TREE MANAGEMENT PLAN

Village of Cayuga Heights, New York

September 2019

Prepared for:

Village of Cayuga Heights
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TREE MANAGEMENT PLAN PURPOSE

Cayuga Heights has a fundamental interest in the success of trees within the Village, conceived as a residential park by one of its founders, Jared T. Newman. Aspects of that original vision include topography-based meandering streets and the picturesque positioning of buildings in a continuous parkland setting. This historic pattern of development emphasizes stewardship of both the built and natural environment within the Village. The Village's community character goal of its 2014 Comprehensive Plan is to, *"Preserve and enhance the rich collection of natural, architectural, cultural, historic, and scenic resources that make the Village a distinctive community."*

The Comprehensive Plan describes seven topics which support a sustainable future for its residents. In both direct and indirect terms, the Village's trees are intertwined with each of the seven topics, enhancing the purpose and need for this tree management plan.

Topics of Comprehensive Plan	Corresponding Tree Management Plan Topic
Quality of Life	Ecological Benefits
Community Character	Tree Species Diversity
Ecology and Scenic Assets	Air Quality / Carbon Sequestration
Economy	Structural Benefits
Housing	Proper Street Tree Stocking Level
Transportation	Storm Readiness
Public Services and Utilities	Tree Management Program (Pruning / Training)

ACKNOWLEDGMENTS

Cayuga Heights is thankful for the grant funding it received from the New York State Department of Environmental Conservation. The Cayuga Heights Tree Inventory and Management Plan was financially supported by an $18,100 NYSDEC grant. The Department of Environmental Conservation’s Urban and Community Forestry grant projects are made available through New York State’s Environmental Protection Fund, providing crucial assistance for communities to help develop and implement comprehensive projects to create healthy forests and enhance quality of life for residents. The Village also recognizes the support of its Mayor and Board of Trustees.

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

EXECUTIVE SUMMARY

This plan was developed for the Village of Cayuga Heights by DRG with a focus on addressing short-term and long-term maintenance needs for inventoried public trees. DRG completed a tree inventory in July 2019 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 Village's existing program and vision for the urban forest were utilized to develop this *Tree Management Plan*. Also included in this plan is a storm response readiness section.

State of the Existing Urban Forest

The July 2019 inventory included trees, stumps, and planting sites along public street rights-of- way (ROW) in Cayuga Heights, New York. A total of 3,380 sites were recorded during the inventory: 2,851 trees, 57 stumps, and 472 planting sites. Analysis of the tree inventory data found the following:

- The street tree population is insufficiently diverse with two species, *Acer platanoides* (Norway maple) and *Pinus strobus* (white pine), comprising a large percentage of the population (15% and 11%, respectively).
- The diameter size class distribution of the inventoried tree population contains too few young trees suggesting the need for additional new plantings.
- The overall condition of the inventoried tree population is rated Good to Fair; 33.28% of the inventoried trees had dead or dying parts noted and 10.68% of the inventoried trees had a clearance issue.
- Overhead utilities not interfering with street trees occur among 18.49% of the population.
- Granulate ambrosia beetle (*Xylosandrus crassiusculus*) and gypsy moth (*Lymantria dispar dispar*) pose the biggest threats to the health of the inventoried population.
- Cayuga Heights' trees have a structural value of $5,220,000 and $238,000 in total carbon storage.
- Trees provide approximately $10,000 in the following functional annual benefits:
    - *Air quality improved:* 1,278 pounds of pollutants removed valued at $2,978 per year.
    - *Total carbon sequestered:* 19.76 tons valued at $3,370 per year.
    - *Avoided stormwater runoff:* 435,274 gallons valued at $3,889 per year.

Tree Maintenance and Planting Needs

Trees provide many environmental and economic benefits that justify the time and money invested in planting and maintenance. Recommended maintenance needs include: Tree Removals, Stump Removals, Routine Pruning Program, Young Tree Training Program, and Tree Planting with Maintenance Costs. Overall inventory maintenance should be prioritized by addressing trees with the highest risk first. The inventory noted some Extreme and High Risk trees (2% of trees assessed). These trees should be removed or pruned immediately to promote public safety. Low and Moderate Risk trees should be addressed after all Extreme and High Risk tree maintenance has been completed. Trees should be planted to mitigate removals and create canopy.

Cayuga Heights' 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 300 young trees should be structurally pruned each year during the young tree training cycle, and approximately 500 trees should be cleaned each year during the routine pruning cycle.

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). DRG recommends planting at least 25 trees of a variety of species each year to offset these losses, increase canopy, maximize benefits, and account for ash tree loss.

Tree planting throughout the Village should focus on replacing tree canopy 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. A variety of tree species should be planted; however, the planting of Norway maple should cease at this time. Due to the threat posed by emerald ash borer (EAB, *Agrilus planipennis*), all *Fraxinus* spp. (ash) trees should be temporarily removed from the planting list.

Urban Forest Program Needs

Adequate funding will be needed for the Village 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 $109,617. The total cost of the 5-year program is $516,224. Costs can be reduced by extending the time frame of the program. Increasing the program to 10 years would cost approximately $50,000 annually. The overarching goal of the budget is to provide estimated annual costs of reducing existing public risk as noted in the July, 2019 tree inventory.

In the 5-year program, the total annual cost will decrease by approximately $2,500 per year by Year 5 of the program. 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. Annual estimated costs for a 5-year program and the recommended actions are provided in Figure 1 on the following page.

Over the long term, supporting proactive management of trees through funding will reduce municipal tree care management costs and potentially minimize the costs to build, manage, and support certain Village infrastructure. Maintaining the inventory data using TreeKeeper® or similar software is crucial for making informed management decisions and projecting accurate maintenance budgets.

Cayuga Heights 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.

FY 2020 **$109,617**

- 55 Extreme or High Risk Removals
- 18 Extreme or High Risk Prunes
- 9 Stump Removals
- RP Cycle: 1/5th of Public Trees Cleaned, 544 Trees
- YTT Cycle: 300 Trees
- 25 Trees Recommended for Planting and Follow-Up Care
- Newly Found Priority Tree Work (Removal or Pruning): Costs TBD

FY 2021 **$104,421**

- 29 Moderate or Low Risk Removals
- 25 Stump Removals
- RP Cycle: 1/5th of Public Trees Cleaned, 521 Trees
- YTT Cycle: 297 Trees
- 25 Trees Recommended for Planting and Follow-Up Care
- Newly Found Priority Tree Work (Removal or Pruning): Costs TBD

FY 2022 **$103,588**

- 53 Moderate or Low Risk Removals
- 22 Stump Removals
- RP Cycle: 1/5 of Public Trees Cleaned, 521 Trees
- YTT Cycle: 297 Trees
- 25 Trees Recommended for Planting and Follow-Up Care
- Newly Found Priority Tree Work (Removal or Pruning): Costs TBD

FY 2023 **$102,597**

- 117 Moderate or Low Risk Removals
- RP Cycle: 1/5 of Public Trees Cleaned, 521 Trees
- YTT Cycle: 297 Trees
- 25 Trees Recommended for Planting and Follow-Up Care
- Newly Found Priority Tree Work (Removal or Pruning): Costs TBD

FY2024 **$96,003**

- 165 Moderate or Low Risk Removals
- RP Cycle: 1/5 of Public Trees Cleaned, 521 Trees
- YTT Cycle: 297 Trees
- 25 Trees Recommended for Planting and Follow-Up Care
- Newly Found Priority Tree Work (Removal or Pruning): Costs TBD

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INTRODUCTION

The Village of Cayuga Heights is home to more than 3,600 full-time residents who enjoy the beauty and benefits of their urban forest. The Village'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). Cayuga Heights' public works department maintains a staff committed to developing a strong urban forest. Funding for the Village's urban forestry program comes from the Shade Tree Fund. The Village has a tree ordinance, tree board, maintains a budget of $2.78 per capita for tree-related expenses, celebrates Arbor Day, and has been a Tree City USA community for 6 years. Past urban forestry projects have demonstrated a desire to improve the environment through higher levels of public tree care.

Photograph 1. *Trees along Marcham Hall in Cayuga Heights.*

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 summer of 2019, Cayuga Heights worked with DRG to inventory trees and develop a management plan. This plan considers the diversity, distribution, and general condition of the inventoried trees, but also provides a prioritized system for managing public trees. The following tasks were completed:

- Inventory of trees, stumps, and planting sites along the street ROW and within one public park.
- Analysis of tree inventory data.
- Development of a plan that prioritizes the recommended tree maintenance.
- Evaluation of tree inventory for storm prone species.

This plan is divided into four 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 Cayuga Heights.
- *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. This section also addresses Tree Risk Reduction Guidelines.
- *Section 4: Storm Response Readiness* utilizes the inventory data to evaluate tree risks associated with weather events within the regional context of Cayuga Heights.

SECTION 1: TREE INVENTORY ANALYSIS

In July 2019, DRG arborists assessed and inventoried trees, stumps, and planting sites along the street rights-of-way. A total of 3,380 sites were collected during the inventory: 2,851 trees, 57 stumps, 472 planting sites. Figure 1 provides a detailed breakdown of the number and type of sites inventoried.

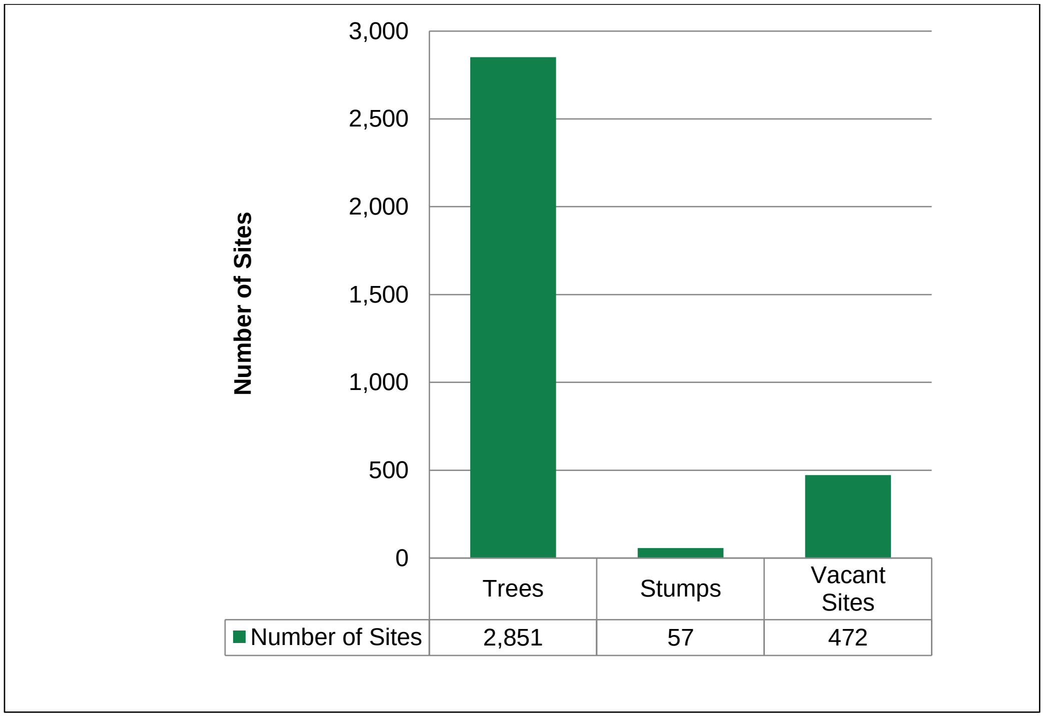
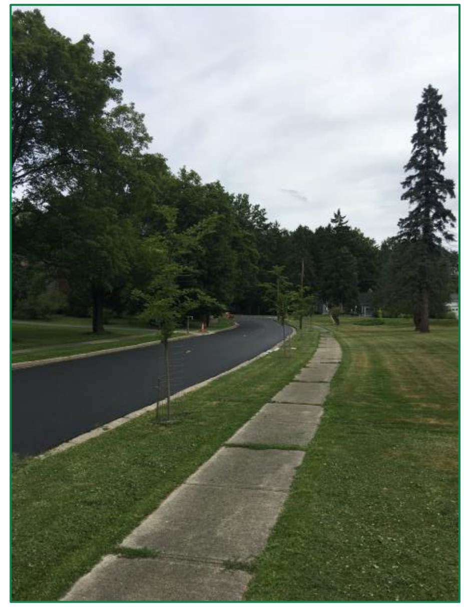


Figure 1. Sites collected during the July 2019 inventory.

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 2. *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*, 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.
- *Street ROW 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* 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 the Midwest.

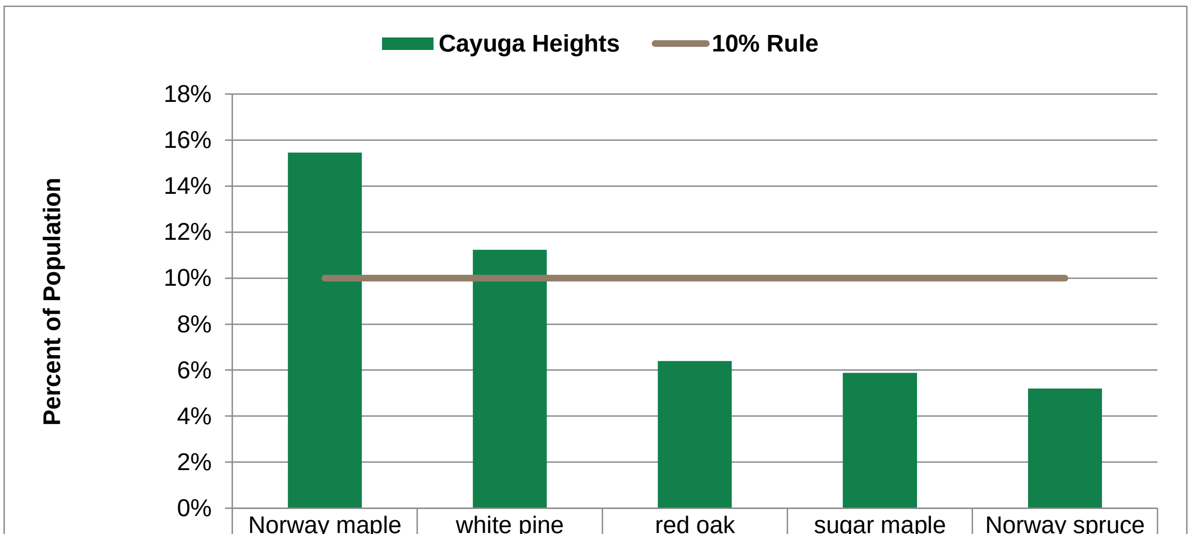
Due to the spread of Dutch elm disease in the 1930s, combined with the disease's prevalence today, massive numbers of *Ulmus americana* (American elm), a popular street tree in northeastern cities and towns, perished (Karnosky 1979). Several Midwestern communities were stripped of most of their mature 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, which is a biodiversity concern. Emerald ash borer (EAB, *Agrilus planipennis*) and Asian longhorned beetle (ALB, *Anoplophora glabripennis*) 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 (Santamour 1990) 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

Analysis of Cayuga Heights tree inventory data indicated that the overall tree inventory had relatively good diversity, with 58 genera and 123 species represented.

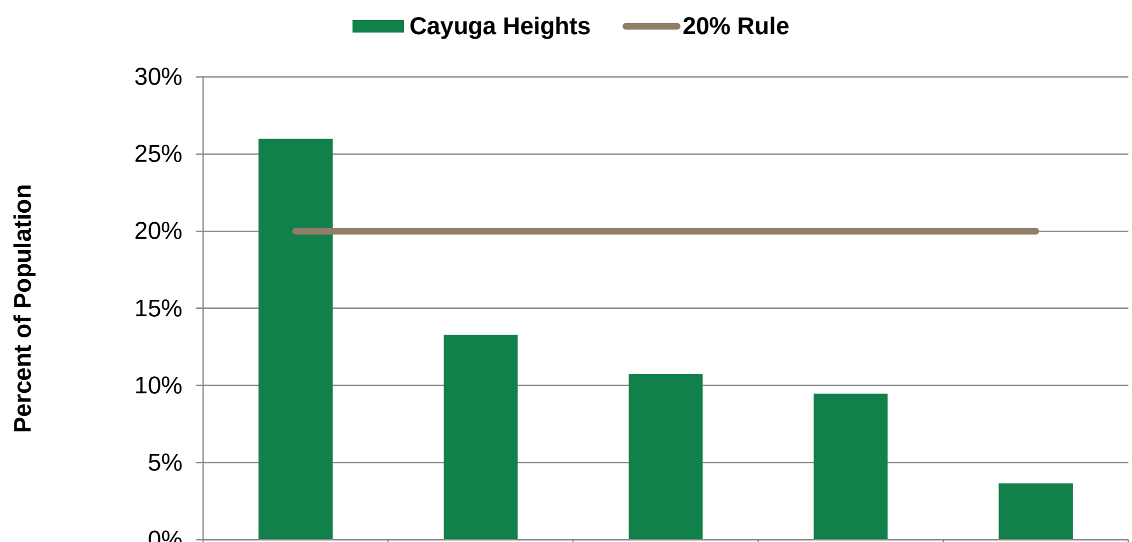
Figure 2 uses the 10% Rule to compare the percentages of the most common species identified during the inventory of the street tree populations. *Acer platanoides* (Norway maple) and *Pinus strobus* (white pine) exceed the recommended 10% maximum for a single species in a population, comprising 15% and 11% of the inventoried tree population, respectively. No other species are approaching this 10% threshold.



	Norway maple	white pine	red oak	sugar maple	Norway spruce
Cayuga Heights	15%	11%	6%	6%	5%
10% Rule	10%	10%	10%	10%	10%

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 street tree population. *Acer* (maple) exceeds the recommended 20% maximum for a single genus in a population, comprising 26% of the inventoried tree population. No other genera approach the 20% threshold.



	maple	pine	oak	spruce	cherry
Cayuga Heights	26%	13%	11%	9%	4%
20% Rule	20%	20%	20%	20%	20%

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

Discussion

Acer platanoides (Norway maple) exceeds the 10% rule, creating a biodiversity concern due to its abundance in the landscape. Continued diversity of tree species is an important objective that will ensure the street tree population of Cayuga Heights is sustainable and resilient to future invasive pest infestations. Norway maple is also considered an invasive species in New York State. Continued planting is not recommended to prevent the spread of the species. Consider planting non-maple native trees as a substitute.

