SEASIDE PARK TREE INVENTORY

BRIDGEPORT, CONNECTICUT

JANUARY 4, 2022

Submitted by:

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TREEFOIL

CONSULTING ARBORISTS

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ACKNOWLEDGEMENTS

PLANNING TEAM

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CONSULTING ARBORISTS

Treefoil, LLC

Bradley Painter | Principal, Senior Consultant
Isabelle Zaffetti | Arborist Technician, Connecticut Licensed Arborist

ABBREVIATIONS

ANSI	American National Standards Institute
ANSI A300	United States, industry-developed, national consensus standards of practice for tree care.
ANSI Z133.1	United States Safety standards for arborists
BMP	best management practice
B&B	balled & burlapped
CAES	Connecticut Agricultural Extension Service
CODIT	compartmentalization of decay in trees
CRZ	critical root zone
DBH	diameter at breast height
D-tape	diameter tape
GIS	geographic information system
IPM	integrated pest management
ISA	International Society of Arboriculture
ISA LEVEL 1	International Society of Arboriculture Level 1 (limited visual assessment, see glossary)
ISA LEVEL 2	International Society of Arboriculture Level 2 (basic assessment, see glossary)
ISO	International Organization for Standardization
PHC	plant health care
RCA	Registered Consulting Arborist
TPZ	tree protection zone
TRAQ	tree risk assessment qualification
VTA	visual tree assessment

EXECUTIVE SUMMARY

A sound approach to management of the tree canopy at Seaside Park is to quantify and interpret existing park conditions by setting up a direction and pace with which to achieve the desired goals. A tree inventory supplies the base information to create a tree management plan that aims to target goals and evaluate progress over a set period. The tree management plan is a tool for communicating with other stakeholders to proactively plan, prioritize, schedule, and scope areas of work, with an end goal of reducing unanticipated costs that are incurred by a municipality when in a reactive setting.

Plan Development Team

This inventory was developed for Reed Hilderbrand Landscape Architects by consulting arborists Treefoil LLC, to understand and focus on current and future tree canopy needs. Treefoil LLC staff involved with the project include Bradley Painter, principal, and Ms. Isabelle Zaffetti, Connecticut licensed arborist and technician

Inventory Scope

Treefoil LLC completed the tree inventory December 2021 to achieve insight into the existing canopy at Seaside Park and to anticipate future for tree care and planting.

The tree inventory included collection of data from existing trees in the managed areas of Seaside Park. The Reed Hilderbrand landscape architects requested the inventory be split into three distinct areas: Area A with 65 acres, Area B with 83 acres and Area C 38 acres. The consultants were able to develop this report after analysis of the collected tree inventory data and added input from Reed Hilderbrand Landscape Architects.

Figure 1 Seaside Park Areas A,B,C (Reed Hilderbrand)

Inventory Results

- A total of 1093 trees were inventoried, with 557 in Area A, 380 in Area B and 156 in Area C.

CLIENT SITE	COUNT	PERCENTAGE
Seaside A	557	51.0%
Seaside B	380	34.8%
Seaside C	156	14.3%

Figure 2 Tree Inventory Count by Area

- Area counts of trees in good condition are Area A 364, Area B 223 and Area C 118.

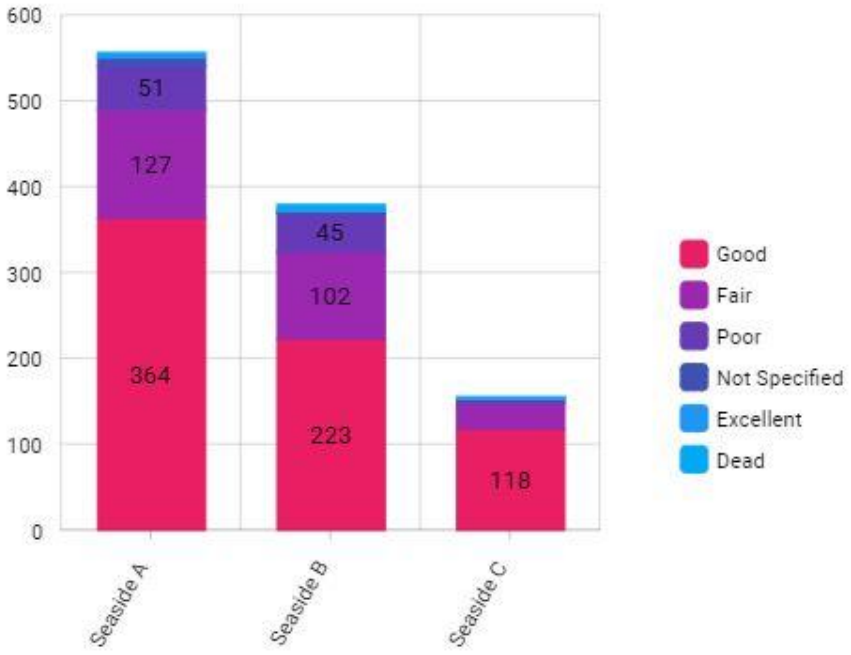
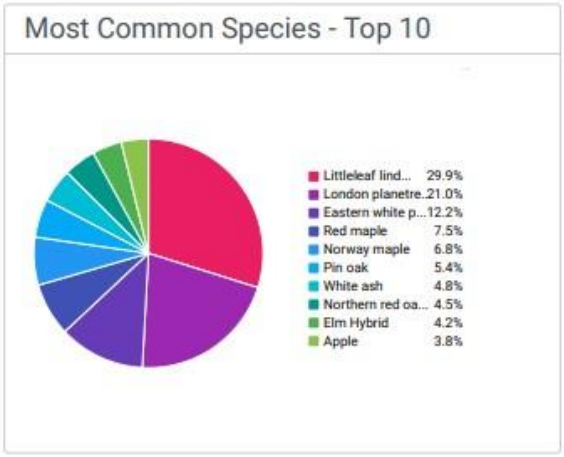


Figure 3 Quantities of Trees Condition by Area

- The ten most common species of the three areas are as noted below:



Most Common Species - Top 10

COMMON NAME	COUNT	PERCENTAGE
Littleleaf linden	243	29.9%
London planetree	171	21.0%
Eastern white pine	99	12.2%
Red maple	61	7.5%
Norway maple	55	6.8%
Pin oak	44	5.4%
White ash	39	4.8%
Northern red oak	37	4.5%
Elm Hybrid	34	4.2%
Apple	31	3.8%

Figure 4 Ten Most Common Species

- Pruning tasks by Area:

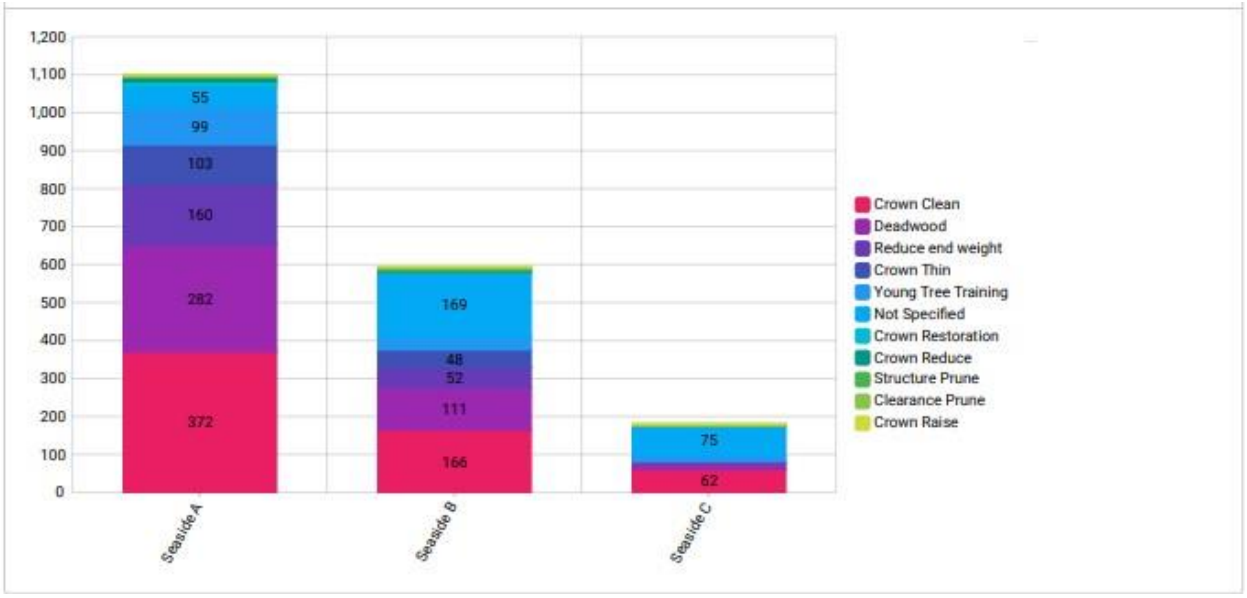


Figure 5 Pruning Task Count by Area

- Recommended removals of trees in Area A is 35, Area B is 55 Area C is 8:

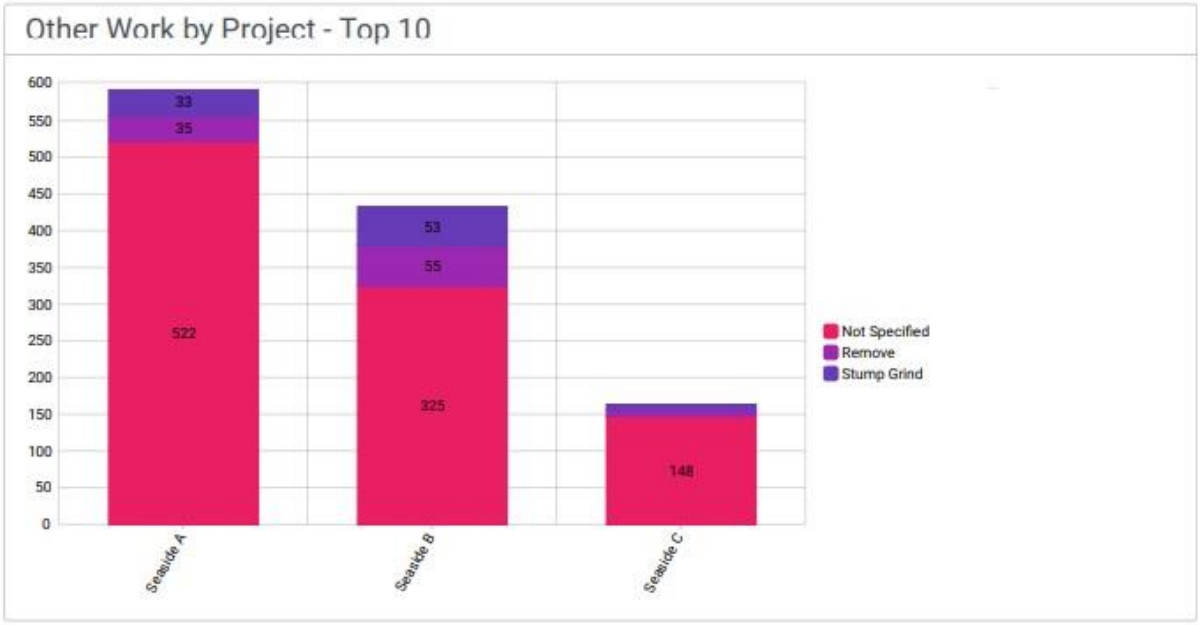


Figure 6 Removal Count by Area

INTRODUCTION

Seaside Park Tree Related History

Seaside Park was envisioned by famed landscape architect Frederick law Olmsted and Calvert Vaux in 1867 with financial and land donation support from the Bridgeport community, notably by P.T. Barnum, Nathaniel Wheeler and Colonel William Noble. The original design part was the easternmost 44 acres of the current total 325 acres Seaside Park acres (Connecticut Office of Tourism, 2021).

