)**

   DOTs are responsible for the safety and maintenance of interstate and state routes within and around municipalities. During a storm emergency, they can respond with staff and equipment to clear such rights-of-way and assist with municipal streets if authorized. The DOT will likely have a priority clearing routes which may affect debris staging or removal patterns for the municipality. Check with the local district DOT authority to reflect upon their responsibilities and the municipal expectations for each storm category.

3. **Contractors**

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

4. **State of New York**

   When the response efforts appear to be beyond the capability of the municipality or the county, the state can normally provide the next level of assistance by declaring a state of emergency. The New York Department of Homeland Security's Division of Emergency Response and Recovery aids local emergency response leaders for major or complex emergencies or disasters. The division also assists local jurisdictions with recovery from natural or man-made disasters, in addition to coordinating mitigation programs designed to reduce the impact of future disasters on a community. The division typically evaluates the disaster situation and provides advice to the governor on the availability of state resources to assist local efforts.

   The Department of Homeland Security's website, http://www.dhses.ny.gov/, offers a toolbox of information to assist with the process of requesting aid and making claims for reimbursement. It offers several guide sheets and forms that provide excellent information about the application process and how to maintain adequate records of debris cleanup costs and contracting procedures.

5. **Federal Government**

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

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

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

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

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

FEMA Funding Programs

Following is a summary of key federal disaster aid programs that were offered by FEMA and administered by the state in 2014 when under a presidential disaster declaration:

- Payment of not less than 75% of the eligible costs for emergency protective measures taken to save lives and protect property and public health. Emergency protective measures assistance is available to state and eligible local governments on a cost-sharing basis (Source: FEMA funded; state administered).
- Payment of no less than 75% of the eligible costs for repairing or replacing damaged public facilities, such as roads, bridges, utilities, buildings, schools, recreational areas, and similar publicly owned property, as well as certain private non-profit organizations engaged in community service activities (Source: FEMA funded, state administered).
- Payment of no less than 75% for snow assistance, for a specific period of time during or proximate to the incident period. Snow Assistance may include snow removal, de-icing, salting, snow dumps, and sanding of roads (Source: FEMA funded, state administered).
- Payment of no more than 75% of the approved costs for hazard mitigation projects undertaken by state and local governments to prevent or reduce long-term risk to life and property from natural or technological disasters (Source: FEMA funded; state administered).