Figure 4 shows the spatial distribution of Norway maple in Cayuga Heights based on the 2019 inventory data. Although widely distributed, its highest concentration is along Kline, Overlook, and Wyckoff Roads.

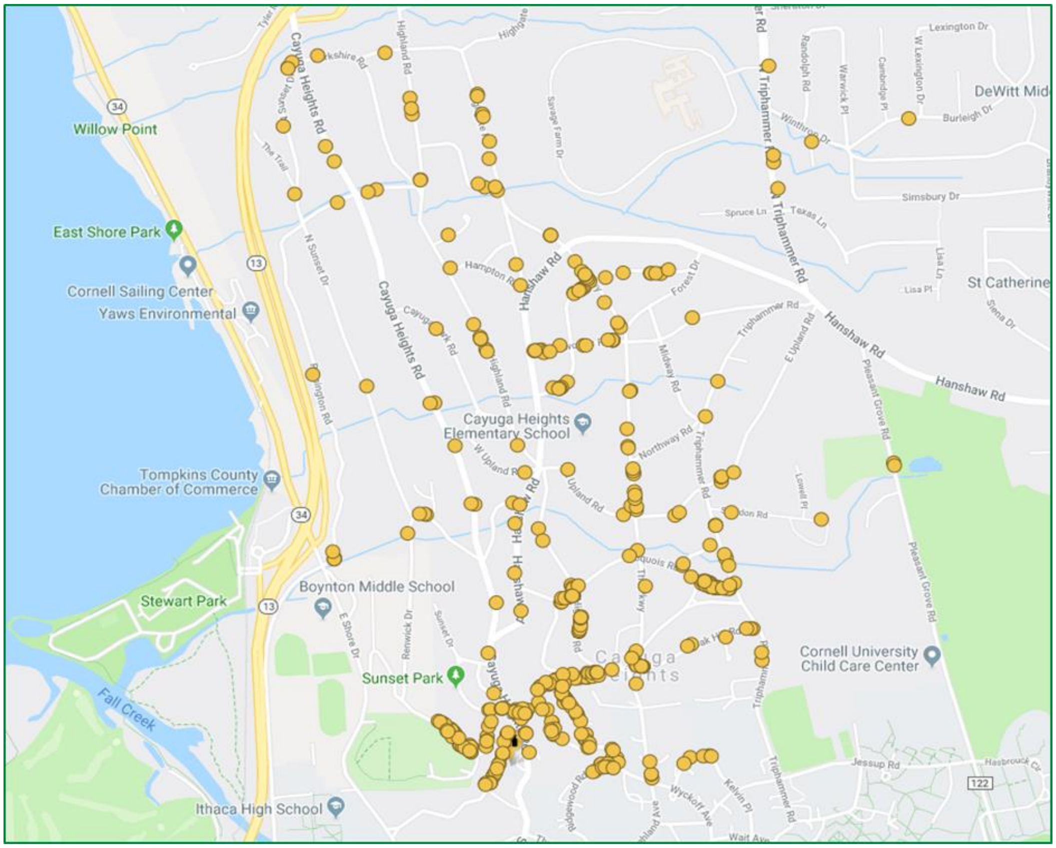


Figure 4. Norway maple distribution in Cayuga Heights.

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 trees (9–17 inches DBH), maturing trees (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.

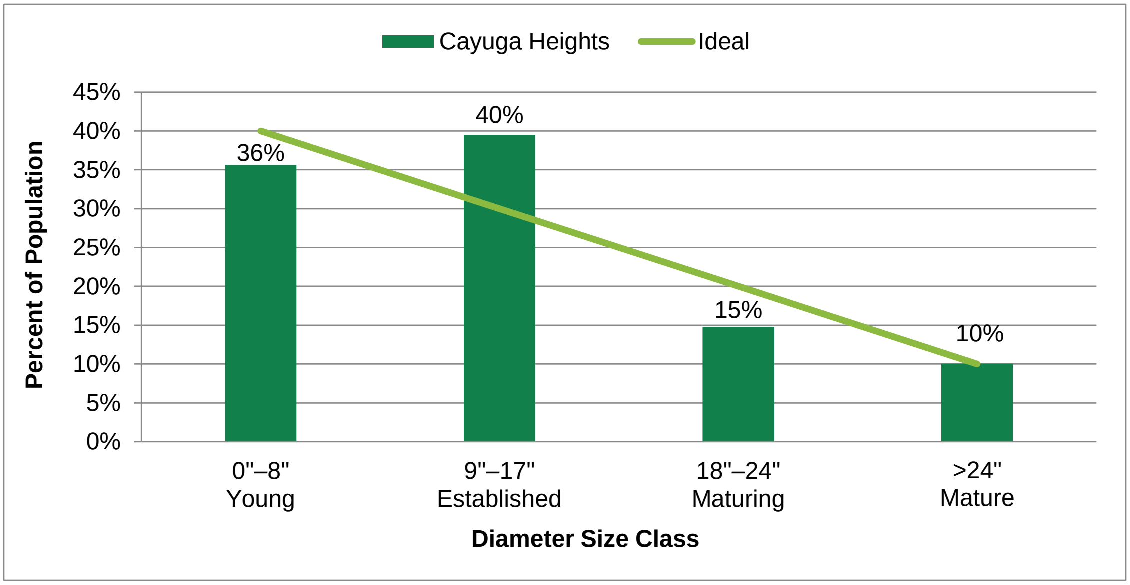


Figure 5. Comparison of diameter size class distribution for inventoried trees to the ideal distribution.

Figure 5 compares the diameter size class distribution of inventoried trees to the ideal distribution proposed by Richards (1983). The inventory distribution trends toward the ideal with the percentage of young trees exceeding the percentages of maturing and mature trees. However, there are too few young trees relative to the number of established trees and the number of maturing trees should be greater relative to the number of mature trees.

Discussion

The inventory has too few maturing and young trees, and perhaps too many established trees, which indicates that the distribution is somewhat non-ideal. DRG recommends that Cayuga Heights support increased levels of new plantings to ensure that enough young, healthy trees are in place to fill gaps in the tree canopy and replace older declining trees. Additionally, the bulge in the number of established trees will likely lead to an overabundance of maturing trees, which will require increased levels of pruning and maintenance. Therefore, while the Village should plant more young trees to normalize the population, it will also need to be proactive in caring for its existing trees to ensure their long term survival.

Special attention should be given to the large numbers of maturing and mature *Pinus strobus* (white pine) planted as an allee along the length of The Parkway. These pines contribute to the Village's identity and sense of place, but they are nearing the end of their service lives and will need to be replaced.

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 noted during the inventory in July 2019. Comparing the condition of the inventoried tree population with relative tree age (or trunk diameter 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).

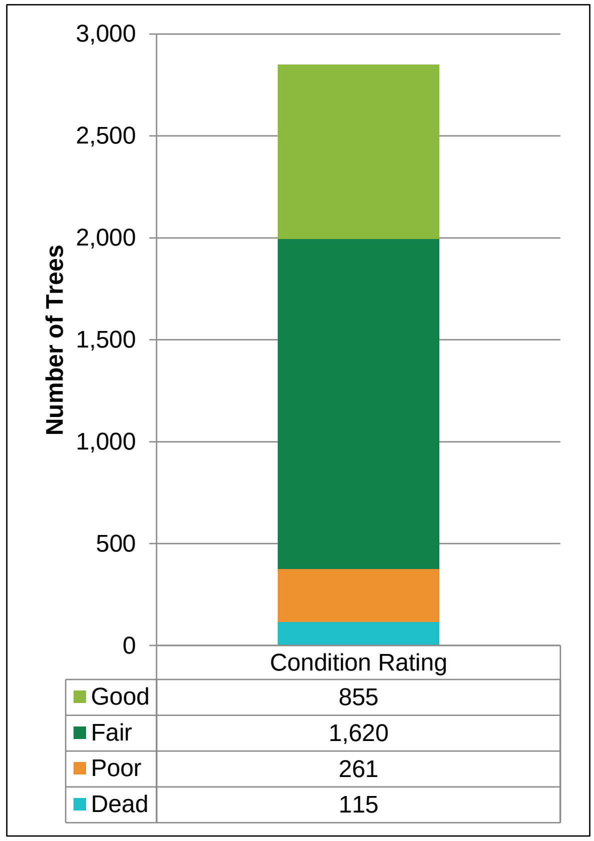


Figure 6. Conditions of inventoried trees.

Figures 6 and 7 illustrate the general health and distribution of young, established, mature, and maturing trees relative to their condition.

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.

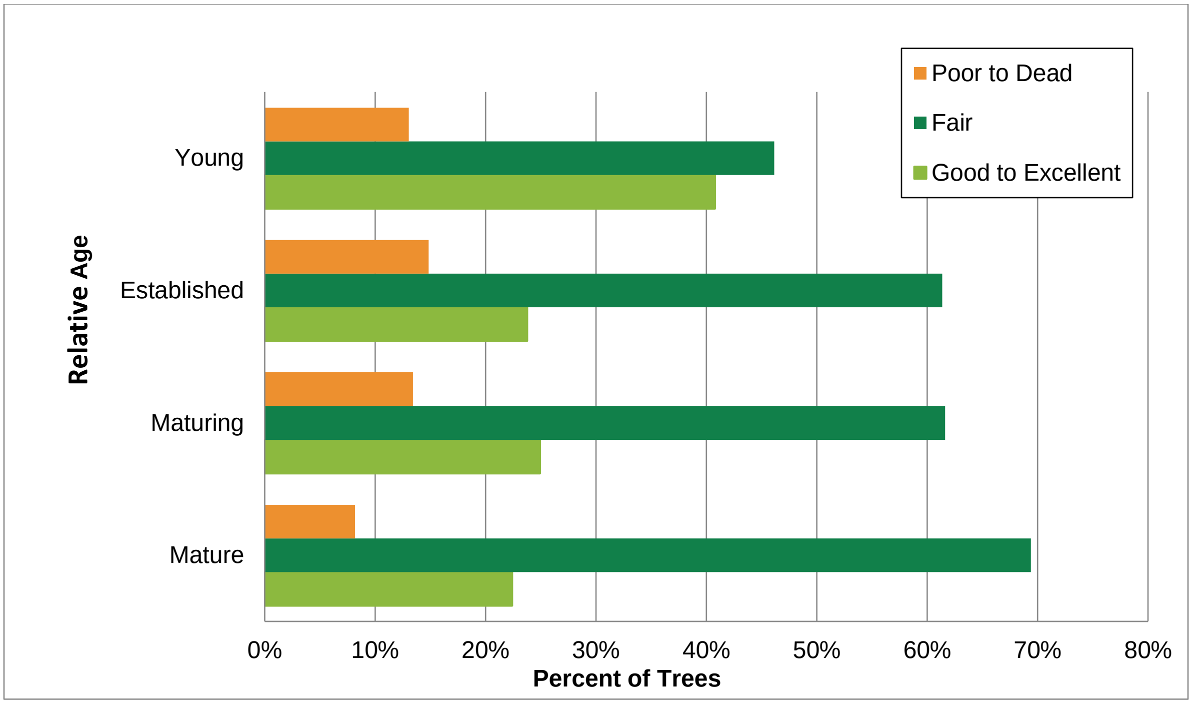


Figure 7. Tree condition by relative age during the July 2019 inventory.

Findings

Most of the inventoried trees were recorded to be in Good or Fair condition, 30% and 57%, respectively (Figure 6). Based on these data, the general health of the overall inventoried tree population is rated Fair. Figure 7 illustrates that most of the young, established, and maturing trees were rated to be in Fair condition, and that most of the mature trees were rated to be in Fair condition. Figure 8 is a graph of the top ten species noted in Poor condition and their corresponding amount in the inventory.

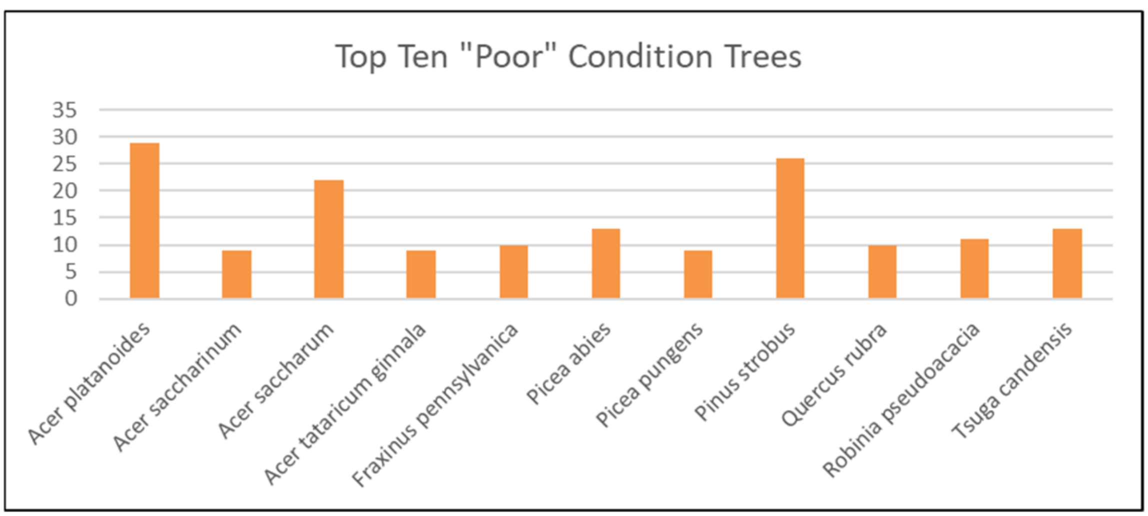


Figure 8. Top ten species in poor condition in the inventory.

Discussion

The condition of Cayuga Heights inventoried tree population is in Fair condition. Data inspection has provided the following insights into maintenance needs and historical maintenance practices:

Dead trees and trees in poor condition should be removed because of their failed health; these trees will likely not recover, even with increased care.

- Younger trees rated in Fair or Good 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. The larger trees may require secondary professional inspections.
- Proper tree care practices are needed for the long-term general health of the urban forest. 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.

Street ROW Stocking Level

Stocking is a traditional forestry term used to measure the density and distribution of trees. For an urban/community forest such as Cayuga Heights, stocking level is used to estimate the total number of sites along the street ROW that could contain trees. Park trees and public property trees are typically excluded from this measurement.

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, DRG recommends that the street ROW stocking level be at least 90% so that no more than 10% of the potential planting sites along the street ROW are vacant.

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. However, street ROW stocking levels can be estimated using only the number of trees present and the number of street miles in the community.

To estimate stocking level based on total street ROW miles and the number of existing trees, it is assumed that any given street ROW should have room for one tree for every 50 feet along each side of the street. For example, 10 linear miles of street ROW with spaces for trees to grow at 50-foot intervals along each side of the street account for a potential 2,110 trees. If the inventory found that 1,055 trees were present, the stocking level would be 50%.

The potential stocking level for a community with ten street miles is as follows:

5,280 feet/mile ÷ 50 feet = 106 trees/mile

106 trees/mile × 2 sides of the street = 212 trees/mile

212 trees per street mile × 10 miles = 2,120 potential sites for trees 1,055 inventoried trees ÷ 2,110 potential sites for trees = 50% stocked

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.

Cayuga Heights inventory data set included planting sites. Since the data included vacant planting sites, the stocking level can be more accurately projected and compared to the theoretical stocking level.

Findings

Calculations of trees per capita are important in determining the density of a Village's urban forest. The more residents and greater housing density a Village possesses, the greater the need for trees to provide benefits.

The inventory found 472 planting sites. Of the inventoried sites, 125 were potential planting sites for large-size trees (8-foot-wide and greater growing space size); 198 were potential sites for medium-size trees (6- to 7-foot-wide growing space sizes); and 149 were potential sites for small-size trees (4- to 5-foot-wide growing space sizes). Based on the data collected during this inventory, Cayuga Heights' current street ROW tree stocking level is 86%, including stumps and standing dead. If existing stumps and dead trees were to become vacant sites in the inventory, the stocking level would be 82%.

Based on a theoretical stocking level, the Village has 21 linear miles of street ROW (Cayuga Heights, 2014 Comprehensive Plan) and 2,787 trees, which is an average of 133 trees per street mile. In theory, any given street should have growing space for one tree every 50 feet along each side of a street, or 212 trees per mile. This equates to 4,452 theoretical sites. This suggests that there is room for an additional 1,665 street trees in Cayuga Heights to reach full theoretical stocking potential.

In Cayuga Heights, the ratio of street trees per capita is 0.758, which falls significantly above the mean ratio of 0.37 reported for 22 U.S. cities (McPherson and Rowntree 1989). According to the inventory, there is one tree for every 1.3 residents. Cayuga Heights's potential is one tree for every 1.2 residents.

Discussion

Inadequate tree planting and maintenance budgets, along with tree mortality, will result in lower stocking levels. Nevertheless, working to attain a fully stocked street ROW is important to promote canopy continuity and environmental sustainability. Fully stocking the street ROW with trees is an excellent goal. Removing every existing dead tree and stump in the current inventory and installing a new tree for every removal would increase the stocking level to 86%, which is a good percentage.

The Village could consider improving its street ROW population's stocking level of 82% and work toward achieving the ideal of 90% or better. Generally, this entails a planned program of planting, care, and maintenance for the Village's street trees. As is, the Village would need to plant 255 trees (after removal of dead trees and stumps) to accommodate a 90% ROW coverage.

The Village estimates that it plants 5 to 10 trees per year and the inventory revealed an ample total of 472 available planting sites along the street right of way. At 10 plantings per year, it would take approximately 25 years for the Village to reach the recommended stocking level of 90%. If budgets allow, DRG recommends that Cayuga Heights plant 25 trees per year based on a 10-year plan. If possible, exceed this recommendation to better prepare for impending threats and to increase the benefits provided by the urban forest. The ample available sites will allow the Village to scrutize the selection of each site before planting.

Other Observations

Observations were recorded during the inventory to further describe a tree's health, structure, or location when more detail was needed. Further detail can be found in the Comments or Notes portion of the data where the inventorying arborist describes with greater specificity issues of concern to the managing municipality.