The original design is an example of the historic American park movement, led by Frederick Law Olmsted, to provide relief and an outlet for city residents subject to industrial pollution, heat, and unsanitary conditions by creating a freely accessible park setting with a cooling and cleansing native tree canopy over walks and carriage paths interspersed with open meadows creating interest and highlighting vistas (Gilchrist A., 1982).

Seaside Park also has a dike, multiple breakwaters and a two-mile masonry wall all noted for their 19th century engineering. The considerable expense and needed interest to maintain the extensive project was supported by notable P. T, Barnum from 1864-1891(Gilchrist, 1982).

The consultant undertook the assignment of conducting a complete tree inventory. Part of the inventory assignment was to note trees that may be "legacy trees" or trees that may have historical relevance or trees that were consistent with plantings as directed by a landscape plan. It is important to note that the consultant was not aware of any noted historic trees nor plans detailing tree locations or species but has interpolated similarities with site visits or available materials of other parks (Beardsley, Prospect Park and Central Park) designed by Frederick Law Olmsted.

Figure 7 The Only Seaside Park Landscape Plan by Frederick Law Olmsted' Firm (The Olmsted Legacy Trail)

Any noted "legacy trees" tend to be larger in diameter size with the understanding that tree size is influenced by many factors (species, environmental conditions, past construction activities, etc.) and is not necessarily a reliable gauge of age. Though not recommended by the consultant, one method to find correct age is invasive core increment drilling that could be performed but not without risk to the tree as the process exposes a channel for bacteria, insects and decay and therefore is not recommended.

Developing the Seaside Park Tree Inventory

Trefoil LLC staff involved with the project include Bradley Painter, principal, a Connecticut licensed arborist (S-6397), International Society of Arboriculture certified arborist (6931-A) and ISA Tree Risk Assessment Qualified, and American Society of Consulting Arborist registered consulting arborist (RCA), # 634 and Treefoil arborist technician, Ms. Isabelle Zaffetti, a Connecticut licensed arborist # S-6691.

The Reed Hilderbrand team requested the inventory and the consultant prescribed tree tag numbers, location, size, condition, and species be recorded on the consultant's ArcGIS digital tree platform for export as csv and shapefiles for the landscape architect's use.

The Treefoil consultants referenced numerous sources for information: Connecticut Agricultural Extension Service, Dirr's *Manual of Woody Plants*, International Society of Arboriculture (ISA) publications, and the University of Connecticut Plant Database. The consultants also drew on their experience to interpret any subjective data collection about interpreting tree architecture, health, conditions, and future prognosis.

METHODOLOGY

Pre-Inventory Phase

The pre-inventory phase served to review and finalize data and associated collection fields with management team members. Data structure was completed for collection and csv file and AutoCAD compatible shapefile deliverables. Project liaisons were found for associated parties and protocols were established for communications, project updates, and any other data requests.

Reed Hilderbrand principal, Ms. Beka Sturges, coordinated the schedule and defined the scope of the project for Treefoil staff. Ms. Sturges was supported by staff Louise Lewis, senior associate and Nan Guo, associate.

There were three separate areas assigned by Reed Hilderbrand for the collection of data: Area A, Area B, and Area C.

Figure 8 Areas A, B, C Designations and Acreage (Reed Hilderbrand)

Area A Overview

Figure 9 Area A (in green)

Figure 10 Area Inventoried Tree Locations

Area A is the most populated zone with 557 trees or 51% of the total Seaside Park tree population. 93 trees were designated as potential legacies and 35 recommended for removal. This is the most easterly zone, and its approximate 65 acres are bordered to the outside by Linden Avenue, Waldmere Avenue and Broad Street to the north. The southernmost border Soundview Avenue is found within the park and sits on a 19th century engineered dike with and multiple designated parking lanes. There is a wide sidewalk running parallel to the length of Soundview Avenue.

Area A displays the primary park landscape features associated with Frederick Law Olmsted with a mix of what the consultant identified as potential legacy tree species flanking winding walkways and named roadways with available parking throughout: Grove Road, Howe Drive and Monument Drive. There are a few monuments in Area A including a statue of one park benefactor P.T. Barnum.

Figure 11 PT Barnum Statue

The park area can be accessed through other entryways, though the Percy Memorial Arch main entrance off Park Avenue is the most formal and memorable reinforcing a sense of the park experience.

Figure 12 Percy Memorial Arch

One noticeably entertaining feature is the wild monk parakeet population. There are numerous 4-6' x 2-3' nests found in the Sweetgum (*Nyssa sylvatica)* grove adjacent to the concession stand as well as the field by amphitheater (Connecticut Audubon Society, 2022)

Figure 13 Parakeet Nests in Nyssa at Amphitheater Field

Figure 14 Parakeets on Ground by Concessions in Area A and Nest at Right

Area A has two baseball fields as well as a meadow with an amphitheater and surrounding running track. There are large open mowed meadow spaces with open vistas bordered by a variety of species of mature trees interspersed with benches, picnic tables and grills under the canopy. Well maintained playgrounds are found under the mature canopy as well.

Figure 15 Area A Canopy Looking West to Amphitheater

The consultant was directed to evaluate some of the trees found in Area A's northeast corner for preservation within the context of a significant rise in grade currently being considered. The zone is in an area of low topography (elevation 4.0' per Reed Hilderbrand Graphic, December 2020) within a community of potential legacy trees along with other non-legacy trees. Several factors are considered during an evaluation: species construction tolerance, condition, DBH size, moisture conditions and final construction details. The concepts discussed will give the design team a broader understanding of such factors when setting up their design direction.

Figure 16 Inventoried Trees at Area A and Right Sat View of Area with Trees

Figure 17 CRZ Zone for Trees in Area A and TPZ right

Area B Overview

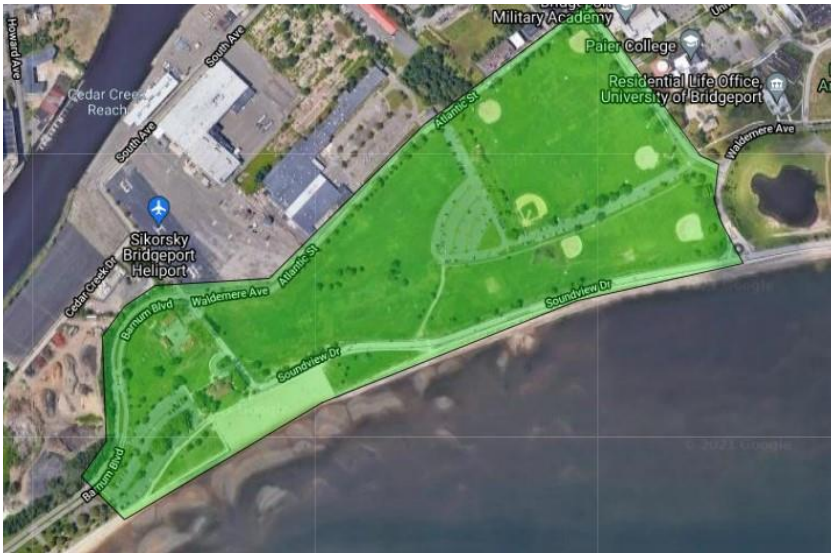


Figure 18 Area B in Green

Figure 19 Area B Sat View

Area B is a zone populated with 380 trees or 34.8% of the total Seaside Park population. There were 12 potential legacy trees identified and 55 trees recommended for removal This is the central zone, and its approximate 83 acres are bordered to the North by Waldmere Avenue, Atlantic Avenue and Iranistan Avenue. There is also a part of the western end that includes Barnum Boulevard on the north side. The southernmost border Soundview Avenue is found within the zone with a wide sidewalk running the length and adjacent available small scale parking lots and associated planting islands with established trees.

Figure 20 Area B Typical Field Views Left and Right

Figure 21 Area B View Looking East

Area B is made up of mowed open space bordered by various size trees and species on the outside perimeter. The interior meadow spaces have a noticeably lower topography than Soundview Avenue along the top of the dike. The open space is occupied by a pond, an amphitheater with a running track surround and mowed fields, six baseball fields, parking lots, and a larger mowed field on the west end of the zone. A mixed population of tree species and sizes encompass the field areas. The portion of 8 blue spruce and 100 white pine (*Pinus strobus*) on the north side of P.T. Barnum were inventoried but not tagged as they operated as a hedge and were of small size.

Area C Overview

Figure 22 Area C in Green

Figure 23 Area C with Trees in Sat View

Area C is the least populated zone with 156 trees or 14.3% of the total Seaside Park population. One tree was designated as a potential legacy tree and 8 trees recommended for removal. This relatively flat topography zone is located on the westernmost side of the park, and its approximate 38 acres include Barnum Boulevard to the north and the beach relatively close by to the south. The portion of 20 white pine (*Pinus strobus*) on the north side of P.T. Barnum were inventoried but not tagged as they ran as a hedge and were of small size.

Figure 24 Area C Typical Parking (Typical)

There are numerous parking areas with islands planted with established trees (often London planetree), picnic areas, two playgrounds, and a bathhouse. The beach is very accessible and directly next to the parking areas. A wide sidewalk also running the length of the beach that borders the length of the southern part of Area C. Trees are predominantly located in the parking island areas and along the interior of Barnum Boulevard.