Findings

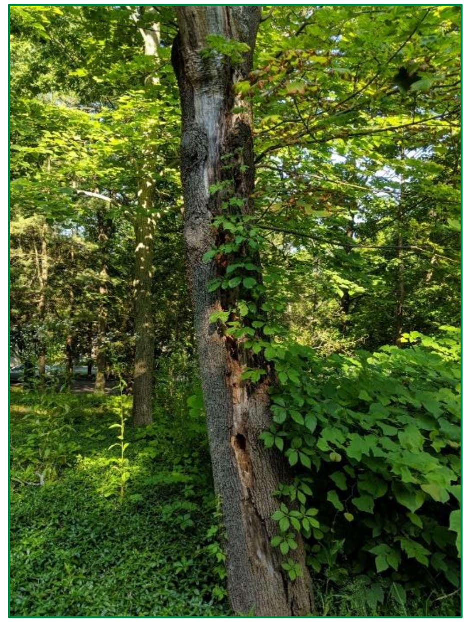
Dead and dying parts and missing or decayed wood were most frequently observed and recorded (33.28% and 6.89% of inventoried trees, respectively). Of all the trees noted for defects, 419 trees were recommended for removal, and eight were rated to be High or Extreme Risk trees. Table 1 provides the numbers and percentages of trees either in good, fair or poor condition with significant defects in the inventory. Dead trees, stumps, or sites were not included.

Table 1. Observations Recorded During the Street Tree Inventory

Defects Noted	Number of Trees	Percent
Broken and/or hanging branches	40	1.46%
Cracks	12	0.44%
Dead and dying parts	1049	38.34%
Missing or decayed wood	200	7.31%
Nothing noted	986	36.04%
Other	216	7.89%
Root problems	3	0.11%
Tree architecture	14	0.51%
Weakly attached/codominant	216	7.89%
Total good, fair, poor rated trees	**2736**	

Discussion

Unless slated for removal, trees noted as having dead and dying parts (1,125 trees) or missing and decayed wood (233 trees) should be regularly inspected. Corrective actions should be taken when warranted. If their condition worsens, removal may be required. Of the 233 trees noted for missing and decayed wood, 108 were recommended for removal. Of the 1,125 trees noted for dead and dying parts, 218 were recommended for removal.



Photograph 3. *This tree is noted as standing dead is and should be removed.*

New tree staking should only be installed when necessary to keep trees from leaning (windy sites) or to prevent damage from pedestrians and/or vandals. Stakes should only be attached to trees with a loose, flexible material. Installed hardware that has been attached to any tree for more than one year, and hardware that may no longer be needed for its intended purposes, should be inspected and removed as appropriate.

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 buildings, sidewalks, and utility wires and pipes, which may pose risks to public health and safety. Existing or possible conflicts between trees and infrastructure recorded during the inventory include:

- *Clearance Requirements:* The inventory noted trees blocking the visibility of traffic signs or signals, streetlights, or other safety devices. This information should be used to schedule pruning activities.
- *Overhead Utilities:* The presence of overhead utility lines above a tree or planting site was noted; it is important to consider these data when planning pruning activities and selecting tree species for planting.
- *Hardscape Damage:* Trees can adversely impact hardscape, which affects tree root and trunk systems. The inventory recorded damage related to trees, causing curbs, sidewalks, and other hardscape features to lift. These data should be used to schedule pruning and plan repairs to damaged infrastructure. To limit hardscape damage caused by trees, trees should only be planted in growing spaces where adequate above ground and below ground space is provided.

Findings

Within the inventory, there were 361 trees recorded with some type of clearance issue for overhead utilities. Of those trees, 16 were noted as standing dead with DBHs between 2 and 18. There were 625 trees with utilities directly above, or passing through, the tree canopy but not conflicting. Table 2 below notes the type and percentages of trees with overhead utilities. Trees of all condtion were included in this table. Stumps and planting sites were not included.

Table 2. Trees Noted to be Conflicting with Overhead Utility Concerns

Conflict	Presence	Number of Trees	Percent
Overhead Utilities	Present and Conflicting	361	12.41%
	Present and Not Conflicting	625	21.49%
	Not Present	1,922	66.09%
Total			

Discussion

Tree canopy should not interfere with vehicular or pedestrian traffic, nor should it rest on buildings or block signs, signals, or lights. Pruning to avoid clearance issues and raise tree crowns should be completed in accordance with ANSI A300 (Part 9) (2011). DRG's clearance distance guidelines are as follows: 14 feet over streets; 8 feet over sidewalks; and 5 feet from buildings, signs, signals, or lights.

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.

When planting around hardscape, it is important to give the tree enough growing room above ground. Guidelines for planting trees among hardscape features are as follows: give small-growing trees 4–5 feet, medium-growing trees 6–7 feet, and large-growing trees 8 feet or more between hardscape features. In most cases, this will allow for the spread of a tree's trunk taper, root collar, and immediate larger diameter structural roots. Completing these recommendations will reduce conflicts with Cayuga Heights infrastructure and citizens.

Photograph 4. *Trees along ROW where powerlines are conflicting.*

Growing Space

Information about the type and size of the growing space was recorded. Growing space size was recorded as the minimum width of the growing space needed for root development. Growing space types are categorized as greater than or less than four feet.

Findings

Of the inventoried sites, 3,291 (97%) were located in tree lawns 4 feet wide or larger, and only 89 sites (3%) were located in tree lawns less than 4 feet wide.

Discussion

To prolong the useful life of street trees, small-growing tree species should be planted in tree lawns 4–5 feet wide, medium-size tree species in tree lawns 6–7 feet wide, and large-growing tree species in tree lawns at least 8 feet wide. The useful life of a public tree ends when the cost of maintenance exceeds the value contributed by the tree. This can be due to increased maintenance required by a tree in decline, or it can be due to the costs of repairing damage caused by the tree's presence in a restricted site. Appendix B provides suggested tree species for plantings.

The largest benefits are provided from the largest trees, but there are site specific considerations that will impact the tree selection. Believe firmly in the right tree, right place mantra. There are excellent street trees that can become a financial headache in the long run if planted in a constrictive space or in poor soil conditions. While gaining the maximum ecological benefit from each street tree is an excellent objective, trees should not be planted without first assessing the site.

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, Village staff should investigate as soon as possible to determine appropriate corrective actions. Risk Assessment guidelines can be found in Appendix C.

Findings

DRG recommends 323 trees for further inspection. Figure 9 shows the 52 trees for insect monitoring, 223 for multi-year annual inspection, and 48 for a Level 3 assessment.

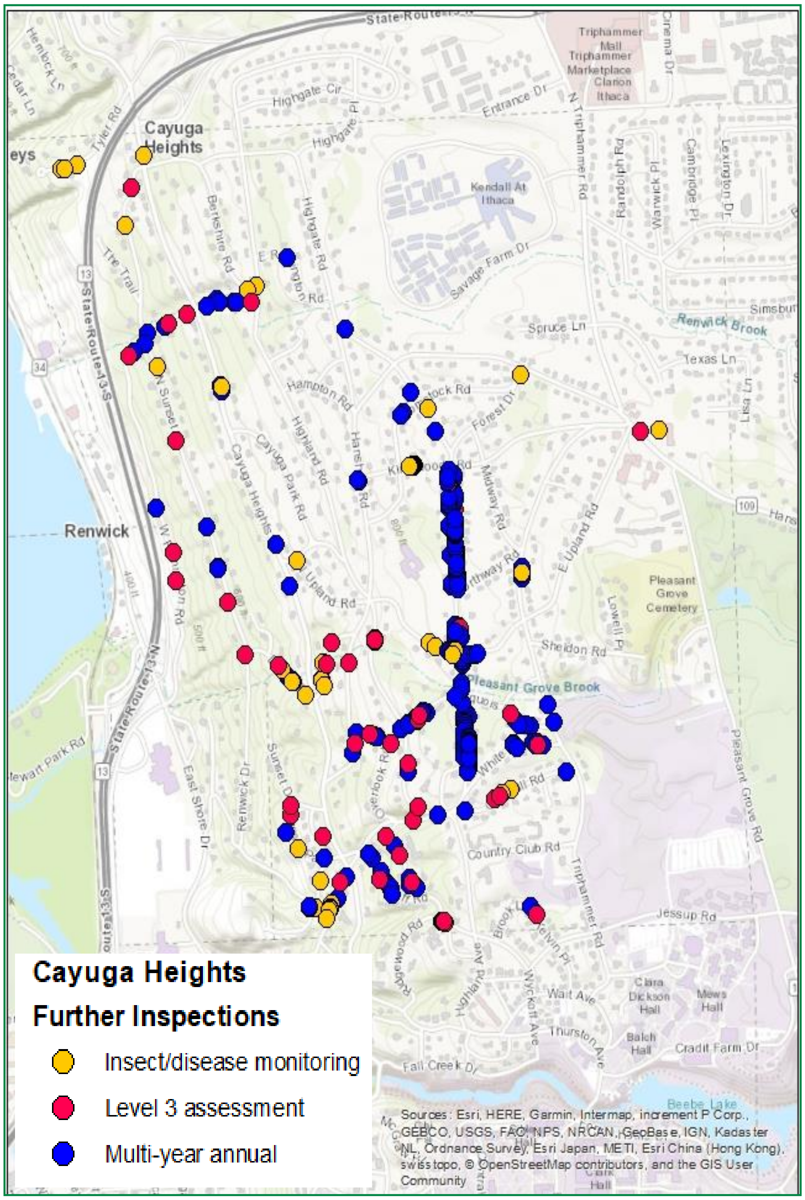


Figure 9. Village map showing trees requiring further inspection.

Discussion

An ISA Certified Arborist should perform additional inspections of the identified 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.

Potential Threats from Pests

Insects and diseases pose serious threats to tree health. Awareness and early diagnosis are essential to ensure the health and continuity of street and park trees. Appendix D provides information about some of the current potential threats to trees in Cayuga Heights and includes websites where more detailed information can be found.

Many pests target a single species or an entire genus. 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 Figure 10 only presents data collected from the inventory. More trees throughout Cayuga Heights, including those on other public and private property, may be susceptible to these invasive pests.

***Photograph 5**. This hemlock was noted as requiring further inspection. Observations from the ground were noted as being infected with an insect pest. The extent of the infection and need for treatment should be further evaluated. An ISA Certified Arborist should perform the additional inspection.*

Emerald Ash Borer (EAB). EAB first arrived in the U.S. in 2002 near Detroit and attacks all native ash trees, including white, green, blue, and black ash. Among the public trees managed by the Village, 3% (87 trees) are ash and thus susceptible to EAB. Treatment options exist but can be costly. However, without treatment, the mortality rate is 100%. Management options are provided in the recommendations. Initial symptoms include yellowing and/or thinning of the foliage and longitudinal bark splitting. The entire canopy may die back, or symptoms may be restricted to certain branches. Declining trees may sprout epicormic shoots at the tree base or on branches. Adults exit from the trunk and branches in a characteristic D-shaped exit hole that is about 1/8 inch in diameter. The loss of water and nutrients from the intense larvae tunneling can cause trees to lose between 30% and 50% of their canopies during the first year of infestation; trees can die within two years following infestation Once an ash tree is infested with EAB, branches become weak which can lead to limb failure from wind events or snow loading. Eventually, if left untreated and the infestation becomes worse, complete tree failure is probable.

The inventory contains 3% ash including 32 white ash and 51 green ash trees. Of these 87 ash trees, 55 are rated Fair, 14 are rated Good, 15 are rated Poor and 3 were Dead. These totals do not include additional ash trees that may be located on private property and public sites which were not inventoried. With the ongoing threat posed by the emerald ash borer (EAB, *Agrilus planipennis*), these trees warrant periodic inspection and a plan of action should be developed to deal with them.

Asian Longhorned Beetle (ALB). 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. Within the inventory, 903 trees are potentially at risk from ALB.

Table 3. ALB Genera of Cayuga Heights's Inventory

Genus	Common	Amount in Inventory
Acer	Maple	725
Betula	Birch	27
Aesculus	Horse Chestnut	4
Populus	Poplar	27
Salix	Willow	7
Ulmus	Elm	26
Fraxinus	Ash	87

Because it is untreatable, if found, the United States Department of Agriculture (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 Village staff is so important.

Oak Wilt. Oak wilt comes from a fast-acting fungus (*Ceratocystis fagacearum*) considered to be an invasive and aggressive disease. It can result in the decline and death of oak trees in as little as two weeks by clogging the trees' vascular system. Oaks comprise 300 individuals of Cayuga Heights' public trees and likely the similar number of private trees. Within New York State, oak wilt has been found near Albany, Canandaigua, and in Queens. The fungus is spread from tree to tree by borers and through root grafts underground. This disease is most devastating to trees in the red oak subgenus, including *Quercus coccinea* (scarlet oak), *Q. imbricaria* (shingle oak), *Q. palustris* (pin oak), *Q. phellos* (willow oak), and *Q. rubra* (northern red oak). Oak wilt also attacks trees in the white oak subgenus, though it is not as prevalent and spreads at a much slower pace in these trees. The most resistant species include *Q. macrocarpa* (bur oak) and *Q. muehlenbergii* (chinkapin). Control and management of oak wilt involves a thorough knowledge of preventive strategies and control protocols such as wound dressings. The best preventive strategy is to limit wounding (including pruning wounds) of oak during warm weather when the insect vectors are flying.

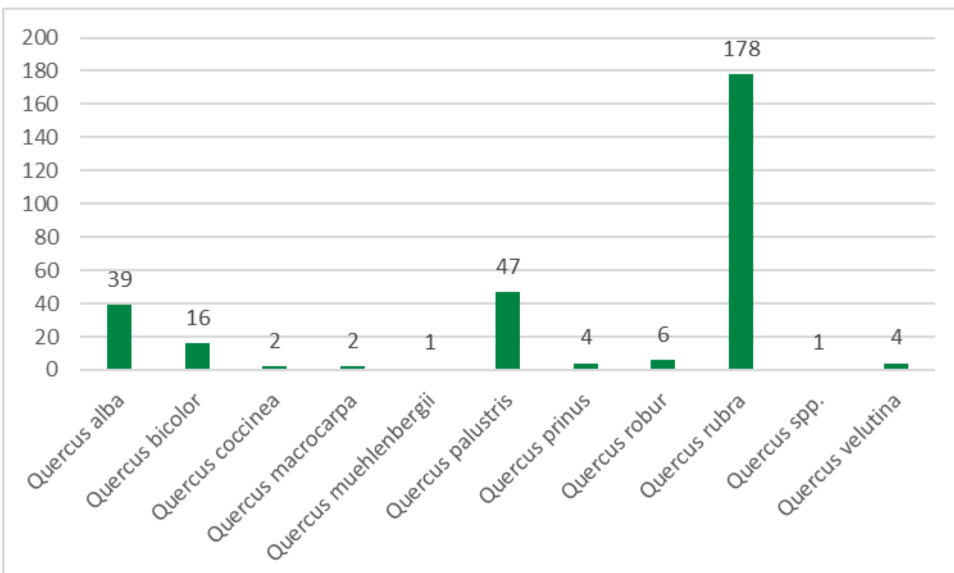


Figure 10. Oak inventory for Cayuga Heights.

Other Diseases. Aside from EAB, ALB, and oak wilt, there are other diseases and pest issues that can affect trees in Cayuga Heights, including anthracnose and verticillium wilt. These diseases require proper management and steps to minimize impact to canopy levels.

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

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

1. Rake and destroy infected leaves and prune off cankered branches. This will reduce the potential for infection.
2. Fungicidal treatments during leaf development will help prevent leaf infection and defoliation. Trunk injections of Arbortect® can also be used to manage sycamore anthracnose.
3. Over the long term, Cayuga Heights should understand that anthracnose will periodically surface on susceptible species. The effects over the Village's entire tree canopy can be reduced by planting tree species resistant to the fungus.

Verticillium Wilt is caused by a soil-borne fungus. It is often associated with maple but can affect several other species, including ash, Kentucky coffee tree, elm, and plum. Symptoms include yellow foliage, abnormally heavy seeding, and dieback of shoots and branches. Streaking of vascular tissue can accompany external symptoms. The fungus will persist in the soil indefinitely. If replacement of trees affected with Verticillium wilt is needed, replace with species not susceptible to the fungus such as birch, gingko, pear, or poplar.

Findings

Granulate ambrosia beetle (*Xylosandrus crassiusculus*) and Asian longhorned beetle (ALB or *Anoplophora glabripennis*) are known threats to a large percentage of the inventoried street trees (54% and 27%, respectively). These pests were not detected in Cayuga Heights during the inventory, but if they were detected, the Village could see severe losses in its tree population. Figure 11 represents the findings and their suspectable associated known pests.

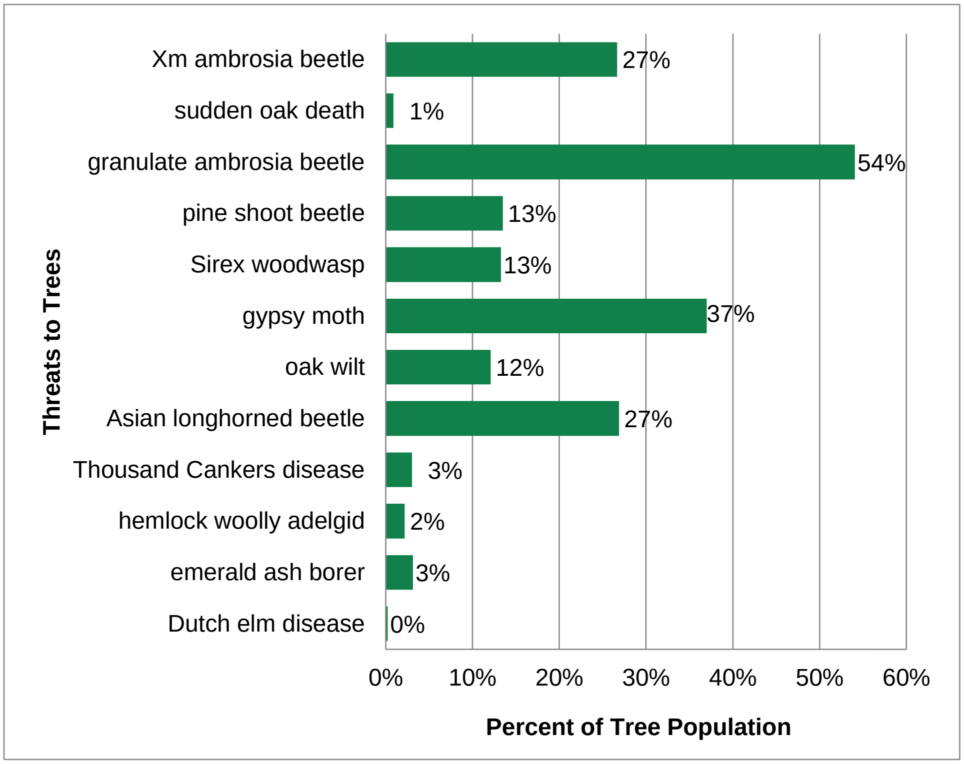


Figure 11. Potential impact of insect and disease threats noted during the 2019 inventory.

Discussion

Cayuga Heights 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 of tree removal or treatment, selecting the correct treatment, properly timed management strategies, recordkeeping, and evaluating results. The most immediate threat is the EAB and the inventory identified 87 ash trees. The Village should closely monitor its ash trees and keep informed about the EAB both locally and in New York State.

A newer pest of concern is the Spotted Lanternfly (SLF, *Lycorma delicatula*). Figure 12 is a New York State Department of Agriculture map representing the regional spread of SLF. This pest is known to infest over 70 species of plants. The invasive tree-of-heaven (*Ailanthus altissima*) is a common host. There are 14 tree-of-heavens in the inventory, 13 of which are in Good condition. Those trees could be a concern should the SLF arrive in Cayuga Heights. See appendix D for further information about pests affecting the region.

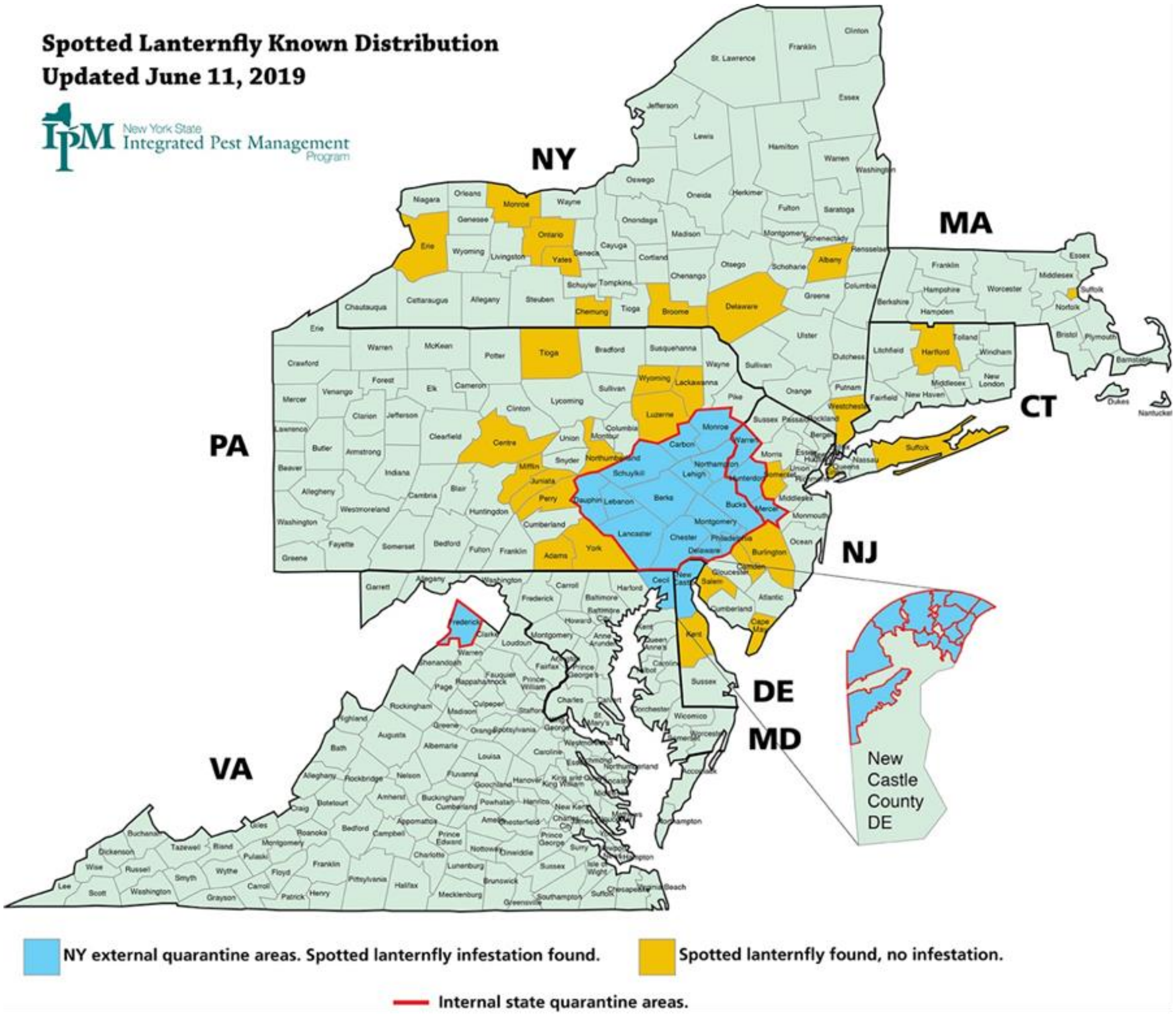


Figure 12. New York State Integrated Pest Management SLF Known Distribution Map

https://nysipm.cornell.edu/environment/invasive-species-exotic-pests/spotted-lanternfly/

SECTION 2: BENEFITS OF THE URBAN FOREST

There is a growing understanding and validation of the importance of trees to a community. The urban forest plays an important role in supporting and improving the quality of life in urban areas. A tree's shade and beauty contribute to a community's quality of life and soften the hard appearance of urban landscapes and streetscapes. Scientists and researchers have studied the positive effects of trees on air quality, stormwater runoff, human behavior, and lower crime rates. When properly maintained, trees provide communities abundant economic, environmental, and social benefits that far exceed the time and money invested in planting, pruning, protection, and removal. This section will highlight each element of the collective benefits the trees in the inventory provide.

Both the functional and structural benefits of trees can be assessed by i-Tree Eco. The functional benefits of trees are associated with their ability to provide ecosystem benefit. 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 municipalities the means to advocate for the funding needed to manage trees effectively. i-Tree Streets has moved into a legacy role and the new Eco v6, which includes the functionality of the Streets model, is the most up-to-date eco-benefit estimator available. Trees are evaluated based upon the population (collective group of species) and individual tree performances within the inventory data collected.

i-Tree Eco can be utilized with a complete inventory to simplify the benefit quantification process. Regional data, including energy prices and stormwater costs, are required inputs to generate the environmental and economic benefits trees provide. If community program costs or local economic data are not available, i-Tree Eco uses frequently updated economic inputs for georeferenced locations selected by the United States Forest Service (USFS) for the local climate zone. The entire inventory collected during in the 2019 collection was uploaded into i-Tree Eco v6 model to generate benefit estimates.

Functional benefits include atmospheric removal of 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 quantifiable by i-Tree Eco through tree growth algorithms incorporating tree data supplied by the inventory. 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 ten microns in size (PM_{10}). Coder (1996) found that trees could reduce cemetery level 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.

When location in the landscape is matched with healthy, high-quality tree species, tree valuation can be readily quantified utilizing the Council of Tree and Landscape Appraiser's methodology within the i-Tree Eco suite of software. The monetary values of trees are based on four characteristics, which are condition, location, species, and trunk area. This information has been complemented with 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).

Structural values are on the comparable cost of replacing the specific tree with a similar tree. i-Tree Eco determines these values via an appraisal methodology utilized by the Council of Tree and Landscape Appraisers. Carbon storage is considered a structural value as it is not considered an annual benefit but is amassed over the life of the tree. Carbon storage and sequestration will be discussed in the same section, although they are separate classes of ecological benefits.

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 USFS indicates that 100 mature tree crowns intercept about 100,000 gallons of rainfall per year, reducing runoff and providing cleaner water (United States Department of Agriculture (USDA) Forest Service, 2003(a)). trees will retain approximately 10 million gallons of rainwater per year (United States Department

Trees are associated with 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 A typical community forest of 10,000 of Agriculture (USDA) Forest Service, 2003(b).

The graphic below summarizes the science behind the community tree benefits provided by the urban forest.

Environmental Benefits

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

Economic Benefits

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

Social Benefits

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

Findings

Cayuga Heights currently receives $10,246 annually in total functional ecological benefits from the 2,787 trees in the 2019 inventory (not including unknown trees). These cumulative benefits can be valued at an annual average of approximately $3.68 per tree in the inventory. Figure 13 displays the annual dollar amounts for each functional benefit.

Functional Values

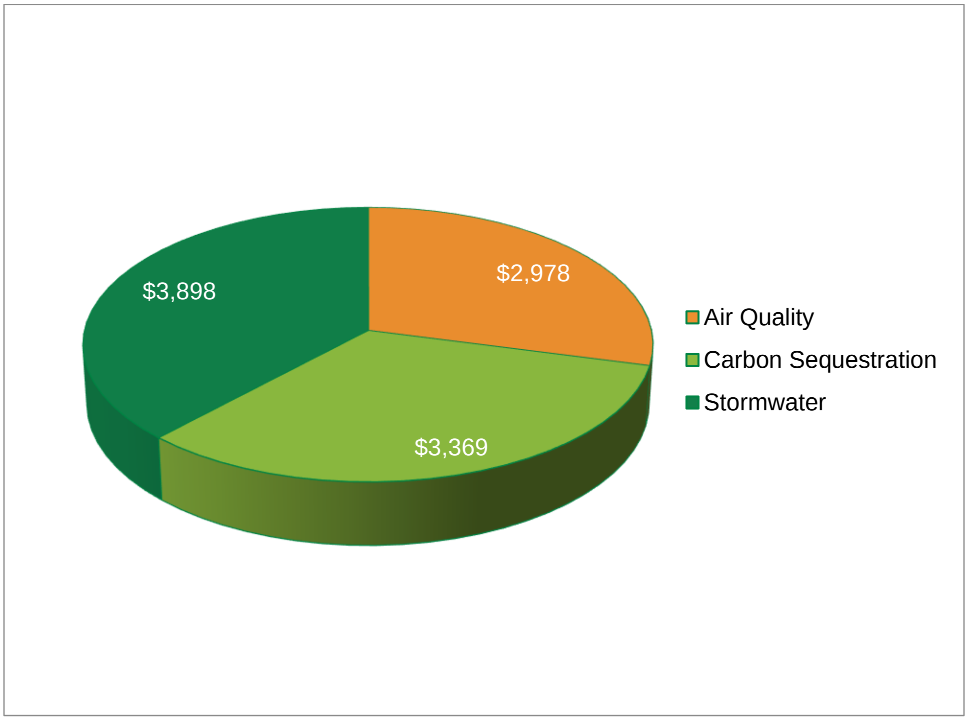


Figure 13. Annual functional benefits of the inventoried trees.

Air Quality

The inventoried tree population annually removes 1,278 pounds of air pollutants, including ozone, nitrogen dioxide, sulfur dioxide, and particulate matter, the latter through deposition. Figure 14 conveys the months of the year where the trees provide the highest return to the community in the form of improved air quality. The total inventory produces 52.7 tons per year of oxygen. Table 4 presents the top performing species populations in the 2019 inventory.

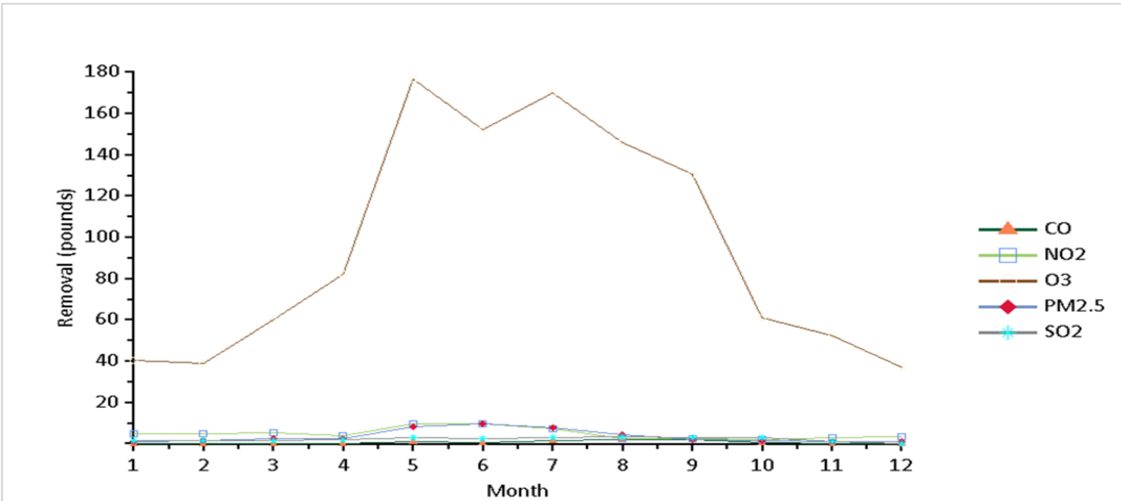


Figure 14. Monthly air pollutants removed per contaminant in Cayuga Heights.

Table 4. Top Air Quality Benefits per Tree Species in Inventory

Species	Tree Count	Air Quality (ton/yr)	($/yr)
Norway maple	431	0.12000	$556.33
Eastern white pine	313	0.10000	$451.21
Northern red oak	178	0.06000	$300.41
Norway spruce	145	0.05000	$217.21
Sugar maple	164	0.04000	$187.61
Black walnut	84	0.04000	$165.11
Silver maple	41	0.02000	$97.16
Pin oak	47	0.02000	$94.99
Black locust	80	0.02000	$89.54
White oak	39	0.02000	$71.67
American basswood	47	0.01000	$63.10
Shagbark hickory	57	0.01000	$43.97
Green ash	51	0.01000	$43.19
Black cherry	30	0.01000	$25.95
White ash	32	0.01000	$25.34
Total Eco Inventory	**2,787**	**0.64000**	**$2,978.33**

The i-Tree Eco calculation takes into account the biogenic volatile organic compounds (BVOC's) that are released from trees. Trees emit various BVOCs such as isoprenes and monoterpenes, which can also contribute to formation of ozone, a harmful gas that pollutes the air and damages vegetation. These BVOC emissions are accounted for in the air quality net benefit. The inventory produces 297.4 pounds per year of monoterpenes and 470.7 pounds per year per year. Total VOCs per year are 768.1 pounds per year. The inventoried trees removed or avoided more pollutants than they emitted, resulting in a positive economic value. Table 5 lists the largest emitters of BVOCs in the current inventory.

i-Tree Tools

A common example of a natural BVOC is the gas emitted from pine trees, which creates the distinct smell of a pine forest.

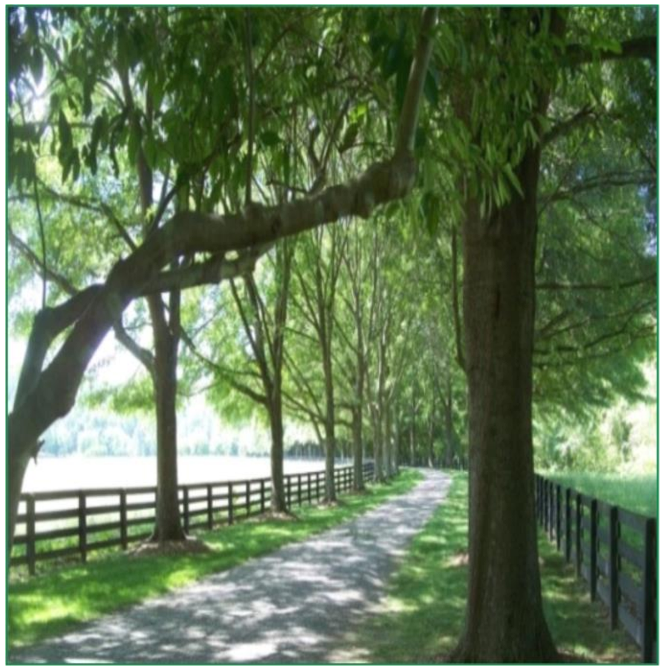
Table 5. Trees with Highest Emitting BVOCs in the Inventory

Species	Amount in Inventory	Monoterpene (lb/yr)	Isoprene (lb/yr)	Total VOCs (lb/yr)
Northern red oak	178	3.00	209.30	212.30
Norway spruce	145	94.40	81.80	176.20
Pin oak	47	1.10	75.20	76.30
Eastern white pine	313	75.60	0.50	76.10
White oak	39	0.70	45.60	46.30
Norway maple	431	30.50	0.40	30.90
Black walnut	84	25.20	0.20	25.40
Blue spruce	56	9.70	8.40	18.10
Eastern cottonwood	15	0.10	13.40	13.50
Sugar maple	164	11.50	0.10	11.60
White spruce	32	4.90	4.30	9.20
Black locust	80	0.60	8.40	9.00
Scots pine	32	5.80	0.00	5.90
Silver maple	41	5.20	0.10	5.30
Chestnut oak	4	0.10	4.20	4.20
Total Eco Inventory	2,787	**297.40**	**470.70**	**768.10**

Carbon Sequestration and Storage

Trees store some of the carbon dioxide (CO_2) they absorb. This prevents CO_2 from reaching the upper atmosphere, where it can react with other compounds and form harmful gases like ozone, which adversely affects air quality. These trees also sequester some of the CO_2 during growth (Nowak et al. 2013).

The i-Tree Eco calculation takes into account the carbon emissions that are not released from power stations due to the heating and cooling effect of trees (i.e., conserved energy in buildings and homes). It also calculates emissions released during tree care and maintenance, such as driving to the site and operating equipment.



Photograph 6. *Trees improve quality of life and help enhance the character of a community. Trees filter air, water, and sunlight, moderate local climate, slow wind and stormwater, shade homes, and provide shelter to animals and recreational areas for people.*

Cayuga Heights' tree inventory sequesters 19.76 tons of carbon annually, based on reduction amounts of atmospheric carbon. The carbon storage amount reflects the amount of carbon the trees have amassed during their lifetimes. The total carbon storage of the complete inventory was valued at $238,078.27, with an annual sequestration total of $3,369.34. The average carbon storage per tree was valued at $85.42, with an average $1.21 per tree.

Per the inventory, the population of northern red oaks provided the most carbon benefits, with each tree storing an annual average of $241.60 and sequestering $2.75 worth of carbon. All of the red oaks in the inventory have amassed $43,005.23 worth of carbon. Table 6 lists the top performing carbon storage and sequestration tree species population in the inventory.

On an average per tree basis, the top carbon storing tree species was pin oak at $461.51 per tree. Pin oaks also accounted for the most annual carbon sequestration at $4.44 average per tree. Existing overall population within the inventory, size and tree species characteristics all contribute to these amounts. Table 7 lists the top performing carbon storage and sequestration tree species on an average per tree basis in the inventory.