Inventory Phase

Data collection began in Area A and concluded in Area C from early December 2021 to the end of December 2021. All trees with trunks 2 inches and greater in diameter within Areas A-C were tagged, assessed, and digitally mapped with the exception of a hedge row of like white pine on the north side of Barnum Boulevard in Area C. The pines were inventoried, and GIS located though not tagged due to their proximity and homogeneity.

Figure 25 Tree # 336 is a White Ash (Fraxinus americana)

Collection Phase

Bradley Painter from Treefoil LLC and arborist technician, Isabelle Zaffetti were the primary collectors of data, using proprietary software and GPS on iPhones and an iPad. Data collection occurred during December 2021.

The data were downloaded, post-processed, edited, and supports this report separately as an attachment in the form of csv and shapefiles.

Collection Fields

The following data fields are the final list of data the project team agreed to have collected during the initial design phase. The following narrative describes the data field and the parameters used within each field. In some instances, added comments are provided to present discussions on relevance and ramifications of the data collected, which should serve as guidance documentation for staff and contractors.

1. Inventory Date.

2. Assessor Name.

3. Tag Number. Number on tag attached to tree. Manually entered. Separate staff tagged most of the trees in advance of the assessors. In most cases, the tags were placed at a height of six feet on the north side of the tree.

4. Area. Name of the area in which the subject tree resides. The choices were either Area A, Area B or Area C.

5. Event 1. Assigned the event type of "Inventory" to the record. The date would show when the record for the subject tree was created and create the opening register of an ongoing maintenance history.

6. Common Name. The common name assigned to the inventoried tree

7. Diameter. The diameter was measured to the nearest tenth. Trees two inches or greater were measured at diameter breast height (DBH), four and a half feet above ground.

8. Condition. The condition of the subject tree was assigned a composite rating (Excellent, Good, Fair, Poor, and Dead) informed by the tree's health, structure, and form

   Note: The condition rating does imply or assign a maintenance action or risk to the subject tree. In most cases, however, trees noted as "Dead" were marked for removal. A tree in Poor condition does not imply a hazard exists. The recommended actions reflect what the assessor felt was required of the tree, given the specific contexts observed.

9. Defects. A defect is a visible flaw or an aberration that causes an item to be less than perfect. Regarding trees, any singularly observed defect can range from benign to severe. Noting a defect, therefore, does not necessarily or automatically constitute a hazardous situation. The severity of the issue observed by the assessor informs, along with other details on the recommended mitigation action.

10. Cavity/Decay. Cavity/decay is the deterioration of wood by a decay fungi. It is a natural process in mature trees and occurs at every form of wounding, including pruning cuts. Depending on the tree and fungi species, the ability of the tree to compartmentalize decay can be very localized or extensive. The presence of decay fungi conk (fruiting body) is a positive indicator of decay.

    As with any defect, the presence of a conk does not necessarily identify a high-risk issue. Decay fungi vary in their ability to deteriorate xylem

11. Event 2. Recommended maintenance actions, other than "Inventory". The selections included: Prune, Removal, Cable, and Grind Stump. If more than one maintenance action was assigned, they were noted in the comments field.

12. Prune. If Prune was selected in Event 2, a specific type of pruning was noted in this field. This list consisted of all A300 recommended pruning:

- ***Cleaning***–Removal of all dead, crossing, and diseased branches in the trees. Crown cleaning is the industry standard for conducting a comprehensive arboricultural maintenance action on a tree.

- ***Clearance***–Pruning to reduce a range of obstructions. These included street, sidewalk, and line-of-sight clearances.

- ***Reduction***–An arboricultural practice that serves to meet a range of goals. These include reducing weight on a high-stress point or reducing building obstructions.

- ***Structural***–An arboricultural practice typically assigned to younger trees. The primary purpose of structural pruning is to prepare the form of the tree for its mature phase and to reduce future risk issues.

13. Monitor. Tree had some structural aberration that requires a shorter inspection interval.

14. Latitude. 1984 State Plane Coordinates—Connecticut

15. Longitude. 1984 State Plane Coordinates—Connecticut

16. Comments. Field for additional details to be recorded.

COLLECTION RESULTS

The inventory data yields insight into the park's tree population. Patterns can appear when the data is processed and interpreted. Each park area (Area A, B or C) can be interpreted independently or as whole.

Species and Genus Distribution

Insight into the quantity, condition and location of genus and species allows the manager to understand current and future assets and vulnerabilities related to existing species. Future planting efforts can offset species heavy planting and introduce new or underrepresented genus/species to increase biodiversity. For instance, little leaf linden (*Tilia cordata*) is currently the most overrepresented species with 243 trees or 22.23% of the species, or 243 trees and 26.2% of the top ten genus represented when underrepresented native species like white oak (*Quercus alba*) at 1.10% should be considered.

One genus should not make up more than twenty percent of the population allowing a better buffer to tree damage/eradication due to pests and disease. One species should not exceed ten percent of any given population as well. Linden (*Tilia sp.*) should not continue to be planted at Seaside Park due to the high genus percent, 26.2% of top ten most common genus, or 29.9% of top ten species.

Potential Legacy Trees

Part of the inventory assignment was to note trees that may be "legacy trees" or trees that may have historical relevance or trees that were consistent with plantings as directed by a landscape plan. It is important to note that the consultant was not aware of any noted historic trees nor plans detailing tree locations or species but has interpolated similarities with site visits or available materials of other parks.

Any noted "legacy trees" tend to larger in diameter size with the understanding that tree size is influenced by many factors (species, environmental conditions, past construction activities, etc.) and is not necessarily a reliable gauge of age. Though not recommended by the consultant, one method to figure out accurate age is invasive core increment drilling that could be performed but not without risk to the tree as the process exposes a channel for bacteria, insects and decay and therefore is not recommended.

Top 10 Species Distribution By DBH

Trees vary in their ability to adapt and become resilient in the face of extreme environmental conditions. A broader range of appropriate species can help provide a broader resilience to pest and disease, and extreme climatic events. Diversity in species selection can increase tree population resistance and minimize reliance on dominant species planting.

Trunk Diameter Distribution

Trunk diameter distribution offers tree data that are presented in terms of diameter size class. This detail is important for figuring out current management needs as well as predicting how needs will change, given total numbers and aging of individual species. The size distribution within a tree population influences present and future costs as well as the flow of benefits. A staggered or unevenly aged population allows managers to distribute annual maintenance costs uniformly over many years and assure continuity in overall tree canopy coverage. Total diameter inches for each class are supplied as it may inform on some potential maintenance costs derived by total class-size inches.

Species by Condition

Condition of a particular species can supply insight into patterns that are indicative of otherwise unseen negative impacts on a particular species. Similar patterns of balanced conditions between species allows another pattern to be clear. In the case of Seaside Park, the condition of the white ash (*Fraxinus americana*) is clear with the condition of poor, fair or dead noted in conditions.

Observations – Characteristics

Figure 26 Tree Cavity

Data results of observations allow clear insight when evaluating a population of trees. Characteristics such as deadwood, co-dominant trees and/or limbs, broken limb, cavity, leaning trunk and more are recorded by the arborists during the inventory. Results can be interpreted allowing insight into the tree population. 195 or 7.5% of trees at Seaside Park were observed as "leaning". This can alert managers of the need to stake young trees initially, perhaps due to coastal winds that can initially displace new plantings.

Abiotic Observations

Abiotic factors are events that can negatively affect plant health. While pests are usually more easily recognizable, they are often only present once a tree has been previously stressed by abiotic factors such as: drought, severe winter cold, summer heat, soil compaction, gridling roots, constructional grade change, or mechanical damage. Being able to recognize and assess the severity of these sorts of issues is critical for maintaining plant health.

Figure 27 Girdling Roots

Biotic Observations

Biotic Pest are living organisms that can negatively affect the tree such as bacteria, boring insects, fungus, leaf feeding insect, vertebrae, and bacteria. Being able to recognize and assess the severity of these sorts of issues is critical for maintaining plant health.

Figure 28 Tree # 640 with small D-shaped Borer Holes and Right, Young Tree Damage by Deer

Pruning Work

Observations of pruning needs allow managers to understand and plan work to the canopy. A substantial number of trees require A300 crown cleaning. The amount of deadwood found correlates with this action being assigned. A crown cleaning is the removal of all dead, diseased, and crossing limbs above a specified diameter size. It is not uncommon after a system-level tree inventory to have the number of tree removals range from 1.5 to 2 percent of the population. The tree inventory found a moderately high number of trees for removal at 98 or 8.3% of the population.

Development of the Tree Management Plan

The Seaside Park tree management plan and associated recommendations were developed after a review of each area's tree inventory data results. The data provides specific recommendations for the management for planning, maintenance, inspections, resilience, and planting based on tree location, size, species, and condition.

SEASIDE PARK TREE INVENTORY OVERVIEW

Figure 29 All Areas Inventoried Tree Locations

Species Distribution

A total of 1,093 trees were inventoried between Seaside Park area A, B and C.

- Area A has 557 trees or 51% of inventoried trees
- Area B has 380 trees or 34.8% of inventoried trees
- Area C has 156 trees or 14.3% of inventoried trees campus

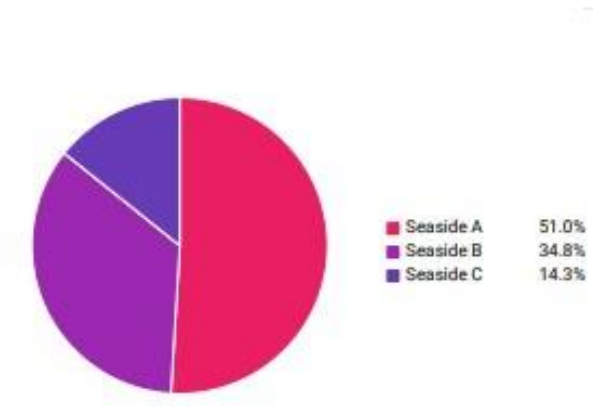


Figure 30 Tree Distribution Areas A, B, C

Potential Legacy Trees

A total of 106 Potential Legacy trees were identified between Areas A, B and C.