Table 6. Top Performing Tree Species for Carbon Storage and Sequestration

Species	Tree Count	Total Carbon Storage(ton)	Total Carbon Storage ($)	Total Carbon Sequestration (ton/yr)	Carbon Sequestration ($/yr)
northern red oak	178	252.15	$43,005.23	2.87	$489.44
eastern white pine	313	196.27	$33,473.98	2.27	$387.17
Norway maple	431	155.48	$26,518.06	2.85	$485.92
pin oak	47	127.18	$21,691.09	1.22	$208.89
silver maple	41	83.06	$14,165.87	0.57	$96.58
white oak	39	74.18	$12,651.13	0.79	$134.81
sugar maple	164	66.44	$11,331.72	1.27	$217.29
Norway spruce	145	58.43	$9,964.53	0.87	$147.65
black locust	80	54.84	$9,353.24	0.78	$132.98
black walnut	84	40.46	$6,901.20	0.76	$129.27
black cherry	30	19.22	$3,278.71	0.28	$47.68
shagbark hickory	57	17.27	$2,945.90	0.44	$75.11
boxelder	26	14.85	$2,532.69	0.16	$27.13
American basswood	47	13.04	$2,224.61	0.26	$44.02
green ash	51	12.93	$2,206.01	0.18	$30.15
white mulberry	30	12.69	$2,164.01	0.21	$35.22
honeylocust	22	11.90	$2,029.15	0.21	$36.52
eastern cottonwood	15	10.53	$1,795.18	0.12	$19.86
red maple	22	8.25	$1,407.40	0.15	$25.13
white ash	32	7.91	$1,349.13	0.19	$33.23
Siberian elm	12	7.90	$1,347.58	0.10	$16.38
apple species	35	7.68	$1,309.29	0.17	$28.76
Scots pine	32	7.58	$1,293.36	0.13	$21.98
blue spruce	56	6.79	$1,158.61	0.15	$26.08
northern hackberry	16	6.75	$1,150.77	0.13	$22.29
Total Eco Inventory	**2,787**	**1395.94**	**$238,078.27**	**19.76**	**$3,369.34**

Table 7. Top Performing Individual Tree Species for Carbon Storage and Sequestration

Species	Tree Count	Avg Carbon Storage per Tree (ton)	Avg Carbon Storage per Tree ($)	Avg Carbon Sequestration (ton/yr/) per tree	Carbon Sequestration ($/yr) per tree
pin oak	47	2.706	$461.51	0.026	$4.44
silver maple	41	2.026	$345.51	0.014	$2.36
white oak	39	1.902	$324.39	0.020	$3.46
northern red oak	178	1.417	$241.60	0.016	$2.75
eastern cottonwood	15	0.702	$119.68	0.008	$1.32
black locust	80	0.686	$116.92	0.010	$1.66
Siberian elm	12	0.658	$112.30	0.008	$1.37
black cherry	30	0.641	$109.29	0.009	$1.59
eastern white pine	313	0.627	$106.95	0.007	$1.24
boxelder	26	0.571	$97.41	0.006	$1.04
honeylocust	22	0.541	$92.23	0.010	$1.66
black walnut	84	0.482	$82.16	0.009	$1.54
white mulberry	30	0.423	$72.13	0.007	$1.17
northern hackberry	16	0.422	$71.92	0.008	$1.39
sugar maple	164	0.405	$69.10	0.008	$1.32
Norway spruce	145	0.403	$68.72	0.006	$1.02
red maple	22	0.375	$63.97	0.007	$1.14
Norway maple	431	0.361	$61.53	0.007	$1.13
shagbark hickory	57	0.303	$51.68	0.008	$1.32
American basswood	47	0.277	$47.33	0.006	$0.94
green ash	51	0.254	$43.26	0.004	$0.59
white ash	32	0.247	$42.16	0.006	$1.04
Scots pine	32	0.237	$40.42	0.004	$0.69
apple species	35	0.219	$37.41	0.005	$0.82
blue spruce	56	0.121	$20.69	0.003	$0.47
Total Eco Inventory	**2,787**	**0.501**	**$85.42**	**0.007**	**$1.21**

Stormwater Benefits

Trees intercept rainfall, which helps lower the cost of managing stormwater runoff. In the absence of trees, precipitation results in quicker supersaturation of the soil which increases peak stormwater flows. Leaf area attenuates the precipitation and the trees uptake some of the water. The inventoried trees in Cayuga Heights intercept 1,977,922 gallons of rainfall annually based on 124.26 acres of total leaf area. The total avoided runoff is 435,274 gallons and the annual savings for the Village in stormwater runoff management is $3,889. The avoided runoff model is based on local weather station data and computed rainfall interception. i-Tree Eco models contrast the calculated leaf area for a given geography versus zero leaf area for the same geography.

In the inventory, Norway maples contributed the most annual stormwater benefits. This is attributable to the prevalence of Norway maple in the inventory, the size of these trees, and their combined leaf area. The population of Norway maple (15.5% of the inventory) intercepted approximately 369,409 gallons of rainfall. Table 8 lists the top performing tree genera for stormwater benefits in the inventory.

On a per tree basis, large trees with leafy canopies provided the most value. An eastern cottonwood in the inventory led the inventory with 3,878 gallons intercepted and 853 gallons of avoided runoff. This cottonwood provided $7.63 annually in stormwater benefits. White oak, red oak, black walnut, London planetree and other large-statured trees with big canopies are other top performers. Table 8 lists the top individual trees for stormwater benefits in the inventory.

Table 8. Top Performing Tree Species for Stormwater Benefits in Cayuga Heights

Top 20 Species for Avoided Runoff in Dollars		Inventoried Tree Count	Percent of Inventory	Total Rainfall Interception	Total Avoided Runoff
Common Name	Leaf Area (acres)		2,787	Gallons / Year	Dollars / Year
Norway maple	23.21	431	15.5	369,409	$726.55
eastern white pine	18.82	313	11.2	299,608	$589.26
northern red oak	12.53	178	6.4	199,473	$392.32
Norway spruce	9.06	145	5.2	144,232	$283.67
sugar maple	7.83	164	5.9	124,577	$245.02
black walnut	6.89	84	3.0	109,636	$215.63
silver maple	4.05	41	1.5	64,516	$126.89
pin oak	3.96	47	1.7	63,074	$124.05
black locust	3.74	80	2.9	59,457	$116.94
white oak	2.99	39	1.4	47,591	$93.60
American basswood	2.63	47	1.7	41,900	$82.41
shagbark hickory	1.83	57	2.0	29,197	$57.42
green ash	1.8	51	1.8	28,677	$56.40
black cherry	1.08	30	1.1	17,233	$33.89
white ash	1.06	32	1.1	16,823	$33.09
eastern red cedar	0.97	36	1.3	15,439	$30.37
Scots pine	0.97	32	1.1	15,426	$30.34
white mulberry	0.95	30	1.1	15,167	$29.83
eastern hemlock	0.95	61	2.2	15,095	$29.69
European beech	0.94	13	0.5	15,038	$29.58
blue spruce	0.91	56	2.0	14,559	$28.63
boxelder	0.91	26	0.9	14,446	$28.41
red maple	0.9	22	0.8	14,246	$28.02
northern hackberry	0.89	16	0.6	14,220	$27.97
eastern cottonwood	0.88	15	0.5	14,076	$27.68
eastern redbud	0.7	54	1.9	11,182	$21.99

Table 9. Top Performing Individual Trees for Stormwater Benefits in the Inventory

Tree ID	Species Name	Leaf Area(ft²)	Potential Evapotranspiration (gal/yr)	Evaporation (gal/yr)	Transpiration(gal/yr)	Water Intercepted (gal/yr)	Avoided Runoff (gal/yr)	Avoided Runoff Value ($/yr)
1136	eastern cottonwood	10613.90	17,457	3,873	6,083	3,878	853	$7.63
2230	white oak	9614.00	15,813	3,509	5,511	3,513	773	$6.91
1617	northern red oak	9212.50	15,152	3,362	5,280	3,366	741	$6.62
5076	European beech	8990.40	14,787	3,281	5,153	3,285	723	$6.46
4192	white oak	8870.00	14,589	3,237	5,084	3,241	714	$6.37
4334	black walnut	8744.90	14,383	3,191	5,012	3,195	703	$6.28
4948	black walnut	8744.90	14,383	3,191	5,012	3,195	703	$6.28
3909	silver maple	8539.10	14,044	3,116	4,894	3,120	687	$6.14
1848	London planetree	8536.90	14,041	3,115	4,893	3,119	687	$6.13
1588	northern red oak	8407.00	13,828	3,068	4,819	3,072	676	$6.04
1634	northern red oak	8407.00	13,828	3,068	4,819	3,072	676	$6.04
4608	northern red oak	8407.00	13,828	3,068	4,819	3,072	676	$6.04
4779	northern red oak	8407.00	13,828	3,068	4,819	3,072	676	$6.04
1559	northern red oak	8162.90	13,426	2,979	4,679	2,983	657	$5.87
1466	Norway spruce	8040.20	13,224	2,934	4,608	2,938	646	$5.78
2168	Norway spruce	8040.20	13,224	2,934	4,608	2,938	646	$5.78
2319	Norway spruce	8040.20	13,224	2,934	4,608	2,938	646	$5.78
4277	black walnut	8004.10	13,165	2,921	4,587	2,925	643	$5.75
4222	northern red oak	7705.00	12,673	2,812	4,416	2,815	619	$5.54

Structural Values

The most straightforward way to establish a monetary value for an urban 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. The 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. Carbon storage is considered a structural value and is noted as $238,078.27 and reviewed in the previous carbon sequestration and carbon heading.

Tree Values

The structural value of the entire inventory is valued at $5,219,503, with a per tree average of $1,872. The 25 highest valued populations in the inventory are listed in Table 10. The population of eastern white pines was found to be the highest valued street tree species. Table 11 lists the 25 highest valued individual trees in the inventory; a baldcypress was the top valued tree.

Table 10. Trees with Highest Structural Value in the Inventory

Species	Trees in Inventory	Structural Value in Dollars	Structural Value per Tree in Dollars
eastern white pine	313	$1,156,684.06	$3,695.48
northern red oak	178	$803,119.43	$4,511.91
Norway maple	431	$546,033.04	$1,266.90
Norway spruce	145	$313,067.10	$2,159.08
pin oak	47	$300,354.45	$6,390.52
sugar maple	164	$265,204.71	$1,617.10
white oak	39	$237,492.78	$6,089.56
black walnut	84	$159,226.84	$1,895.56
black locust	80	$130,574.36	$1,632.18
silver maple	41	$121,140.28	$2,954.64
American basswood	47	$95,114.12	$2,023.70
shagbark hickory	57	$72,763.51	$1,276.55
green ash	51	$64,448.85	$1,263.70
northern white cedar	62	$55,254.93	$891.21
Scots pine	32	$50,679.92	$1,583.75
honeylocust	22	$45,947.89	$2,088.54
black cherry	30	$40,598.34	$1,353.28
blue spruce	56	$39,237.45	$700.67
white mulberry	30	$36,922.60	$1,230.75
eastern red cedar	36	$34,390.71	$955.30
white ash	32	$34,359.06	$1,073.72
red maple	22	$31,708.57	$1,441.30
eastern hemlock	61	$31,194.45	$511.38
apple species	35	$30,640.08	$875.43
Total	**2,787**	**$5,219,503.40**	**$1,872.80**

Table 11. Individual Trees in the Inventory with Highest Structural Values

Species	Tree ID # in Inventory	Structural Value in Dollars	Structural Value per Tree in Dollars
baldcypress	1	$7,185.82	$7,185.82
pin oak	47	$300,354.45	$6,390.52
white oak	39	$237,492.78	$6,089.56
chestnut oak	4	$18,954.04	$4,738.51
northern red oak	178	$803,119.43	$4,511.91
bur oak	2	$9,018.95	$4,509.48
eastern white pine	313	$1,156,684.06	$3,695.48
black maple	1	$3,603.21	$3,603.21
London planetree	2	$6,912.74	$3,456.37
silver maple	41	$121,140.28	$2,954.64
American yellowwood	1	$2,833.69	$2,833.69
Norway spruce	145	$313,067.10	$2,159.08
honeylocust	22	$45,947.89	$2,088.54
Douglas fir	5	$10,134.47	$2,026.89
American basswood	47	$95,114.12	$2,023.70
black walnut	84	$159,226.84	$1,895.56
European beech	13	$24,428.08	$1,879.08
horse chestnut	2	$3,712.24	$1,856.12
black oak	4	$7,165.53	$1,791.38
Freeman maple	4	$6,608.39	$1,652.10
hawthorn species	2	$3,299.97	$1,649.99
birch species	1	$1,644.20	$1,644.20
black locust	80	$130,574.36	$1,632.18
sugar maple	164	$265,204.71	$1,617.10
Total Inventory	**2,787**	**$5,219,503.40**	**$1,872.80**

Discussion

The i-Tree Eco analysis found that the inventoried trees provide environmental and economic benefits to the community by virtue of their mere presence on the streets. Trees manage stormwater through rainfall interception, provide shade and windbreaks to reduce energy usage, and store and sequester CO_2.

To increase the benefits that its street trees provide, the Village should prioritize planting large-statured tree species where site conditions permit. Working with the i-Tree species tool in conjunction with site analysis can provide appropriate tree selections for Cayuga Heights (https://species.itreetools.org/).

- The net air quality improvement provided by inventoried trees is valued at approximately $2,980 per year with the removal of 1,278 pounds annually. Norway maple and eastern white pine are the largest contributors to air quality improvement due to their prevalence in the inventory.
- Carbon sequestration totals 19.76 tons per year and is valued at $3,369 annually.
- Carbon storage in the form of tree biomass amounts to 1,400 tons with an estimated value of $238,078.
- 52.7 tons of Oxygen is produced annually.
- Inventoried trees intercept 1,977,922 gallons of stormwater per year and 435,274 gallons of avoided runoff. This is an average of 156 gallons per tree. The total annual value of this benefit is $3,889 for an average value of $1.40 per tree.
- The structural value of Village street trees is $5.22 million dollars (replacement cost).
- Inventoried trees account for 24.99 acres of tree cover and 124.26 acres of leaf area.

SECTION 3: TREE MANAGEMENT PROGRAM

This tree management program was developed to uphold Cayuga Heights' comprehensive vision for preserving its urban forest. This five-year program is based on the 2019 tree inventory data. The program was designed to reduce risk through prioritized tree removal and pruning, and to improve tree health and structure through proactive pruning cycles. Tree planting to mitigate removals and increase canopy cover and public outreach are important parts of the program as well.

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 assigned risk rating; however, routinely monitoring the tree population is essential so that other 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 and High Risk trees) must sometimes 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. An example would be an arborist who is an ISA Certified Arborist with Tree Risk Assessment Qualification (TRAQ). 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 appropriately. Utilize 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. Cayuga Heights has a large population of trees that are susceptible to pests and diseases, such as ash, oak, and maple. Ongoing inspections are paramount to a good urban forestry management program.

Priority and Proactive Maintenance

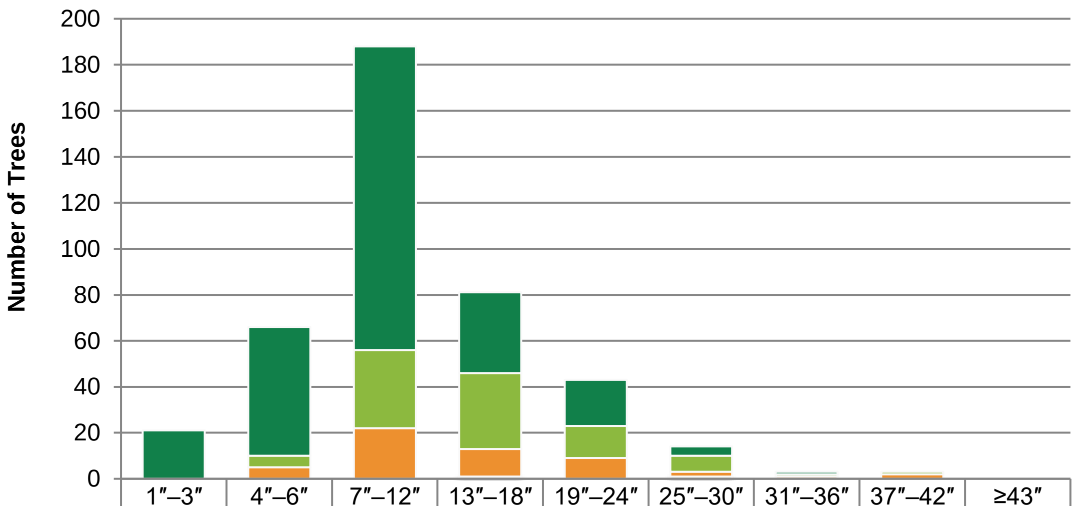
In this plan, the recommended tree maintenance work was divided into either priority or proactive maintenance. Priority maintenance includes tree removals and pruning of trees with an assessed risk rating of High and Extreme. Proactive tree maintenance includes pruning of trees with an assessed risk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

Extreme Risk	• Perform tree maintenance immediately to reduce hazards • Includes tree removal and pruning • Mostly high-use areas
High Risk	• Perform tree maintenance immediately to reduce hazards and improve tree health • Includes tree removal and pruning • Generally high-use areas
Moderate Risk	• Perform tree maintenance as soon as possible to improve tree health • Includes tree removal and pruning • May be high- or low-use areas
Low Risk	• Perform tree maintenance when convenient to improve aesthetics and eliminate nuisance trees and stumps • Includes tree removals and pruning • Mostly low-use areas but may be high-use areas as well
Routine Pruning	• Perform tree maintenance when convenient to improve aesthetics and eliminate nuisance trees
Training Prune	• Perform corrective pruning to young trees to increase structural integrity and develop a strong architecture of branches before serious problems develop

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, physical injury due to vehicles, vandalism and root disturbances. 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.

Tree removal priority is based upon the evaluated risk assessment and DBH of the inventoried trees. 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. Figure 15 presents tree removals by risk rating and diameter size class.



Risk Rating	1″–3″	4″–6″	7″–12″	13″–18″	19″–24″	25″–30″	31″–36″	37″–42″	≥43″
Low	21	56	132	35	20	4	1		
Moderate		5	34	33	14	7	1	1	
High		5	22	12	9	2	1	2	
Extreme				1		1			

Diameter Size Class

Figure 15. Tree removals by risk rating and diameter size class.