- Area A has 93
- Area B has 12
- Area C has 1

Figure 31 Legacy Tree Locations

Top 10 Species Distribution By DBH

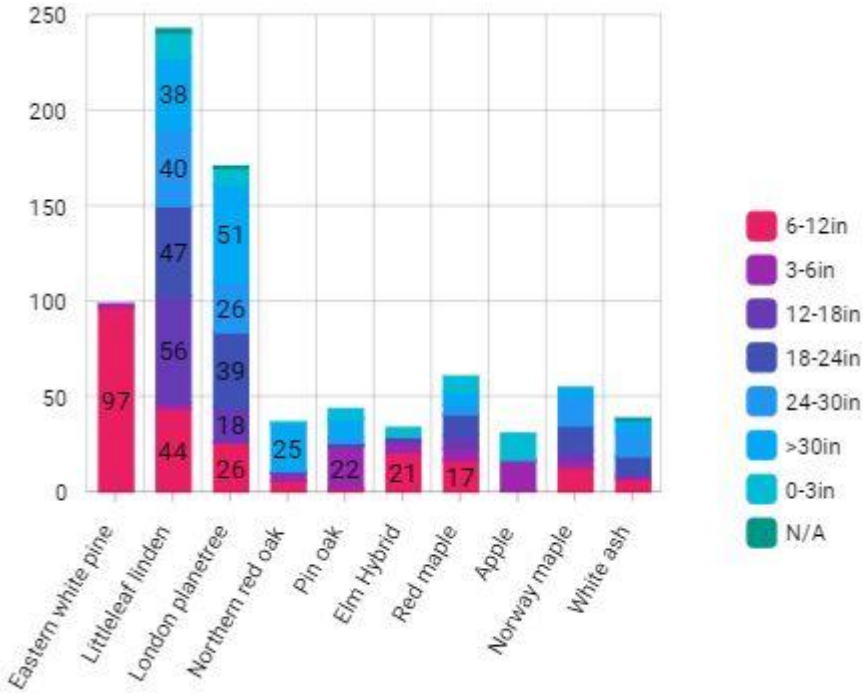


Figure 32 Most Common Species by size

Trees by DBH		
DBH RANGE	COUNT	PERCENTAGE
6-12in	287	26.3%
>30in	184	16.8%
18-24in	137	12.5%
3-6in	135	12.4%
24-30in	127	11.6%
12-18in	119	10.9%
0-3in	91	8.3%
N/A	13	1.2%

Figure 33 Tree Distribution by Diameter at Breast Height

Species by Condition

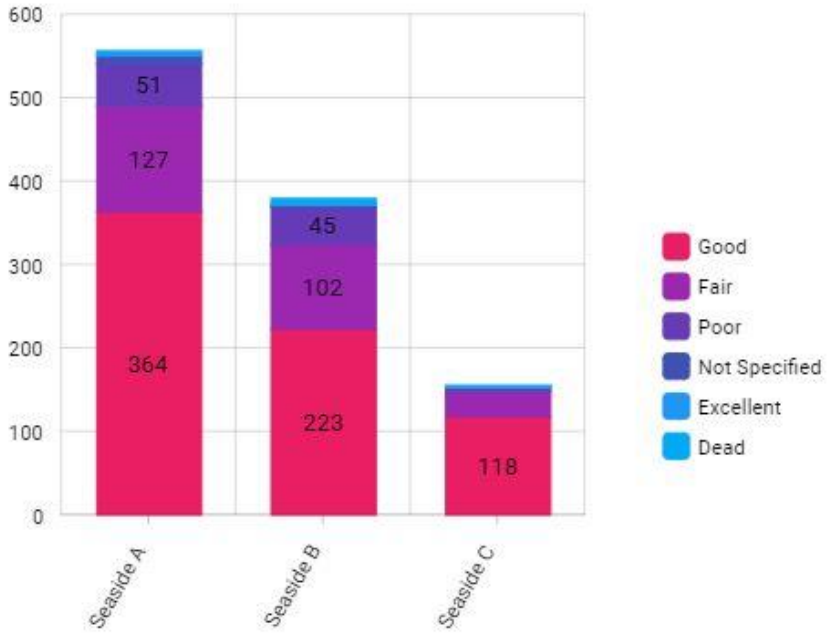


Figure 34 Area Trees by Condition

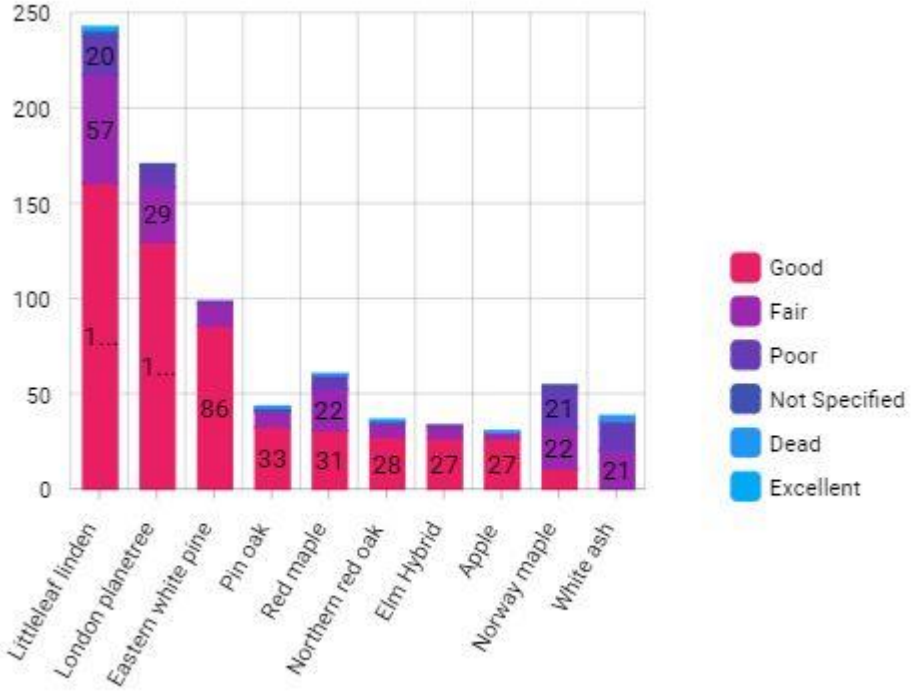
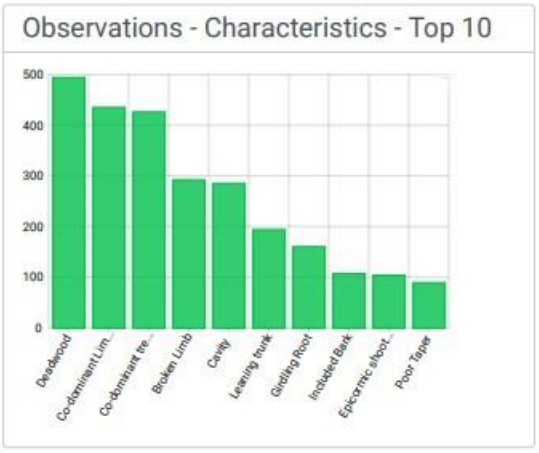


Figure 35 Species by Condition

Observations - Characteristics



Observations - Characteristics - Top 10

OBSERVATIONS-CHARACTERISTICS	COUNT	PERCENTAGE
Deadwood	495	19.1%
Co-dominant Limbs	436	16.8%
Co-dominant tree	427	16.4%
Broken Limb	293	11.3%
Cavity	286	11.0%
Leaning trunk	195	7.5%
Girdling Root	161	6.2%
Included Bark	108	4.2%
Epicormic shoots	105	4.0%
Poor Taper	90	3.5%

Figure 36 Top Ten Observed Characteristics (All Areas)

Abiotic Observations

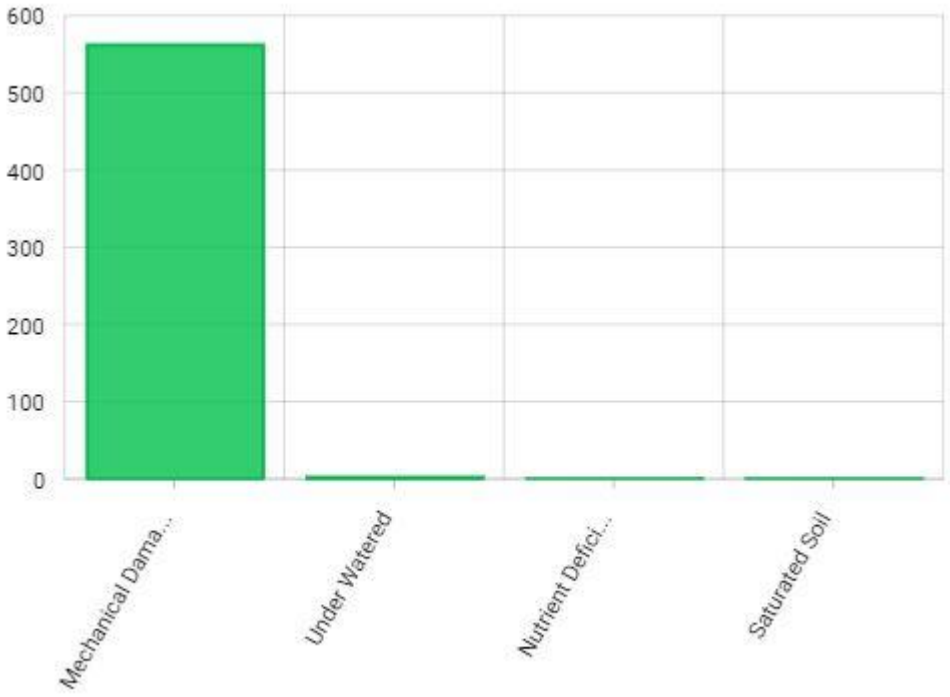


Figure 37 Abiotic Observed Conditions (All Areas)

Biotic Observations

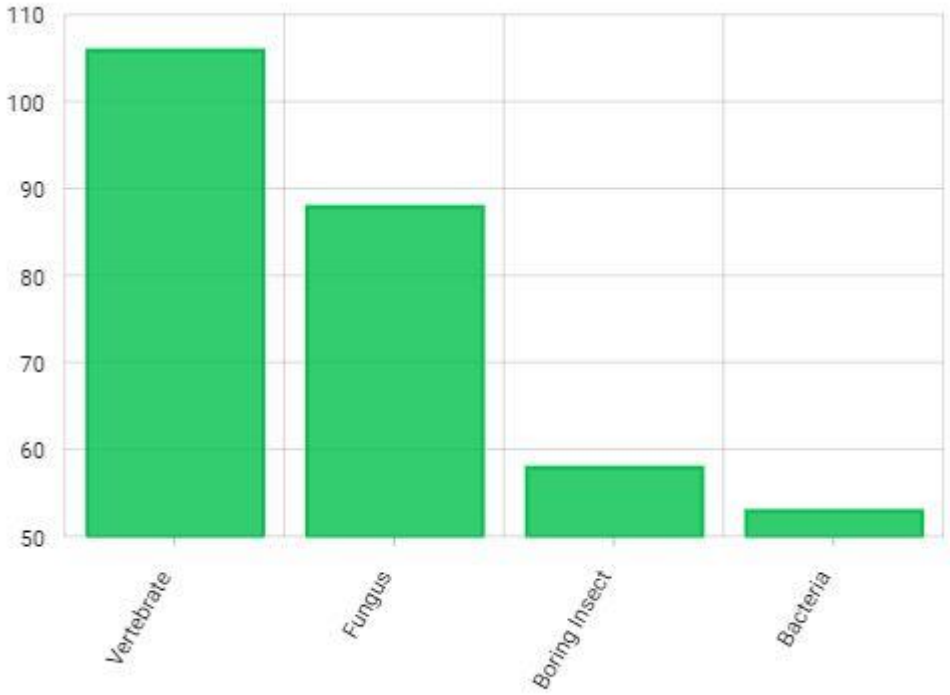


Figure 38 Observed Biotic Conditions (All Campus)