The inventory identified two Extreme Risk trees, 53 High Risk trees, 95 Moderate Risk trees, and 269 Low Risk trees that are recommended for removal. Healthy trees growing in poor locations or undesirable species are also included in this category. The diameter size classes for High Risk trees ranged between 4 and 42 inches DBH. These trees should be removed based on their assigned risk. Most Moderate Risk trees were smaller than 19 inches DBH. These trees should be removed as soon as possible after all Extreme and High Risk removals have been completed. Low Risk removals pose little threat; these trees are generally small, dead, invasive, or poorly formed trees that need to be removed when feasible. Eliminating these trees will reduce breeding site locations for insects and diseases and will increase the aesthetic value of the area. The inventory identified 57 stumps recommended for removal. Stump removals should occur when convenient; they are an aesthetic concern and a safety issue for larger sized diameter stumps. The stump sizes range from 2 to 55 inches.

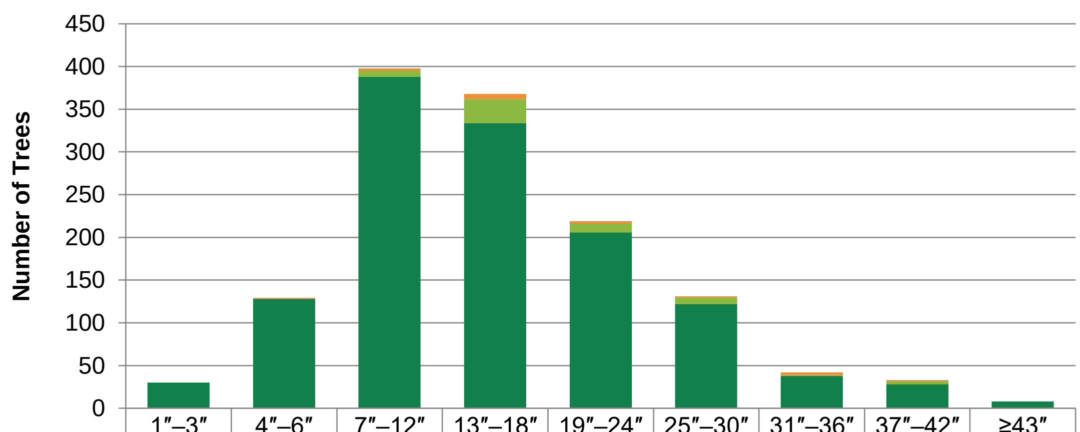
Discussion

Trees not recommended for removal, but with defects noted as having dead or dying parts (907 trees) or missing and decayed (125 trees), should be inspected on a regular basis. Corrective action should be taken when warranted. If their condition worsens, tree removal may be required. Proactive tree maintenance that actively mitigates elevated risk situations will promote public safety.

Continue to update this new tree inventory data. Doing so can streamline workload management and lend insight into setting accurate budgets and staffing levels. Inventory updates should be made electronically and can be implemented using TreeKeeper® or similar computer software.

Tree Pruning

Extreme and High 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 16 presents the number of trees recommended for pruning by risk and size class. Trees in the below chart represent trees noted as pruning required during inventory collection; not every tree in the inventory will require pruning.



	1″–3″	4″–6″	7″–12″	13″–18″	19″–24″	25″–30″	31″–36″	37″–42″	≥43″
Extreme		0							
High		1	3	6	3	1	3	1	
Moderate			7	28	10	8	1	4	
Low	30	128	388	334	206	122	38	28	8

Diameter Size Class

Figure 16. Pruning by risk and diameter size class.

Discussion

The inventory identified 18 High Risk trees and 58 Moderate Risk trees recommended for pruning. High Risk trees ranged in diameter size classes from 13–18 inches DBH to 25–30 inches DBH. This pruning should be performed immediately based on assigned risk and may 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 17 represents the association between condition rating and time between pruning for urban trees.

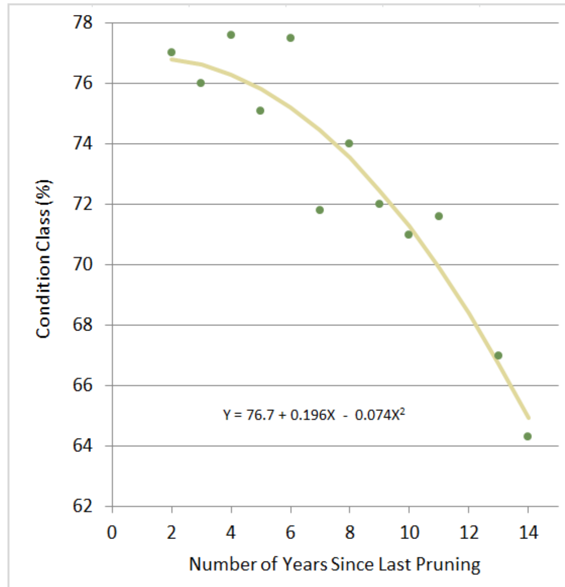


Figure 17. Relationship between average tree condition class and the number of years since the most recent pruning (adapted from Miller and Sylvester 1981).

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 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 length.

The recommended number of trees in the pruning cycles will need to be modified to reflect changes in the tree population as trees are planted, age, and die. Newly planted trees will enter the YTT Cycle once they become established. As young trees reach maturity, they will be shifted from the YTT Cycle into the RP Cycle. When a tree reaches the end of its useful life, it should be removed, eliminated from the RP Cycle and the inventory updated.

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.

For many communities, a proactive tree management program is considered unfeasible. An on-demand response to urgent situations is commonplace. 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 inspected 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.

Young Tree Training Cycle

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.

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.

Photograph 7. An Ulmus hybrid, "Accolade" in Cayuga Heights with proper planting technique and protection in place.

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 future growth will lead to a healthy, structurally sound tree.

Discussion

DRG recommends that Cayuga Heights implement a three-year YTT Cycle to begin after all Extreme and High Risk trees are removed or pruned. During the inventory, 554 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 285 trees be structurally pruned each year over 3 years, beginning in Year One of the management program.

When new trees are planted, they will need to enter the YTT Cycle after establishment, typically a 2 years after planting. Figure 18 displays the number of trees in each DBH range which are recommended to enter the YTT as of the 2019 inventory.

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 Village should strive to prune approximately one-third of its young trees each year.

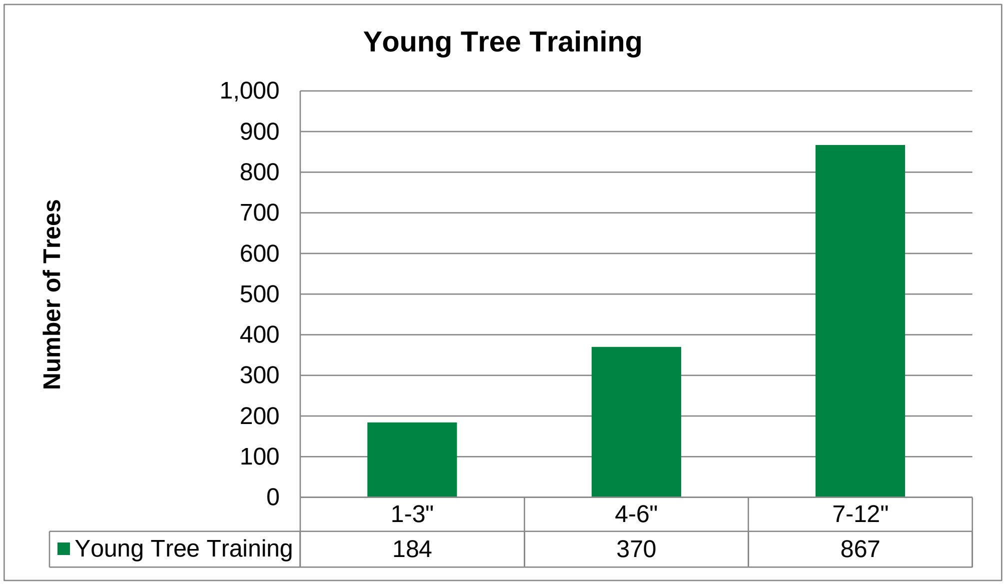
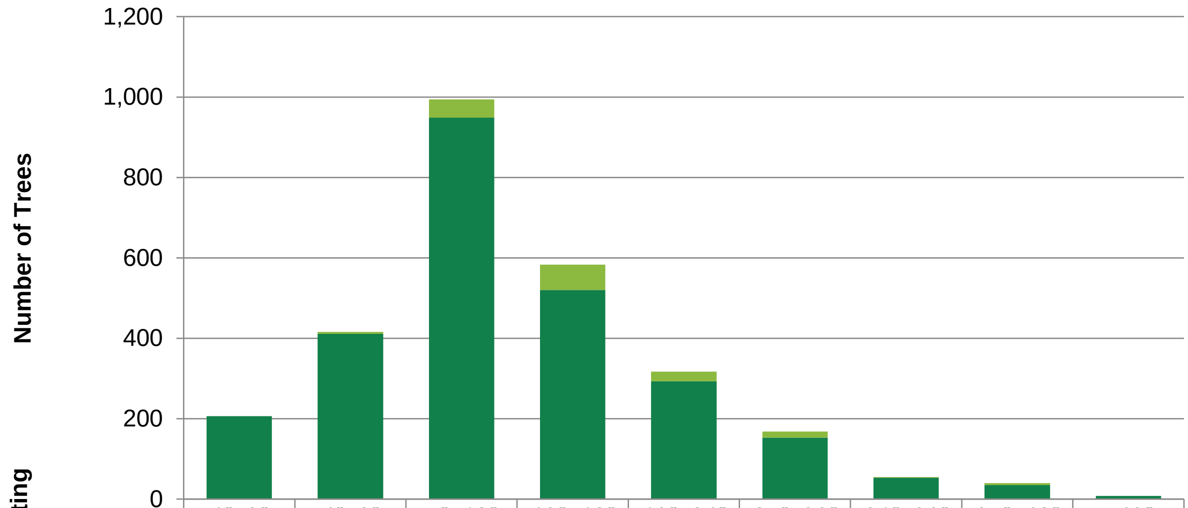


Figure 18. Trees recommended for the YTT Cycle by diameter size class.

Routine Pruning Cycle

The RP Cycle includes established, maturing, and mature trees (mostly greater than 8 inches DBH) that need cleaning, crown raising, and reducing to remove deadwood and improve structure. Over time, routine pruning can reduce reactive maintenance, minimize instances of elevated risk, and provide the basis for a more defensible 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. Generally, the RP Cycle recommended for a tree population is five years but may extend to seven years if the population is large or budget restrictions.



Risk Rating	1″–3″	4″–6″	7″–12″	13″–18″	19″–24″	25″–30″	31″–36″	37″–42″	≥43″
Moderate	0	5	45	63	24	15	2	5	0
Low	206	411	949	520	293	153	53	35	8

Diameter Size Class

Figure 19. Trees recommended for the RP Cycle by diameter size class.

Discussion

DRG recommends that the Village 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 2,787 trees with Moderate and Low Risk that should be pruned over a five-year RP Cycle. An average of 550 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, after all Extreme and High Risk trees are pruned.

As of the 2019 tree inventory, 1,358 trees (48%) were identified during inventory collection which recommended routine pruning at this time. Figure 19 shows that a variety of tree sizes will enter the RPP and possibly require pruning; however, most of the trees that require routine pruning were smaller than 24 inches DBH.

Maintenance Schedule

Utilizing data from the 2019 Village of Cayuga Heights tree inventory, an annual maintenance schedule was developed which details the number and type of tasks recommended for completion each year. DRG made budget projections using industry knowledge and public bid tabulations. A summary of the maintenance schedule is presented; a complete table of estimated costs for Cayuga Heights' five-year tree management program follows.

The schedule provides a framework for completing the inventory maintenance recommendations over the next five years. Following this schedule can shift tree care activities from an on-demand system to a more proactive tree care program. The current budget of $10,000 appears to be inadequate to catch up with the deferred maintenance costs and enacting a proactive program.

To implement the maintenance schedule, the Village's tree maintenance budget should be no less than $109,617 for the first year of implementation, with decreasing amounts to $96,003 by the fifth year. Annual budget funds are needed to ensure that Extreme and High Risk trees are remediated and that crucial YTT and RP Cycles can begin. With proper professional tree care, the safety, health, and beauty of the urban forest will improve. If routing efficiencies and/or contract specifications allow for the completion of more tree work, or if the schedule requires modification to meet budgetary or other needs, then the schedule should be modified accordingly. Unforeseen situations such as severe weather events may arise and change the maintenance needs of trees. Should conditions or maintenance needs change, budgets and equipment will need to be adjusted to meet the new demands.

This proposed budget makes an extraordinary assumption of unlimited funds and offers cost estimates to complete all the work identified in the inventory within five years. The overarching goal of budget terms is to create a sense of cost for cleaning the existing inventory and eliminating all observed risk in the inventory. Existing budgets will define the value of the resource but consider eliminating the items of highest risk with larger DBH to begin the process of moving into a proactive urban forestry program. It is understood the total budget numbers are quite larger than the actual line items for the existing program.

Table 12. Estimated Costs for Five-Year Urban Forestry Management Program

Estimated Costs for Each Activity			Year 1		Year 2		Year 3		Year 4		Year 5		Five-Year Cost
Activity	Diameter	Cost/Tree	# of Trees	Total Cost	# of Trees	Total Cost	# of Trees	Total Cost	# of Trees	Total Cost	# of Trees	Total Cost	
Extreme and High Risk Removals	1-3"	$28	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	4-6"	$58	5	$288	0	$0	0	$0	0	$0	0	$0	$288
	7-12"	$138	22	$3,025	0	$0	0	$0	0	$0	0	$0	$3,025
	13-18"	$314	13	$4,076	0	$0	0	$0	0	$0	0	$0	$4,076
	19-24"	$605	9	$5,445	0	$0	0	$0	0	$0	0	$0	$5,445
	25-30"	$825	3	$2,475	0	$0	0	$0	0	$0	0	$0	$2,475
	31-36"	$1,045	1	$1,045	0	$0	0	$0	0	$0	0	$0	$1,045
	37-42"	$1,485	2	$2,970	0	$0	0	$0	0	$0	0	$0	$2,970
	43"+	$2,035	0	$0	0	$0	0	$0	0	$0	0	$0	$0
Activity Total(s)			**55**	**$19,323**	0	$0	0	$0	0	$0	0	$0	**$19,323**
Moderate and Low Risk Removals	1-3"	$28	0	$0	0	$0	0	$0	0	$0	21	$578	$578
	4-6"	$58	0	$0	0	$0	0	$0	0	$0	61	$3,508	$3,508
	7-12"	$138	0	$0	0	$0	0	$0	83	$11,413	83	$11,413	$22,825
	13-18"	$314	0	$0	0	$0	34	$10,659	34	$10,659	0	$0	$21,318
	19-24"	$605	0	$0	15	$9,075	19	$11,495	0	$0	0	$0	$20,570
	25-30"	$825	0	$0	11	$9,075	0	$0	0	$0	0	$0	$9,075
	31-36"	$1,045	0	$0	2	$2,090	0	$0	0	$0	0	$0	$2,090
	37-42"	$1,485	0	$0	1	$1,485	0	$0	0	$0	0	$0	$1,485
	43"+	$2,035	0	$0	0	$0	0	$0	0	$0	0	$0	$0
Activity Total(s)			0	$0	**29**	**$21,725**	**53**	**$22,154**	**117**	**$22,072**	**165**	**$15,498**	**$81,448**
Stump Removals	1-3"	$18	0	$0	0	$0	1	$18	0	$0	0	$0	$18
	4-6"	$28	0	$0	0	$0	2	$55	0	$0	0	$0	$55
	7-12"	$44	0	$0	0	$0	19	$836	0	$0	0	$0	$836
	13-18"	$72	0	$0	11	$787	0	$0	0	$0	0	$0	$787
	19-24"	$94	0	$0	14	$1,309	0	$0	0	$0	0	$0	$1,309
	25-30"	$110	4	$440	0	$0	0	$0	0	$0	0	$0	$440
	31-36"	$138	3	$413	0	$0	0	$0	0	$0	0	$0	$413
	37-42"	$160	1	$160	0	$0	0	$0	0	$0	0	$0	$160
	43"+	$182	1	$182	0	$0	0	$0	0	$0	0	$0	$182
Activity Total(s)			**9**	**$1,194**	**25**	**$2,096**	**22**	**$909**	0	$0	0	$0	**$4,198**
High Risk Pruning	1-3"	$20	0	$0	0	$0	0	$0	0	$0	0	$0	$0
	4-6"	$30	1	$30	0	$0	0	$0	0	$0	0	$0	$30
	7-12"	$75	3	$225	0	$0	0	$0	0	$0	0	$0	$225
	13-18"	$120	6	$720	0	$0	0	$0	0	$0	0	$0	$720
	19-24"	$170	3	$510	0	$0	0	$0	0	$0	0	$0	$510
	25-30"	$225	1	$225	0	$0	0	$0	0	$0	0	$0	$225
	31-36"	$305	3	$915	0	$0	0	$0	0	$0	0	$0	$915
	37-42"	$380	1	$380	0	$0	0	$0	0	$0	0	$0	$380
	43"+	$590	0	$0	0	$0	0	$0	0	$0	0	$0	$0
Activity Total(s)			**18**	**$3,005**	0	$0	0	$0	0	$0	0	$0	**$3,005**
Routine Pruning (5-year cycle)	1-3"	$20	46	$920	40	$800	40	$800	40	$800	40	$800	$4,120
	4-6"	$30	91	$2,730	80	$2,400	80	$2,400	80	$2,400	80	$2,400	$12,330
	7-12"	$75	189	$14,175	190	$14,250	190	$14,250	190	$14,250	190	$14,250	$71,175
	13-18"	$120	104	$12,480	104	$12,480	104	$12,480	104	$12,480	104	$12,480	$62,400
	19-24"	$170	53	$9,010	60	$10,200	60	$10,200	60	$10,200	60	$10,200	$49,810
	25-30"	$225	33	$7,425	30	$6,750	30	$6,750	30	$6,750	30	$6,750	$34,425
	31-36"	$305	13	$3,965	10	$3,050	10	$3,050	10	$3,050	10	$3,050	$16,165
	37-42"	$380	7	$2,660	7	$2,660	7	$2,660	7	$2,660	7	$2,660	$13,300
	43"+	$590	8	$4,720	0	$0	0	$0	0	$0	0	$0	$4,720
Activity Total(s)			**544**	**$58,085**	**521**	**$52,590**	**521**	**$52,590**	**521**	**$52,590**	**521**	**$52,590**	**$268,445**
Young Tree Training Pruning (3-year cycle)	1-3"	$20	37	$740	37	$740	37	$740	37	$740	36	$720	$3,680
	4-6"	$30	74	$2,220	74	$2,220	74	$2,220	74	$2,220	74	$2,220	$11,100
	7-12"	$75	174	$13,050	174	$13,050	173	$12,975	173	$12,975	173	$12,975	$65,025
Activity Total(s)			**285**	**$16,010**	**285**	**$16,010**	**284**	**$15,935**	**284**	**$15,935**	**283**	**$15,915**	**$79,805**
Replacement Tree Planting	Purchasing	$170	25	$4,250	25	$4,250	25	$4,250	25	$4,250	25	$4,250	$21,250
	Planting	$110	25	$2,750	25	$2,750	25	$2,750	25	$2,750	25	$2,750	$13,750
Activity Total(s)			**50**	**$7,000**	**50**	**$7,000**	**50**	**$7,000**	**50**	**$7,000**	**50**	**$7,000**	**$35,000**
Replacement Young Tree Maintenance	Mulching	$100	25	$2,500	25	$2,500	25	$2,500	25	$2,500	25	$2,500	$12,500
	Watering	$100	25	$2,500	25	$2,500	25	$2,500	25	$2,500	25	$2,500	$12,500
Activity Total(s)			**50**	**$5,000**	**50**	**$5,000**	**50**	**$5,000**	**50**	**$5,000**	**50**	$5,000	**$25,000**
Activity Grand Total			**961**		**910**		**930**		**972**		**1,019**		
Cost Grand Total				**$109,617**		**$104,421**		**$103,588**		**$102,597**		**$96,003**	**$516,224**

SECTION 4: STORM RESPONSE READINESS

The Village of Cayuga Heights, 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. It also sets the stage for severe weather events, such as tornadoes, thunderstorms, hurricanes, hail, high winds, ice, and snow. Severe weather can create catastrophic damage and significant volumes debris that needs to be processed. Therefore, proactive municipalities have developed emergency response and recovery plans. Traditionally, these readiness 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. Beyond the task of collecting and disposing of this debris are additional urban forest management considerations, including increased threat to life, hindrance to life-saving efforts, power outages and property damage. The impacts of these additional tree-related considerations are not always quantifiable but can overwhelm smaller community capabilities and slow down the recovery process.

Global climate change manifested by increased rainfall and atmospheric instability present a sense of urgency for urban forestry professionals. Although beginning off the coast of western Africa, hurricanes do have a history of engaging Tompkins County. Hurricane Nate from 2017 was the most recent, followed by Ernesto, 2006; Dennis, 1999; and Frederic, 1979. The National Oceanic and Atmospheric Administration reports from 1961 through 2011, only seven tornadoes have touched down in Tompkins County. Further they were of smaller scale, level one on the Fujita-Pearson scale. The threat of tornadoes, and the resulting damage that occurs, is relatively low in Cayuga Heights. Nationally, New York State is classified as a moderate 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.

There are a number of threats facing Cayuga Heights in the coming years that will stress and likely reduce the overall canopy cover. The loss of canopy poses a threat to air and water quality and leads to higher levels of carbon in the atmosphere, more heat stress, and a degradation of quality of neighborhoods and property values. The following sections provide a summary of potential future threats. The main urban forestry concerns for this Village are the threats of winter storms including ice storms.

Increased Frequency of Severe Storms

As a result of sea level changes, increases in the frequency and severity of storms are occurring throughout the East Coast and into central New York State. This 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.

A comprehensive urban forest management plan greatly 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.

Funding and Budget for Urban Forest Emergencies

While the scope of this plan does not permit detailed budgeting estimates, Cayuga Heights is strongly encouraged to analyze past storm events (winter 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.

In order to receive FEMA funding, it is critical to be prepared and fully document all losses and money spent (updated tree inventory). 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.

Historically, FEMA funding for storm damage mitigation reimbursements has been made available in New York. In 2014 $9.6 million in public assistance grants were provided in the state after a severe winter storm occurred in January.

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).

Storm Related Training

The Cayuga Heights forestry 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. More storm related information can be found in Appendix E.

Findings

Tree Population Characteristics Related to Storm Damage Risks

With the recent tree inventory data, the vulnerability of Cayuga Heights' urban forest from severe weather events can be assessed. 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. 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 the Cayuga Heights in terms of its urban forest resource.

Tree Condition

The Village tree inventory collected data on 2,851 total trees with condition ratings. Cayuga Heights is recommended to remove the dead trees, perform recommended maintenance along major arterials 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 suited for weather conditions of the region. Approximately 9% of the inventory are Poor rated trees, with 4% 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 adjacent to recent construction pose an increased risk due to potential for stress and damage to the tree's critical root system.

Storm Prone Species Frequency

Cayuga Heights' urban forest shows concern for diversity. Maple is the only genus that exceeds the desired 20% rule. Norway maple which can also suffer large damage in storms make up 15% of Cayuga Heights' species. Tree species such as silver maple and Siberian elm should be avoided when possible. These trees, which are fast-growing and weak-wooded species, are more prone to storm damage and should be monitored closely for defects and disease. Additionally, Hauer et al (2006) describe Siberian elm, honeylocust, Bradford pear, common hackberry, pin oak, sycamore, green ash, and tulip tree as trees species susceptible to ice damage in Illinois. Larger diameter trees with broader crowns incurred the most ice damage with larger DBH trees and exhibited increased removal rates among the species mentioned. Finally, Sisinni et al (1995) analyzed storm event data from Rochester, New York and found that green ash, silver maple, London planetree, callery (Bradford) pear, Norway maple, honeylocust, red maple, littleleaf linden, and sugar maple were the tree species most susceptible to ice storm damage.

Table 13 below combines the findings made in these two studies and lists the most prevalent tree species in Cayuga Heights' inventory susceptible to storm damage. Norway maple is not only the most prevalent of these species, but it is also designated as an invasive species in New York State. Removal of these trees and replacement with a native species where appropriate is recommended.

Table 13. Storm Prone Tree Species in the Inventory

Species	Amount in Inventory	Percent of Tree Inventory
Norway maple	431	14.8%
Littleleaf linden	24	0.82%
Red Maple	22	0.76%
Honeylocust	22	0.76%
Callery (Bradford) pear	8	0.27%
London planetree	2	0.07%

Insect and Disease Issues

Urban forests are consistently under pressure from invasive insects and diseases, but the frequency and severity of such problems are likely to worsen throughout the United States as the climate warms. The solution for local communities lies in proper proactive care (budgeting, monitoring, smart management) as well as planting more resistant tree species. Appendix D contains more information for regional pests.

Discussion

With this Storm Response Readiness Strategy, and other urban forest management resources available to Cayuga Heights, such as the tree inventory, TreeKeeper® software, and the urban forest management plan, the Village of Cayuga Heights is fairly well prepared to handle the severe weather events that inevitably will impact Cayuga Heights' trees.

With only minor adjustments in its approach to storm response, Cayuga Heights 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 through Tompkins County (Swift 911 system). Also visit http://tompkinscountyny.gov/doer for helpful strategies for personal safety concerns.

During and after a storm emergency and depending on the severity of the storm and the damage sustained, Cayuga Heights may call upon municipal employees to address the community's needs. The Cayuga Heights Department of Public Works is staffed and equipped to address infrastructure damage. Contractors are also used to supplement Cayuga Heights staff where needed. These personnel resources have the trucks and equipment to manage and mitigate tree related storm damage.

Storm response and mitigation in Cayuga Heights, 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. These partnerships can produce an effective and efficient response when the expertise and resources of each possible partner is acknowledged. See Appendix E for further storm readiness information.

Recommendations for improving storm response and recovery program and actions:

- Continue to update Cayuga Heights' street tree inventory 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 Cayuga Heights 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 Cayuga Heights staff and partners the procedures for prioritizing and managing urban forest damage after storms per the three storm categories (see Appendix E).
- Provide staff training, particularly on tree risk and working with potential electrical hazards.
- Commit to providing the citizens timely messaging about Cayuga Heights' response and recovery activities and about tree damage and correction topics. Prepare public relations materials ahead of time so they are easily accessible when storms strike.

CONCLUSIONS

Public trees in Cayuga Heights are supporting and improving the quality of life in the Village. 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 Village 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 Village's trees, Cayuga Heights is well positioned to thrive. If the management program is successfully implemented, the health and safety of Cayuga Heights' trees and citizens will be maintained for years to come.

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

- Perform routine inspections of public trees. Windshield surveys (inspections performed from a vehicle) in line with *ANSI A300* (Part 9) (ANSI 2011).
- Update the tree maintenance schedule and the budget as needed in order to efficiently perform tree work. If the recommended work cannot be completed as suggested, modify maintenance schedules and budgets accordingly. Remember to keep risk mitigation priorities as an overlying theme.
- Ensure staff are up to date on best management practices in the industry through professional organizations such as the International Society of Arborists and the Society of Municipal Arborists.
- 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 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 (20%) every year over the course of five years.
- Plant native trees which are suitable for site restrictions and storm readiness parameters.
- Revise the *Tree Management Plan* after five years when the re-inventory has been completed.

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APPENDIX A
DATA COLLECTION AND SITE LOCATION METHODS

Data Collection Methods

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

- Last Change (collector name)
- Inspection Date
- Notes (thoughts during inspection)
- ID (Unique Tree Number)
- Inventory Date
- Inspection Time
- Species
- DBH*
- Multi-Stem
- Condition
- Primary Maintenance Task
- Inspection Recommendation
- Overhead Utility
- ResiRisk
- Assessment Recommendation
- Parcel ID
- Defects
- Risk Assessment (multiple fields)
- Growing Space
- Address
- X and Y Location
- Long / Lat Location

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

Maintenance needs are based on *ANSI A300 (Part 1)* (ANSI 2008). *Best Management Practices: Tree Risk Assessment* (International Society of Arboriculture [ISA] 2017).

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) and Trimble® GPS Pathfinder® ProXH™ receiver(s).

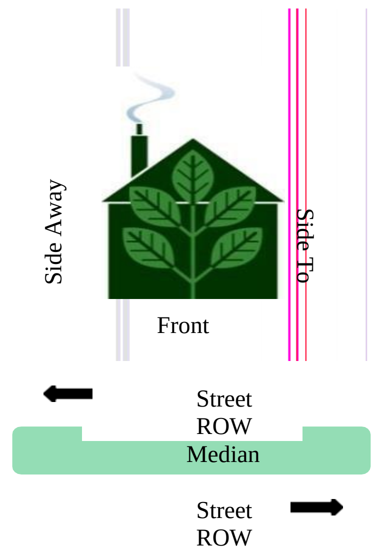
Base map layers were loaded onto these unit(s) to help locate sites during the inventory. The table below lists the base map layers, utilized along with source and format information for each layer.

Base Map Layers Utilized for Inventory

Imagery/Data Source	Date	Projection
Tompkins County GIS Portal http://tompkinscountyny.gov/gis	2018	NAD 1983StatePlane NY Central; Feet
NYGIS Clearinghouse ttp://gis.ny.gov/	2018	NAD 1983StatePlane NY Central; 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). 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.

<u>Corner Lot A</u>

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

<u>Corner Lot B</u>

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

APPENDIX B
SUGGESTED TREE 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 majority of soil and climate conditions found throughout the eastern United States.

Large Trees: Greater than 50 Feet in Height When Mature

Scientific Name	Common Name	Cultivar
Acer rubrum	red maple	'Autumn Flame' 'Bowhall' 'Brandywine' 'Karpick' 'Northwood' 'October Glory' 'Red Sunset'
Acer saccharum	sugar maple	'Commemoration' 'Green Mountain' 'Legacy'
Acer × freemanii	Freeman maple	'Armstrong' 'Autumn Blaze' 'Celebration' 'Scarlet Sentinel'
Celtis laevigata	sugar hackberry	'All Seasons'
Celtis occidentalis	hackberry	'Prairie Pride'
Eucommia ulmoides	hardy rubber tree	
Ginkgo biloba	ginkgo	(Choose male trees only)
Gleditsia triacanthos inermis	thornless honeylocust	hademaster' 'Skyline'
Gymnocladus dioicus	Kentucky coffeetree	Prairie Titan®
Liquidambar styraciflua	sweetgum	
Metasequoia glyptostroboides	dawn redwood	'Emerald Feathers'
Nyssa sylvatica	black tupelo	
Platanus × acerifolia	London planetree	'Bloodgood'
Quercus acutissima	sawtooth oak	
Quercus bicolor	swamp white oak	
Quercus ellipsoidalis	northern pin oak	
Quercus imbricaria	shingle oak	
Quercus macrocarpa	bur oak	
Quercus palustris	pin oak	

Large Trees: Greater than 50 Feet in Height When Mature (Continued)

Scientific Name	Common Name	Cultivar
Quercus robur	English oak	'Attention' 'Skymaster' 'Skyrocket'
Quercus rubra	northern red oak	'Splendens'
Quercus shumardii	shumard oak	
Taxodium distichum	common baldcypress	'Shawnee Brave'
Tilia cordata	littleleaf linden	'Chancole' 'Corzam' 'Fairview' 'Glenleven' 'Greenspire'
Tilia americana	American linden	'Redmond'
Tilia tomentosa	silver linden	'Sterling'
Tilia × euchlora	Crimean linden	
Ulmus ×	hybrid elm	'Frontier' 'Homestead' 'Pioneer' 'Regal' 'Urban' 'Accolade'
Zelkova serrata	Japanese zelkova	'Green Vase' 'Halka' 'Village Green'

Medium Trees: 26 to 49 Feet in Height When Mature

Scientific Name	Common Name	Cultivar
Acer campestre	hedge maple	'Queen Elizabeth' 'St. Gregory'
Acer miyabei	Miyabe maple	'State Street'
Acer truncatum ×	Norwegian sunset maple	'Keithsform'
Acer truncatum ×	Pacific sunset maple	'Warrenred'
Aesculus × carnea	red horsechesnut	'Briotii'
Carpinus betulus	European hornbeam	
Carpinus caroliniana	American hornbeam	
Cercidiphyllum japonicum	Katsura	
Cladrastis kentukea	American yellowwood	'Rosea'
Corylus colurna	Turkish filbert	
Gleditsia triacanthos inermis	thornless honeylocust	'Imperial'
Halesia tetraptera	Carolina silverbell	
Koelreuteria paniculata	goldenraintree	
Ostrya virginiana	American hophornbeam	
Parrotia persica	Persian parrotia	'Vanessa'
Phellodendron amurense	Amur corktree	'Macho'
Styphnolobium japonicum	Japanese pagodatree	'Princeton Upright' 'Regent'
Ulmus parvifolia	lacebark elm	'Dynasty' 'Ohio'

Small Trees: 10 to 25 Feet in Height when Mature

Scientific Name	Common Name	Cultivar
Acer buergerianum	trident maple	
Acer tataricum ssp. ginnala	Amur maple	Red Rhapsody™
Acer griseum	paperbark maple	
Acer pensylvanicum	stripled maple	
Amelanchier spp.	serviceberry.	
Cercis canadensis	eastern redbud	'Forest Pansy'
Chionanthus retusus	Chinese fringetree	
Cornus kousa	Kousa dogwood	'Galzam' 'Milky Way' 'Propzam' 'Samzam' 'Satomi'
Cornus racemosa	gray dogwood	'Cuyzam' 'Ottzam'
Crataegus species	hawthorn	
Malus spp.	flowering crabapple	(Disease resistant only)
Syringa reticulata	Japanese tree lilac	'Ivory Silk'

Special Use Trees

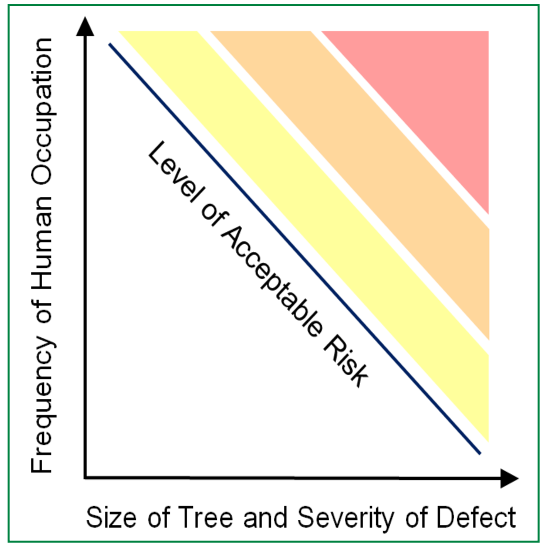
In certain areas of the city, such as the downtown business district or in areas of restricted aboveground space, the best tree choice may be those varieties that grow more upright in what is termed a fastigiate, or columnar, manner. This form achieves two purposes: because of their tighter, upright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

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

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. The newest iteration of Dirr's book is written with Keith Warren and is titled, "The Tree Book – Superior Selection for Landscapes Streetscapes, and Gardens." It was released in Spring 2019.

APPENDIX C
RISK ASSESSMENT/PRIORITY AND PROACTIVE MAINTENANCE

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 **toward** 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.

Risk Rating Matrix Table

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, Cayuga Heights may decide that cabling, bracing, or moving the target may be the best option for reducing risk.

Determination of acceptable risk ultimately lies with municipal 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.

PR 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 D
INVASIVE PESTS AND DISEASES

In today's worldwide marketplace, the volume of international trade brings increased potential for pests and diseases to invade our country. Many of these pests and diseases have seriously harmed rural and urban landscapes and have caused billions of dollars in lost revenue and millions of dollars in cleanup costs. Keeping these pests and diseases out of the country is the number one priority of the USDA's Animal and Plant Inspection Service (APHIS). Updated maps can be found at: https://www.nrs.fs.fed.us/tools/afpe/maps/

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

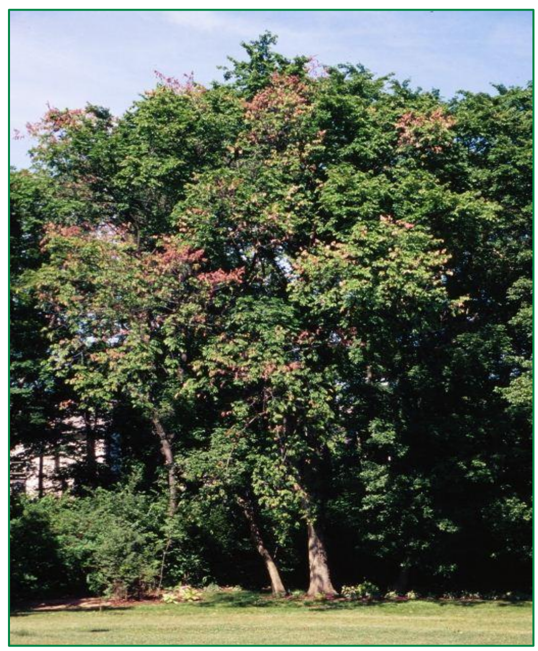
The Asian longhorned beetle (ALB, *Anoplophora glabripennis*) is an exotic pest that threatens a wide variety of hardwood trees in North America. The beetle was introduced in Chicago, New Jersey, and New York City, and is believed to have been introduced in the United States from wood pallets and other 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

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).