Pruning Work

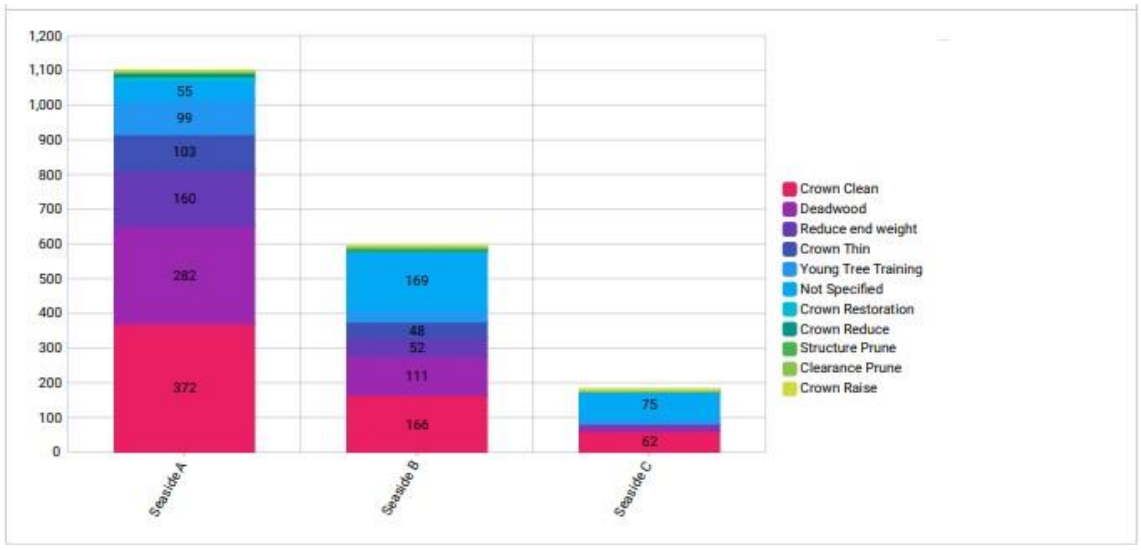


Figure 39 pruning Tasks by Area

Pruning Work		
TREE WORK-PRUNING	COUNT	PERCENTAGE
Crown Clean	600	31.9%
Deadwood	409	21.7%
Not Specified	299	15.9%
Reduce end weight	212	11.3%
Crown Thin	155	8.2%
Young Tree Training	150	8.0%
Crown Restoration	16	0.9%
Clearance Prune	13	0.7%
Crown Reduce	12	0.6%
Structure Prune	10	0.5%
Crown Raise	5	0.3%

Figure 40 Pruning Task Count (All Areas)

INTEGRATED PEST MANAGEMENT (IPM)

Background

The consultant was not advised as to how or if any trees are currently being treated for any pathogens or pests. The Seaside Park campus has 39 ash tree (*Fraxinus*) species trees, though a portion were being removed after the initial inventory was being done. They are clearly infested with emerald ash borer and treatment would not be affective at this point, so removal is the only choice. The current remaining species of concern are elm trees and some of the smaller (10" DBH or less) hybrid elms. The elm trees' survivability without treatment is less known, as some are newly planted hybrids without time-tested proven resistance. Hardwood species like maples (*Acer species*), elms (*Ulmus species*), and horse chestnut (*Aesculus species*) within the managed areas are susceptible to named invasive pests like the Asian longhorned beetle. An integrated pest management plan where regular monthly scouting for signs of a pest or disease allows a suitable response depending on extent, location, and species.

Integrated Pest Management

Integrated Pest Management (IPM) is a method of applying knowledge, prevention, and control to support tree health. There are four pillars of IPM: cultural, physical/mechanical, chemical, and biological. Used together, they follow the life cycle of the pest to effectively deal with the potential issues. The controls can be preventive or corrective and require passage of a certain time before

efficacy is realized. Timing of any treatments should always consider and respect beneficial insect communities (such as pollinators).

1. Cultural controls make the pest less likely to establish on the given specimen(s). This may include simply changing irrigation frequency or adjusting mowing boundaries.
2. Physical/mechanical controls include placing barriers to entry around the plants of concern. Sticky traps for insects or fences for deer grazing are examples.
3. Biological control is the intentional cultivation or release of beneficial insects or pathogens that eat or infect the pest—plant or insect—in any stage of development.
4. Chemical controls are the most discussed treatment options. This may include synthetic or organic chemicals produced to target a single species or a broad spectrum.

Each pillar has its own benefits and shortcomings. Cultural and physical/mechanical can be costly because of the labor needed, but they have the least unintended consequences. Biological is experimental and requires extensive monitoring but could be a cost-effective and less invasive approach. Chemical is usually the least expensive choice, but often it affects more of the surrounding ecosystem than just the intended target pest.

To effectively apply IPM, four steps must be followed: set a threshold, monitor, and identify pests, prevent population development, and treat the specific pest. On the Seaside Park campus, the threshold may vary depending on the specimen. A specimen tree on a main green may have a threshold of zero, while trees on the park perimeters may have a much higher pest threshold; if the tree does succumb to the pest it is less of a risk. The manager, in this case Seaside Park, establishes the tolerance level for the issue.

Wherever these specimen may be, they need to be monitored at regular intervals by qualified and/or trained arborists (Connecticut-licensed and/or International Society of Arboriculture certified arborists). The growing season (allowing a time buffer prior- and post-) mid-March through mid-November is the most critical period, requiring a monthly scouting for threats before they become a problem. A small population of pests may or may not present difficulties, depending on the pest and the manager's tolerance. Properly identifying pests is critical to effectively treating the issue. If the identified pest is considered a threat, the four pillars of IPM can be applied.

The consultants recommend monthly growing season scouting by an arborist of susceptible specimens (legacy trees). Scouting requires observing all specimen trees from the ground up and noting potential threats to the trees' health, including tip dieback, developing cracks or cankers, mushroom growth, flying moths, hazardous deadwood, etc. The individual should be at least a certified arborist or ideally a Connecticut-licensed arborist to ensure that (s)he is aware of potential pests and risks that may affect both the tree and the human population. Any applied treatments need to be performed under the supervision of Connecticut-licensed arborists. IPM monitoring can be time consuming and depends on the ultimate number and location of identified specimens.

Species of Concern:	Common Pests:	Visual Cues:	Survey Method:
Ash *Fraxinus* White Ash *F. Americana* White Fringetree *Chionanthus C. virginicus*	Emerald Ash Borer	Bark blonding Crown dieback Flying adult beetles May 30- Aug 30 Woodpecker damage (Indicates larva) "D" exit hole	Visual Inspection
Beech *Fagus* American Beech *F. grandifolia* European Beech *F. sylvatica*	Bleeding Canker Phytophthora Root Rot	Leaves wilt, dull, and yellow Bark around soil line appears dark Wood beneath bark is red-brown discolored	Visual inspection Visual inspection
Oak *Quercus* Black Oak *Q. velutina* Red Oak *Q. rubra* Pin Oak	Armillaria Root Rot	Leaves wilt, dull, and yellow Mycelial mats develop in infected tissue Honey colored mushroom develops at trunk base Or on surrounding roots	Visual inspection

Q. palustris White Oak *Q. alba*	Phytophthora Root Rot	Leaves wilt, dull, and yellow Bark around soil line appears dark Wood beneath bark is red-brown discolored	Visual inspection
Elm *Ulmus* American Elm *U. americana* Slippery Elm *U. rubra* Elm Hybrids *Ulmus spp.*	Elm Bark Beetle Dutch Elm Disease	Adult beetles May 1 - Sep 30 Sawdust in bark crevices or at base of tree Wilting crown Yellowing leaves Heavy defoliation	Visual Inspection Pheromone Traps Visual Inspection
Maple *Acer* Sugar Maple *A. saccharum*	Decline Abiotic	Progressive dieback Thinning canopy Premature fall color	Visual Inspection

Figure 41 IPM Scouting Calendar

The list above is hardly comprehensive, but for targeted pests, it is sufficient. There are some nontarget pests that have not yet become a problem in the Bridgeport, Ct area but should also be addressed. When a nontarget pest becomes prevalent, it becomes a problem for many tree and shrub species, which can drastically affect the campus canopy

Biotic Factors: Pests to Guard Against

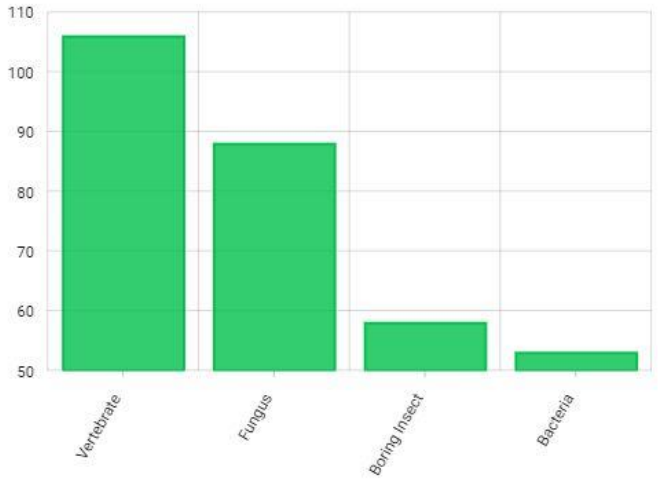


Figure 42 Biotic Factors Observed (All Areas)

Deer Browse and Antler Rubbing

Deer damage is a prevalent problem on the Seaside Park campus. Most newly planted trees throughout all area designation had recent evidence oof deer damage, mostly the result of antler rubbing. Most trees lost a significant part of their protective bark and had their vascular systems compromised. This will result in added stress diminishing the trees' ability to become established and prosper.

Figure 43 Deer Rubbing of Antlers Left and Right, Fencing Solution

Gypsy Moth (not usually a problem unless three dry springs)

Gypsy moth is an invasive problem in regions of Eastern and Northern Connecticut. The moth is the adult form, but the larva is the pest. Its favorite meal is oak (*Quercus),* but it will feed on beech (*Fagus)*, birch *(Betula),* tupelo (*Nyssa),* elm *(Ulmus),* fir (*Abies),* linden (*Tilia),* maple (*Acer),* pine *(Pinus),* hemlock *(Tsuga),* and spruce (*Picea).* The adults lay egg masses on the underside of large tree branches, which overwinter and hatch mid-May. The larva feed in the canopy of the tree for the first three instars (larval growth stages) of life. During the fourth and fifth instars, the black and red fuzzy larvae migrate up the trunk during the day for feeding and down the trunk at night to remain safe from predators. These later instars cause the most damage to the trees' foliage. Around June 1, the larva turns pupae for two weeks. Adults emerge in late June and can persist into August. The adults are recognizable by their white wings. Trees can usually tolerate one to two aggressive seasons of defoliation, but a third year can be lethal. Treatment options can prevent later instar stages of development or future reproduction.

Figure 44 Gypsy Moth Egg Casings, Moth and Eggs Closeup

Figure 45 Left, Fungus maimaga and resulting dead gypsy moth caterpillars, Right distinct U-shaped dead caterpillars (Gale Ridge, CAES Ct Agricultural Extension Service 2020

Emerald Ash Borer (present at Seaside Park campus)

The emerald ash borer is a small, green beetle that belongs to a large family of beetles known as the buprestidae, or metallic wood-boring beetles. The description is apt, as many of the adult buprestids are indeed glossy, appearing as if their wing covers are made of polished metal. The emerald ash borer, with its green, iridescent wing covers, fits right in. Adult EABs are relatively slender and between 0.3 to 0.55 inches in length—small by most standards but large compared to other buprestidae.

During its life cycle, EAB undergoes a complete metamorphosis. It starts as an egg, becomes a larva (alternatively called a grub), changes into a pupa, and then is an adult. The life cycle of an EAB takes either one or two years to complete. Adults begin emerging from within ash trees around the middle of June. Emergence continues for about five weeks. The female starts laying her eggs on the bark of ash trees about two weeks after she emerges. After seven to 10 days, the eggs hatch and the larvae move into the bark, to begin feeding on the phloem (inner bark) and cambium of the tree. Throughout each of its successive instars (larval growth stages), the larva continues to feed on the phloem and cambium of the tree. The larval stage may last for nearly two years. Before becoming an adult, the insect overwinters as a prepupal larva. It then pupates in the spring and emerges as an adult during the summer.

Figure 46 Emerald Ash Borer Underside

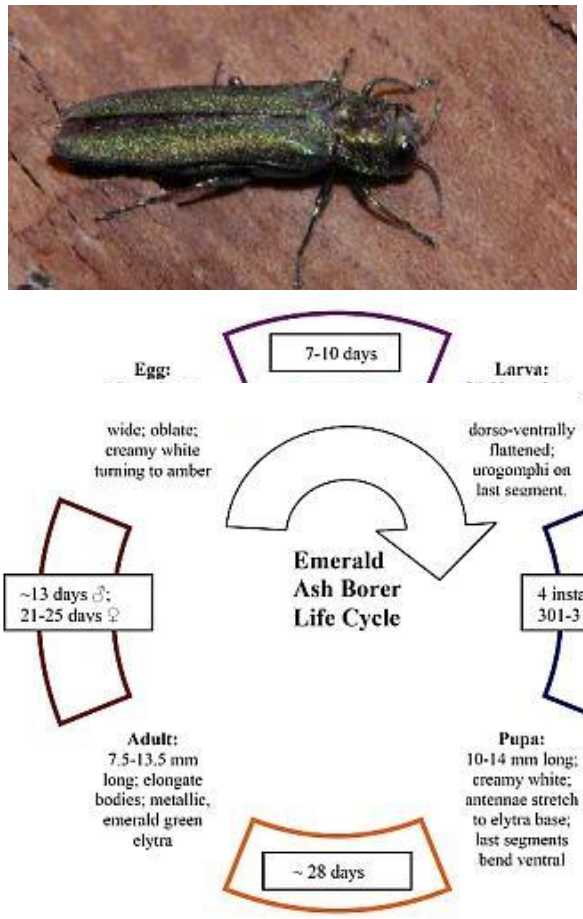


Figure 47 Upper Left Ash Tree, Upper Emerald Ash Borer, and Lower, EAB Life cycle

Figure 48 Emerald Ash Borer Pupa Source: USDA Emerald Ash Borer Program Manual

EAB feeds on ash trees almost exclusively. While the larvae feed on the phloem and cambium, the adults feed on leaves. In Connecticut, there are three species of ash trees—the white ash (*Fraxinus americana*), the green or red ash (*F. pennsylvanica*), and the black ash (*F. nigra*). Despite its common name, mountain ash (*Sorbus* spp.) is not a true ash and does not attract the EAB.

To date, the only non-ash genus EAB is known to feed on is *Chionanthus* (fringe tree). The consultant is unaware if Seaside Park has already identified and begun treatment of the ash population; however, host ash trees show signs of infestation, and a few were cut down while the consultants were performing the inventory.

Asian Longhorned Beetle (not identified on Seaside Park campus but need to monitor for)

The Asian longhorned beetle (ALB) is another pest that has garnered a lot of publicity, primarily because there is no effective treatment option and it will eat nearly any kind of hardwood, though it prefers sugar maple. This means the infected trees must be removed and the wood destroyed to prevent further spread. The species has a shiny black-and-white spotted exoskeleton and long antennae. It has been found in New York and Massachusetts, but when a population is found, it has usually already been present for several years because it prefers treetops.

The adult female lays a single egg in the burrowed-out bark. She may do this up to 90 times a season. The larva hatches and burrows into the heartwood, where it overwinters. The larva pupates the following summer and will emerge as an adult in the fall. When they emerge, they leave ½-inch exit holes. The beetles are poor flyers, so they tend to re-infest the same tree year after year, which leaves pockmarks on the bark where the female bores into the wood.

The trees are usually slow to show symptoms of failing health. It is important to regularly check pruned branches for exit holes and pockmarks, as the infestation begins near the top of the tree. In nearly every instance where ALB was discovered in the United States, it was because a concerned citizen called it in. While there have been no cases in Connecticut up until this point, an infestation would be devastating.

Pictures of scaled (pictured with coin) Asian longhorned beetle here, exit holes:

Figure 49 Asian Longhorned Beetle Exit Holes, Photo: E. Richard Hoebeke, Cornell University

The nearly perfect circles are fresh exit holes. The scarred circles near the top of the image are the previous season's exit holes, while the vertical ovals are previous seasons egg deposits.

Figure 50 Adult Asian Longhorned Beetle, Photo: Joe Boggs, Ohio State University

Spotted Lanternfly (not observed on Seaside Park campus but need to monitor for)

The spotted lanternfly is another pest that should be considered during monthly inspections, despite not having reported cases in Connecticut. Like ALB, the lanternfly does not have a host plant and there are no known treatment options yet. It is a major concern for Connecticut because 47 percent of Connecticut's forests are susceptible to the pest. The nymphs and flies suck the sugary sap from the trees, which depletes the plants' resources. It also leaves plants susceptible to sooty mold, as the sugar sap is a perfect opportunity for fungal growth. The mold is not life threatening, but it is unsightly anywhere, especially on campus trees. While more research is needed, there is a suspicion that part of the reproductive cycle requires access to the invasive tree, tree-of-heaven (*Ailanthus altissima).* By removing the plant population, the spread of the pest can be largely prevented. Additionally, if there is an outbreak, sticky bands placed four inches from the base of trees can prevent the pest from moving up and down.

Figure 51 Adult Spotted Lanternfly

Figure 52 Adult Spotted Lanternfly

Figure 53 Spotted Lanternfly Egg Casings, Photo: Lawrence Barringer, Pennsylvania Department of Agriculture

Figure 54 Adult Flies Feeding on Sap

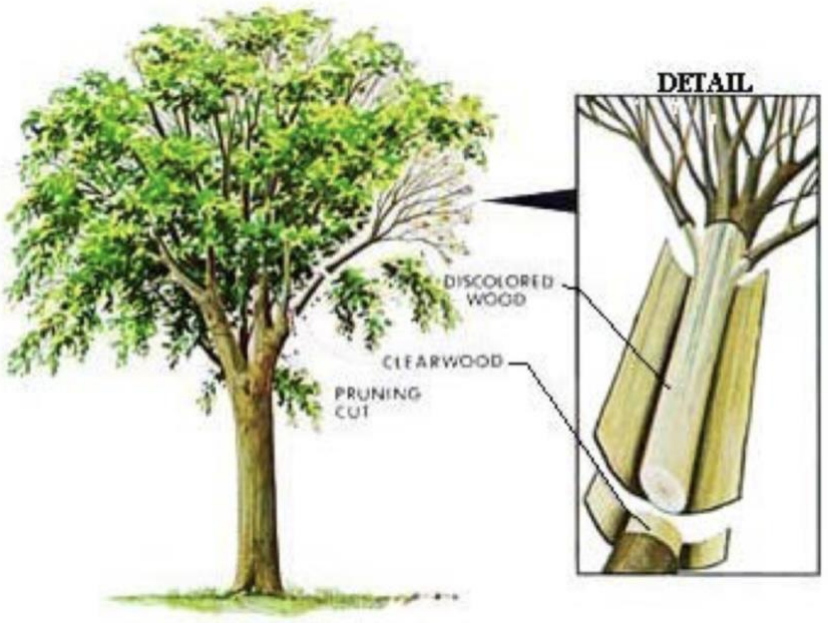
Figure 55 Nymphs Feeding on Young Wood

Photos: Emilie Swackhamer, Penn State University

Dutch Elm Disease (on Seaside Park campus)

Dutch elm disease (*Ophiostoma ulmi* or *O. novo-ulmi*), a fungus, can occur on most elm trees and often on resistant varieties. The fungus is spread via elm bark beetles or by root grafts from adjacent trees. Symptoms develop quickly within a four- to five-week period, usually when the leaves have reached full size. The first visual symptom, usually seen within the crown of the tree, is referred to as "flagging." This occurs when one or more branches develop symptoms of wilting and/or yellowing of the leaves on an otherwise apparently healthy tree. Prior to this occurring, symptoms have developed internally and include the death of xylem cells, the loss of water-conducting ability, and the browning of the infected sapwood in narrow streaks that follow the wood grain channels. Dead branches begin to appear sporadically in parts of the crown. IPM scouting should also continue despite any fungicidal injections.