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.



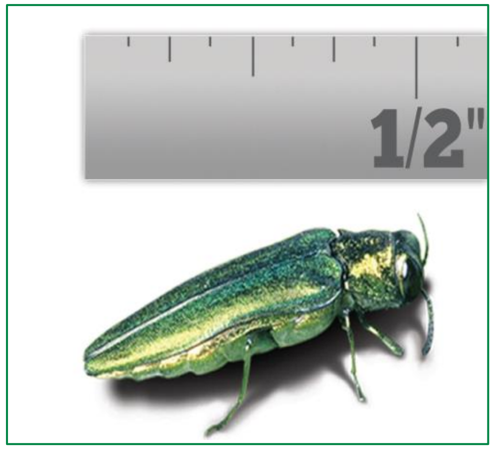
Branch death, or flagging, at multiple locations in the crown of a diseased elm
Photograph courtesy of Steven Katovich, USDA Forest Service, Bugwood.org (2011)

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).

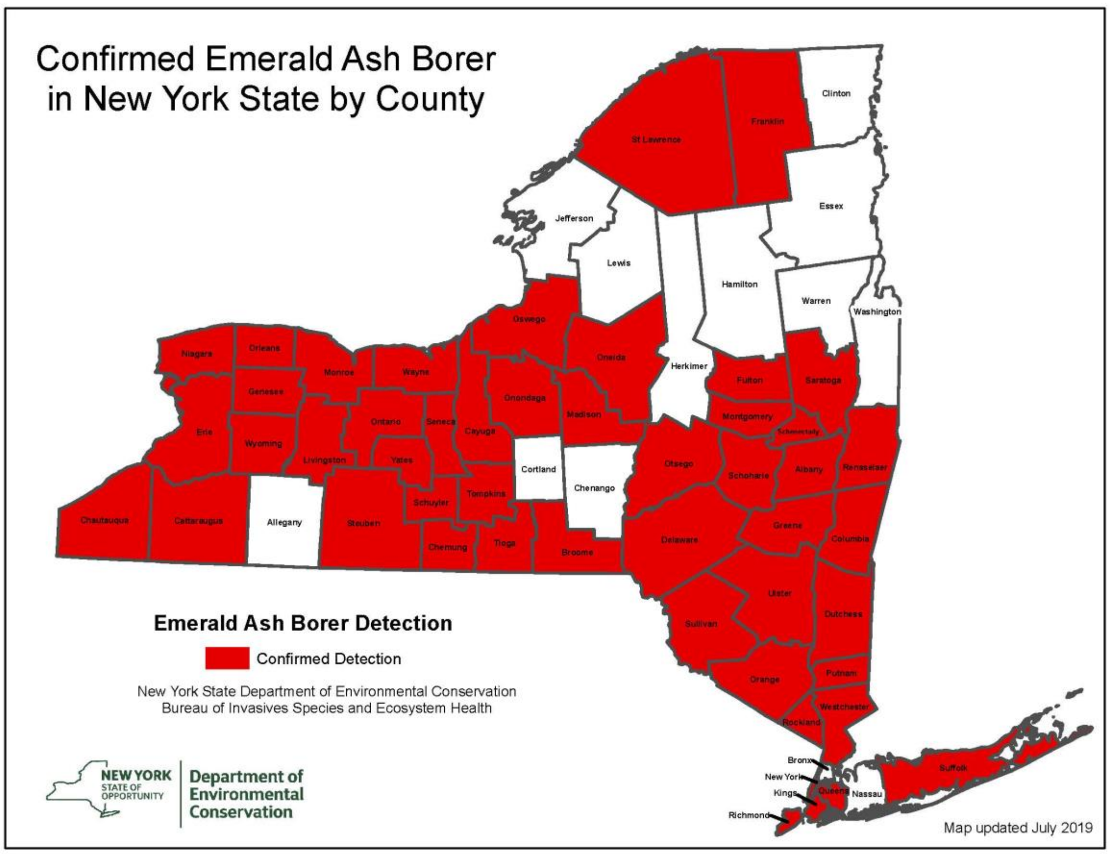
Emerald Ash Borer

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.



Close-up of the emerald ash borer Photograph courtesy of APHIS (2011)

Adult beetles are slender and 1/2-inch long. Males are smaller than females. Color varies but adults are usually bronze or golden green overall with metallic, emerald-green wing covers. The top of the abdomen under the wings is metallic, purplish-red and can be seen when the wings are spread. The EAB-preferred host tree species are in the genus *Fraxinus* (ash).



New York State EAB Spread Map (2019)

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.

Close-up of male (darker brown) and female (whitish color) European gypsy moths
Photograph courtesy of APHIS (2011b)

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).

Granulate Ambrosia Beetle

Adult granulate ambrosia beetle
Photograph courtesy of Paul M. Choate, University of Florida (Atkinson et al. 2011)

The granulate ambrosia beetle (*Xylosandrus crassiusculus*), formerly the Asian ambrosia beetle, was first found in the United States in 1974 on peach trees near Charleston, South Carolina. The native range of the granulate ambrosia beetle is probably tropical and subtropical Asia. The beetle is globally present in countries such as equatorial Africa, Asia, China, Guinea, Hawaii, India, Japan, New South Pacific, Southeast Indonesia, Sri Lanka, and the United States. In the United States, this species has spread along the lower Piedmont region and coastal plain to East Texas, Florida, Louisiana, and North Carolina. Populations were found in Oregon and Virginia in 1992, and in Indiana in 2002.

Adults are small and have a reddish-brown appearance with a downward facing head. Most individuals have a reddish head region and a dark brown to black elytra (hard casings protecting the wings). Light-colored forms that appear almost yellow have also been trapped. A granulated (rough) region is located on the front portion of the head and long setae (hairs) can be observed on the back end of the wing covers. Females are 2–2.5mm and males are 1.5mm long. Larvae are C-shaped with a defined head capsule.

The granulate ambrosia beetle is considered an aggressive species and can attack trees that are not highly stressed. It is a potentially serious pest of ornamentals and fruit trees and is reported to be able to infest most trees and some shrubs (azalea, rhododendron) but not conifer. Known hosts in the United States include: *Acer* (maple); *Albizia* (albizia); *Carya* (hickory); *Cercis canadensis* (eastern redbud); *Cornus* (dogwood); *Diospyros* (persimmon); *Fagus* (beech); *Gleditsia* or *Robinia* (locust); *Juglans* (walnut); *Koelreuteria* (goldenrain tree); *Lagerstroemia* (crapemyrtle); *Liquidambar styraciflua* (sweetgum); *Liriodendron tulipifera* (tulip poplar); *Magnolia* (magnolia); *Populus* (aspen); *Prunus* (cherry); *Quercus* (oak); and *Ulmus parvifolia* (Chinese elm). *Carya illinoinensis* (pecan) and *Pyrus calleryana* (Bradford pear) are commonly attacked in Florida and in the southeastern United States.

Xm Ambrosia Beetle

The Xm ambrosia beetle (*Xylosandrus mutilatus*), is native to Asia and was first detected in the United States in 1999 in traps near Starkville, Mississippi. By 2002, the beetle spread throughout Missouri and quickly became well established in Florida. The species also has been found in Alabama, northern Georgia, and Texas. In addition to its prevalence in the southeastern United States, the Xm ambrosia beetle is currently found in China, India, Indonesia, Japan, Korea, Malaya, Myanmar, Papua New Guinea, Sri Lanka, Taiwan, and Thailand.

Xm ambrosia beetle
Photograph courtesy of Michael C. Thomas, Florida Department of Agriculture and Consumer Services (Rabaglia et al 2003)

This species generally targets weakened and dead trees. Since the beetle attack's small diameter material, it may be commonly transported in nursery stock. Female adults are prone to dispersal by air currents and can travel 1–3 miles in pursuit of potential hosts. This active capability results in a broad host range and high probability of reproduction. The species is larger than any other species of *Xylosandrus* (greater than three millimeters) in the U.S. and is easily recognized by its steep declivity and dark brown to black elytra (hard casings protecting the wings). Larvae are white and C-shaped with an amber colored head capsule.

Known hosts in the U.S. include: *Acer* (maple); *Albizia* (silktree); *Benzoin* (northern spicebush); *Camellia* (camellia); *Carpinus laxiflora* (looseflower hornbeam); *Castanae* (sweet chestnut); *Cinnamomum camphora* (camphor tree); *Cornus* (dogwood); *Cryptomeria japonica* (Japanese cedar); *Fagus crenata* (Japanese beech); *Lindera erythrocarpa* (spicebush); *Machilus thurnbergii* (Japanese persea); *Ormosia hosiei* (ormosia); *Osmanthus fragrans* (sweet osmanthus); *Parabezion praecox*; *Platycarpa*; and *Sweitenia macrophylla* (mahogany).

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.

Hemlock woolly adelgids on a branch
Photograph courtesy of USDA Forest Service (2011a)

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.

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. Oak wilt has been identified in the Finger Lakes Region (Canadaigua, New York).

Pine Shoot Beetle

Mined shoots on a Scotch pine Photograph courtesy of USDA Forest Service (1993)

The pine shoot beetle (*Tomicus piniperda L.*), a native of Europe, is an introduced pest of *Pinus* (pine) in the United States. It was first discovered in the United States at a Christmas tree farm near Cleveland, Ohio in 1992. Following the first detection in Ohio, the beetle has been detected in parts of 19 states (Connecticut, Illinois, Indiana, Iowa, Maine, Maryland, Massachusetts, Michigan, Minnesota, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, Rhode Island, Vermont, Virginia, West Virginia, and Wisconsin).

The beetle attacks new shoots of pine trees, stunting the growth of the trees. The pine shoot beetle may also attack stressed pine trees by breeding under the bark at the base of the trees. The beetles can cause severe decline in the health of the trees and, in some cases, kill the trees when high populations exist.

Adult pine shoot beetles range from 3 to 5 millimeters long, or about the size of a match head. They are brown or black and cylindrical. The legless larvae are about five millimeters long with a white body and brown head. Egg galleries are 10–25 centimeters long. From April to June, larvae feed and mature under the pine bark in separate feeding galleries that are 4–9 centimeters long. When mature, the larvae stop feeding, pupate, and then emerge as adults. From July through October, adults tunnel out through the bark and fly to new or 1-year-old pine shoots to begin maturation feeding. The beetles enter the shoot 15 centimeters or less from the shoot tip and move upwards by hollowing out the center of the shoot for a distance of 2.5–10 centimeters. Affected shoots droop, turn yellow, and eventually fall off during the summer and fall.

P. sylvestris (Scots pine) is preferred, but other pine species, including *P. banksiana* (jack pine), *P. nigra* (Austrian pine), *P. resinosa* (red pine), and *P. strobus* (eastern white pine), have been infested in the Great Lakes region.

Sirex Woodwasp

Close-up of female Sirex Woodwasp

Photograph courtesy of USDA (2005)

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.

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

Adult southern pine beetles
Photograph courtesy of Forest Encyclopedia Network (2012)

The southern pine beetle (SPB, *Dendroctonus frontalis*) is the most destructive insect of pest 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 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.

Sudden Oak Death

The causal agent of sudden oak death (SOD, also known as *Phytophthora* canker disease), *Phytophthora ramorum*, was first identified in 1993 in Germany and the Netherlands on ornamental rhododendrons. In 2000, the disease was found in California. Since its discovery in North America, SOD has been confirmed in forests in California and Oregon and in nurseries in British Columbia, California, Oregon, and Washington. SOD has been potentially introduced into other states through exposed nursery stock. Through ongoing surveys, APHIS continues to define the extent of the pathogen's distribution in the United States and limit its artificial spread beyond infected areas through quarantine and a public education program.

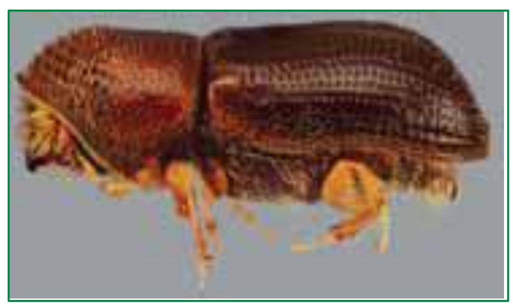
Drooping tanoak shoot
Photograph courtesy of Indiana Department of Natural Resources (2012)

Identification and symptoms of SOD may include large cankers on the trunk or main stem accompanied by browning of leaves. Tree death may occur within several months to several years after initial infection. Infected trees may also be infested with ambrosia beetles (*Monarthrum dentiger* and *M. scutellarer*), bark beetles (*Pseudopityophthorus pubipennis*), and sapwood rotting fungus (*Hypoxylon thouarsianum*). These organisms may contribute to the death of the tree. Infection on foliar hosts is indicated by dark gray to brown lesions with indistinct edges. These lesions can occur anywhere on the leaf blade, in vascular tissue, or on the petiole. Petiole lesions are often accompanied by stem lesions. Some hosts with leaf lesions defoliate and eventually show twig dieback.

This pathogen is devastating to *Quercus* (oak) but also affects several other plant species.

Thousand Cankers Disease

A complex disease referred to as Thousand cankers disease (TCD) was first observed in Colorado in 2008 and is now thought to have existed in Colorado as early as 2003. TCD is considered to be native to the United States and is attributed to numerous cankers developing in association with insect galleries.



Walnut twig beetle, side view
Photograph courtesy of USDA Forest Service (2011b)

TCD results from the combined activity of the *Geosmithia morbida* fungus and the walnut twig beetle (WTB, *Pityophthorus juglandis*). The WTB has expanded both its geographical and host range over the past two decades, and coupled with the *Geosmithia morbida* fungus, *Juglans* (walnut) mortality has manifested in Arizona, California, Colorado, Idaho, New Mexico, Oregon, Utah, and Washington. In July 2010, TCD was reported in Knoxville, Tennessee. The infestation is believed to be at least 10 years old and was previously attributed to drought stress. This is the first report east of the 100th meridian, raising concerns that large native populations of *J. nigra* (black walnut) in the eastern United States may suffer severe decline and mortality.

The tree species preferred as hosts for TCD are walnuts.

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APPENDIX E
STORMS AND THE URBAN FOREST

This material is intended as a supplemental companion to the Storm Response Readiness section, information is provided as informational purposes only. Further research and inquiries to listed emergency agencies as to proper storm related procedures and protocols is the responsibility of the Village.

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 response required by Cayuga Heights are offered for Village consideration and adoption as part of an official Cayuga Heights' wide emergency response plan.

Storm Classification

Class I Minor Storm Event

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

Damage reports and service requests are made to Cayuga Heights directly by citizens and from staff inspections. Damage is corrected, and debris is disposed by Cayuga Heights 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 cleanup are achieved by Cayuga Heights staff and/or contractors, requires no additional funding or special equipment, and is completed quickly.

Class I Storm Mitigation Procedures

- Cayuga Heights staff receive calls/reports from citizens and Cayuga Heights agencies.
- Cayuga Heights staff inspects and determines appropriate mitigation; utility company is called as required.
- Cayuga Heights staff and/or contractors immediately resolve damage and dispose of debris.
- Cayuga Heights 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 in the Cayuga Heights. 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 Cayuga Heights and/or contractors alone. Damage mitigation for these storms will usually require the assistance of outside contractors and from other Cayuga Heights 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

- Cayuga Heights 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.
- Cayuga Heights staff inspect damage, determine mitigation levels and needs, and set work priorities.
- Cayuga Heights designate personnel and equipment resources under the guidance of the EOC leader.
- Cayuga Heights and contractual staff resolve damage, process debris on site where appropriate, or transport debris to storage site.
- Cayuga Heights staff make final inspection and update the tree inventory database.
- Debris is processed appropriately.
- Cayuga Heights staff should communicate with the citizens about its response activities and status using the Cayuga Heights' website, social media platforms, etc.

Class III Catastrophic Storm Event

Class III storms will be rare but can and have occurred in Tompkins County. Generally, these will result from strong widespread ice storms or possibly hurricane remnants. 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 the mayor. Other local, state, and federal emergency management agencies will become involved, as well as NYDOT, New York State Electric and Gas, and other controlling utility companies. It will become necessary to identify Cayuga Heights funds 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

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

Outside Partners

Utility Agencies

Electric distribution lines in Tompkins County are controlled by New York State Electric and Gas Corporation and are a key partner during a storm emergency. Only NYSEG 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 Cayuga Heights will likely also need to communicate and coordinate with the Tompkins County Public Utility Service Agency or New York State Electric and Gas Corporation. Where whole trees or limbs are down or resting on energized lines, rescue and cleanup 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.

New York Department of Transportation (NYSDOT)

NYSDOT is responsible for the safety and maintenance of interstate and state routes within and around the Village of Cayuga Heights. The Village is within Region 3 of NYDOT. During a storm emergency, they can respond with staff and equipment to clear such rights-of-way and assist with Cayuga Heights streets if authorized. Below is a map from 511NY.org for Cayuga Heights area, and freely available online. It provides current information for incidents, including winter road conditions.

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 Cayuga Heights. During an emergency, Cayuga Heights could enter into new emergency contracts and modify existing contracts to supply the personnel and equipment necessary to efficiently deal with storm mitigation efforts.

State of New York

When the response efforts appear to be beyond the capability of Cayuga Heights 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.in.gov/dhs/3312.htm, 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.

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 Cayuga Heights 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 Cayuga Heights for debris removal costs if a federal disaster is declared. FEMA will also reimburse Cayuga Heights 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.

Finally, FEMA will also reimburse Cayuga Heights for hazard reduction pruning immediately following a storm during a federal disaster. In general, broken or hanging branches that are two 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.

Local Partner Information

Tompkins County Emergency Response
http://tompkinscountyny.gov/doer

Tompkins READY – Emergency Preparation site
http://tompkinscountyny.gov/tompkinsready

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

United Way disaster relief
http://www.uwwp.org/disaster-fund.shtml

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

Storm Event Communications

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 and complicate recovery work. Public relations should be coordinated through the emergency services or the mayor’s office.

Guidelines 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 hangers, leaning trees, downed wires, chainsaw injuries, etc.
  - 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 Cayuga Heights 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.