Eradicative pruning can slow the spread if there is enough clear wood between the infected area and the cut (five to 10 inches) (Northeastern Area State & Private Forestry USDA Forest Service



(2020)).

Figure 56 Flagging on Elm (note discolored foliage)

Photo: Dr. Steve Katovich, USDA Forest Service *USDA Forest Service (2020)*

Summary Table	
Causal Agent	Fungus
Disease Vector	Elm bark beetles (or via root grafts)
Damaging Stage of Vector	Adult
Overwintering Stage of Vector	Larva or adult
Number of Generations per Year	2-3
Time of Year when Damage Is Done	May-September
Major Symptoms	Flagging, wilting of foliage, browning of current or previous year's growth ring (sapwood)

Figure 57 Elm Tree Dutch Elm Disease Facts

Source: University of New Hampshire Cooperative Extension (2020)

Abiotic Factors

Abiotic factors also affect plant health. While pests are usually more easily recognizable, they are often only present at the park once a tree has been previously stressed by other factors: drought, severe winter cold, summer heat, soil compaction, constructional grade change, or mechanical damage. Being able to recognize these sorts of issues is critical for supporting plant health.

One area of noticeable concern at Seaside Park was the extent of mechanical damage to the base of new and established trees. Mulch rings help to protect young trees initially and are often discontinued when they are established – usually one year for every inch DBH at planting. The damage is often underway as the young trees have the bark damaged or removed by mowers or weed whackers allowing decay, disease and insects to enter the tree system through the phloem or xylem. A ring fence system also helps prevent mechanical and deer damage (Biotic) and can be easily removed or installed.

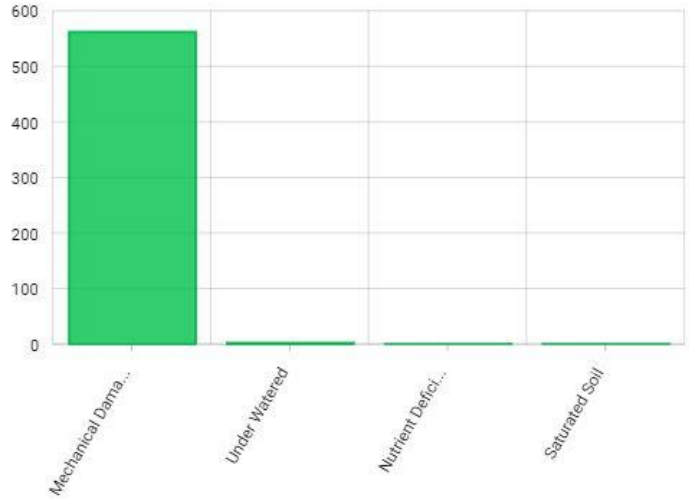


Figure 58 Numbers of TRees with Mechanical Damage at Seaside Park and Fencing Solution Right

Monitoring season	Abiotic concerns	What to recognize	Prevention and cures	Highly susceptible species
Winter	Winter desiccation	Tip dieback or complete necrosis of leaf margins	Regular watering in the fall to prevent winter dehydration and fertilize affected plants in early spring to encourage new growth.	Evergreens, especially soft tip, or broad-leaf evergreens (i.e., rhododendrons and pines)
	Frost cracks	Vertical cracks in bark caused by rapid drops in temperature	Mulch rings when planted to ensure no mechanical damage, encouraging stronger bark, and bracing existing cracks to prevent reopening in later seasons. Also monitor for disease or pests entering cracks	Species outside or on the edge of their natural range and those with soft bark - magnolias, cherries, red maples, beeches, crabapple, sycamore
		Discolored reddish/ brownish bark or bark peels	This occurs when the sun warms up the bark during the day and then the rapid cool of sunset causes the bark to split. For susceptible trees, tree wraps are available in the fall and fertilizing to return vigor in the spring.	Young trees or thin barked trees are most susceptible (see trees susceptible to frost cracks)
	Winter sunscald	Usually on the southern side of the plant	Regular pruning trees and shrubs keeps plant health during the growing season. When the plant is	

	Snow and ice breakage	This is when the weight of snow or ice builds up too much and causes the branches to break	dormant, the weight of ice and snow can be more easily distributed. Additionally, when there is a severe storm, by pruning damaged branches as soon as possible, further damage to the plant is prevented. Putting sufficient mulch rings around the base of new planting will create a barrier between the atmosphere and the soil layer. This protects roots. If the ground does heave, place new much in the cracks as soon as possible.	Fully formed evergreens like yews and arborvitae are most susceptible because the snow and ice gets caught. Pines, spruce, and fir also struggle with the excess weight. New plantings of any species are most susceptible
	Frost heaves	The ground cracks with the frost, leaving exposed roots to dry and freeze Leaf yellowing and browning on edges and discolored roots	Preventatively plant salt tolerant trees near roads or use calcium chloride near sensitive trees (compared to more common sodium chloride). Water drench salted ground around affected plants to flush salt out.	Forest species are sensitive to salt: maples, hickories, dogwoods, and oaks

	Salt damage			
Spring	Soil saturation	Water pooling around tree base		
Summer	Drought	Wilting leaves	Try to maintain regular water intake during spring compared to summer. If there is a lot of rain in the spring, limit irrigation, then water regularly in summer	
	Summer sunscald	Leaf or bark discoloration	Do not prune more than ¼ of the foliage at a time. This exposes excessive amounts of bark and can cause sunburn.	

Figure 59 Abiotic Factors

Source: i-Tree Ecosystem Analysis, Urban Forestry Effects and Values 2020

RECOMMENDATIONS

IPM Recommendations

Timing is critical to proper IPM scouting for pests and can be combined with scouting for abiotic damage such as frost cracks, wind breakage, mechanical damage from vehicles such as mowers or construction equipment. Seaside Park should continue with trees that are already on a program as well as ones that might benefit from being on one such as unique plants, specimens, culturally significant trees or young newly planted trees.

Scouting for IPM is a matter of timing growing degree days with expected pest activity cycles. Most insect activity occurs in the early spring to late fall in New England. Growing degree days is an efficient way to predict pest activity:

- Choose a start date such as March 1
- Choose a threshold temperature like 50 degrees Fahrenheit
- Measure minimum and maximum temperatures
- Calculate an average temperature for each day, for example on March 1, minimum is 45F, maximum is 65F, average is 45 + 65/2 = 55
- Calculate the degree days above threshold for each day; for example, on March 1, the number of degree days is 55-50= 5-degree days.

Environmental Resilience

A resilient landscape is achieved through modifying best managed practices based on current research. Updating and sharing proven methods with other stakeholders is an ongoing process.

- Implement and track plant ratio minimums—10 percent of any one species, 20 percent of any one genus, or 30 percent of any one family for improved biodiversity.
- Use annual cyclic planting minimums to maintain future canopy cover.
- Use replacement planting for trees lost to damage, construction, or pests. Trunk area lost should be translated to trunk area replanting efforts. Larger trees will return environmental benefits sooner.
- Planting pits for trees should be larger and with ideal planting media like "Cornell Mix." (See .http://www.greenhouse.cornell.edu/crops/factsheets/peatlite.pdf)
- Implement Integrated Pest Management (IPM) program either in house or by contract, with the goal of reducing pesticide use. Staff training and support with programs such as International Society of Arboriculture certified arborist with continuing education requirements (CEUs) will assure long-term understanding of the campus and adoption of principles and methods.
- Continue to encourage and support design programs that integrate bio-swale and stormwater capture at the park and adjacent city properties. These bring awareness to the community on the issue of cost and associated pollution of adjacent water courses.

- Encourage repurposing of wood products as the potential for lasting awareness and appreciation of Seaside Park trees.
- Highlight environmental and economic benefits of individual trees by informational posting at individual trees if warranted. Adopt Sustainable Sites (http://www.sustainablesites.org/certification-guide) goals for the park's tree canopy as they relate to carbon sequestration, stormwater, and environmental benefits.

Urban forest management strategies to help improve air quality include (Nowak 2000):

Strategy	Result
Increase the number of healthy trees	Increases pollution removal
Sustain existing tree cover	Maintains pollution removal levels
Maximize use of low VOC-emitting trees	Reduces ozone and carbon monoxide formation
Sustain large, healthy trees	Large trees have greatest per-tree effects
Use long-lived trees	Reduces long-term pollutant emissions from planting and removal
Use low maintenance trees	Reduces pollutants emissions from maintenance activities
Reduce fossil fuel use in maintaining vegetation	Reduces pollutant emissions
Plant trees in energy conserving locations	Reduces pollutant emissions from power plants
Plant trees to shade parked cars	Reduces vehicular VOC emissions
Supply ample water to vegetation	Enhances pollution removal and temperature reduction
Plant trees in polluted or heavily populated areas	Maximizes tree air quality benefits
Avoid pollutant-sensitive species	Improves tree health
Utilize evergreen trees for particulate matter	Year-round removal of particles

Figure 60 Strategies to Improve Air Quality (Nowak, 2000

Tree Inspections

The Seaside Park tree population provides numerous economic and environmental benefits to the community. Larger trees produce more aesthetic and environmental benefits than younger trees and should be maintained at a higher level of care, which ultimately reduces maintenance costs while improving safety and aesthetics. Regular maintenance such as cyclical pruning, monitoring, pest and disease management, inspections, and planting can identify current deficiencies and will improve future urban canopy conditions.

Trees with the highest risk should receive priority attention. Trees recommended for removal often pose the greatest risk, especially larger dead trees in higher pedestrian or vehicular traffic areas. Proactive cyclical pruning can also identify individual tree limbs that pose a risk.

As noted, tree inspections provide the information to monitor and manage a tree population. Inspections served three primary vegetation management goals:

1. **Monitor** the tree population for short- and long-term risk issues. The former typically requires some form of mitigation which can range from deadwood pruning to whole tree removal. The latter concerns observable issues that are not of an imminent nature which is balanced with the benefits the tree provides.
2. **Assess** the tree for overall health and vigor. The most benefits to the Seaside Park community are derived from trees that are healthy with expanding canopies. A scheduled inspection that includes assessing tree health allows staff to make choices that maximize these benefits.
3. **Demonstrate** due diligence by Seaside Park by applying a regular inspection process that is uniformly applied across the total tree population.

The following tree inspection recommendations are presented to enhance the park's overall vegetation management program.

Inspection Cycle. The consultants recommend a five-year cyclic inspection interval. This is a common inspection interval for a proactive urban forestry program in the United States. For the university, this translates to approximately 20 percent of the tree population on each Area (A, B and C) being inspected annually.

Inspection Type. The standard inspection should be the equivalent of an ISA Level 1–Limited Visual Inspection. This is based on the resources available and the size of the tree population requiring an inspection. A limited visual inspection should encompass a 360-degree view of the tree from the

ground. If the tree presents elevated concerns to the inspector, a more advanced assessment may be needed on individual trees.

Inspection Methodology. Each Level 1 inspection should include an assessment of the trunk, scaffold branches, and crown. Record keeping can consist of either working from a hard copy of an inventory-generated tree list or directly accessing an inventory, if available, via an electronic notebook. The primary issues to address are tree health and any short-term mitigation requirements. The inspector should update the tree's diameter, condition, maintenance needs, and inspection date. Basic hand tools to be used include a diameter tape, rubber mallet, and binoculars.

Inspection Scheduling. The best time for the inspection cycle to take place is during the summer when the trees have leaves and are fully leafed out. The optimum scheduling would have the trees that are scheduled for pruning during the forthcoming winter season be the trees scheduled for inspection during the prior summer. This would allow trees noted for removal to be mitigated before the pruning cycle begins. It also allows diameters to be updated to allow current diameter information to be used for contract specification and bidding purposes.

Monitor Trees.

Some trees have been identified as requiring. These trees require annual inspection except as noted in the narrative in the next section. The "Monitor" trees had one or more issues associated with the tree. These could include large stature, high-target area, and/or a structural issue. At the time of the initial inventory assessment, the need for removal was not observed. Future, short-term removals may come from these trees.

Area Specific Considerations. The recommendations noted above should be applied across Seaside Park. Each area, however, has nuances to its specific landscapes that warrant details specific to the campus.

Area A – Area A has the largest number and variety of trees. Most of the trees noted are of a size, location, and quality that a five-year cycle will suffice. One consideration specific to the Area A could affect the recommended inspection cycle.

- Several locations within Area A have several significantly sized trees abutting areas of elevated use such as the playground area, the concession stand, considerable parking along roadways and walking paths.

Area B – Area B also has activity areas such as the ballfields adjacent to mature trees. Most of the trees noted are of a size, location, and quality that a five-year cycle will suffice. One consideration specific to Area B could affect the recommended inspection cycle.

- The ballfield perimeter, parking areas and lots, the amphitheater grounds under adjacent trees. Considering this high visibility and use, maintaining the annual inspection of the Area B trees is valid.

Area C – Area C use could be considered less dense due to limited parking and accessible area. Some of the trees noted are of a size, location, and quality that a five-year cycle will suffice.

Pruning, Cabling, and Removals

The table below shows the count of recommended maintenance action by campus. Of all actions, the identified 98 tree removals should be considered first for action.

The pruning action count is for totals for Area A, B and C. These are considered part of the recommended pruning cycle and should ideally be considered first over other trees during operational planning.

Pruning Work		
TREE WORK-PRUNING	COUNT	PERCENTAGE
Crown Clean	600	31.9%
Deadwood	409	21.7%
Not Specified	299	15.9%
Reduce end weight	212	11.3%
Crown Thin	155	8.2%
Young Tree Training	150	8.0%
Crown Restoration	16	0.9%
Clearance Prune	13	0.7%
Crown Reduce	12	0.6%
Structure Prune	10	0.5%
Crown Raise	5	0.3%

Figure 61 Pruning Work Observed - All Areas

Other Work		
TREE WORK-OTHER	COUNT	PERCENTAGE
Not Specified	995	83.8%
Remove	98	8.3%
Stump Grind	94	7.9%

Figure 62 Removals (98) All Areas

Stump grinding may or may not be a priority to be completed after tree removal based on site use, accessibility, and aesthetics and should be evaluated on a case-by-case basis as decided by Seaside Park and Bridgeport Parks staff.

Comprehensive Pruning

Comprehensive pruning refers to trees under a cyclic pruning cycle or any tree that may require corrective pruning due to storm, disease, or insect damage.

Pruning provides many benefits for a tree. Primarily, it serves to maintain a tree in a healthy and safe state, while promoting longevity. From early structural pruning to maintenance pruning over a tree's mature life, the park can play a significant role in increasing a tree's age and minimizing the reactive cost of future care such as storm damage. A regular pruning cycle is a critical part of an effective forestry program. Seaside Park will derive the following benefits from maintaining the cyclic maintenance program.

- Simply by pruning dead wood, the condition ratings will be upgraded for many of the university trees.
- Reactive requests and storm damage will be reduced.
- Cyclic maintenance guarantees that every tree on the park grounds will be regularly inspected by staff and/or contractors.
- Seaside Park can demonstrate that it is exhibiting "reasonable care" in maintaining its urban park canopy. The notion of "reasonable care" is the strongest defense Seaside Park has in litigation due to a tree or tree part failure.
- Pruning specifications need to include manager notification by the inspector/pruner of any additional observation of concern: decay, cracks, broken branches, etc.

In the United States, most system-level forestry programs try to implement a five- to eight-year pruning cycle. The consultants recommend a five-year pruning cycle for Seaside Park. If the park cannot afford to contract services, a combination of options is available to meet this goal. For example, the trimming of trees with diameters over a certain size can be contracted out and trees with smaller diameters or heights (six inches or trees less than 25 feet in height) can be maintained by staff if under

the supervision of a Connecticut licensed arborist or qualified consulting arborist. The overall objective is to achieve a cyclic pruning program within fiscal and human resource constraints.

All pruning activity should follow the American National Standard for Pruning (ANSI A300)—specifically for crown cleaning and raising. These pruning operations are best performed during winter months:

Crown Cleaning–The removal of defective limbs that are broken, diseased, dying, broken, structurally unstable and rubbing. This process improves tree health, reduces branch failures, and improves aesthetics.

Crown Thinning–The selective removal of branches to increase light penetration and air movement in the crown, or canopy, of a tree.

Crown Raising –The removal of lower branches. Crown raising is often done to allow foot or vehicle traffic or lawn mowers under the tree. Street trees require at least 16 feet of clearance for trucks. Lawn trees need eight feet of clearance for foot traffic. Trees used for screening or windbreak can be allowed to have branches near the ground.

Crown Reduction–The proper removal of upper branches when the tree has become too tall. When a tree is too tall, it is better to remove it. **Never top (removing large branches or/and trunks from treetops, leaving stubs, and not making proper pruning cuts) a shade tree to control its size**. Credit Below: BP Tree Services

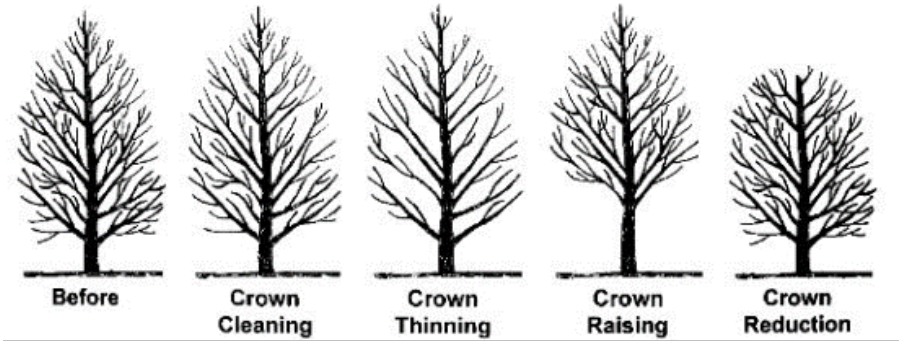


Figure 63 Examples of Types of Pruning

The number of trees requiring crown cleaning on the various park areas is substantial at 600 trees. Some form of cyclic inspection and pruning program should be a primary maintenance goal for Seaside Park. A five-year cycle is the consultant's recommendation. Several approaches can be considered to meet this goal. The most efficacious approach will be informed by the following factors;

- Establish the degree that Seaside or Bridgeport Park's staff can conduct pruning. Staff should be able to prune trees under 12 feet and/or under 6-inch caliper if supervised by an onsite Connecticut licensed arborist. It is important to note that this is driven by Connecticut state law and should conform to those requirements (Ct Arborist Law Sections 23-61a through 23-61f of Ct State Statutes). This determination should consider current operational needs and staff ability to annually prune a portion of the 20 percent of the trees six inches or less in diameter in managed areas.
- Based on tree inventory data, the park's campus has 226 trees that are six inches or less in diameter.
- A larger-size diameter class could be considered for in-house pruning if capability is met: training and supervision under a Connecticut licensed arborist {otherwise, outside licensed contractors would also function as a pruning source).
- Some trees within the cycle may not require pruning, but inclusion in the pruning cycle guarantees that a regular inspection, as a minimum, occurs for the tree.
- Will require Bridgeport Parks contractor or staff training in structural pruning.
- Will require Bridgeport Parks contractor representative or staff training on maintaining pruning/inspection records.
- Contract pruning 20 percent of the balance of trees in managed areas and the perimeter of woodland sites on an annual basis.
- Pruning to A300 standards. Includes crown cleaning and crown raising during winter months.
- Seaside Park/Bridgeport Parks representative or staff to identify the 20 percent to be inspected/pruned for that season. Selection should evenly distribute trees across size classes to guarantee uniform annual budget requirements.
- Inspection in the fall by Seaside Park/Bridgeport Parks representative or staff of the 20 percent of trees to be pruned that season. The purpose of the inspection is to note any specific pruning requirements, update tree conditions, identify any removals, and identify any trees that do not require pruning.
- Provide a methodology and protocol for updating pruning/inspection records.
- Potentially create a field in the tree inventory for assigning a tree to a cycle to allow an easily retrievable project list.
- Develop a tree inspection methodology for Seaside Park/Bridgeport Parks representative or staff, based upon the ALARP model.

Develop pruning specifications to be used at Seaside Park by both contractor and staff (reference A300 pruning standards).

- The current tree inventory GIS platform should be updated with regards to trees cyclically pruned and when by Seaside Park or Bridgeport Parks staff or another qualified representative such as consulting arborist.
- Completed construction footprints, removals; all IPM priority tree actions and plantings should also be recorded and inventoried and updated by the consulting arborist.

Pruning Work		
TREE WORK-PRUNING	COUNT	PERCENTAGE
Crown Clean	600	31.9%
Deadwood	409	21.7%
Not Specified	299	15.9%
Reduce end weight	212	11.3%
Crown Thin	155	8.2%
Young Tree Training	150	8.0%
Crown Restoration	16	0.9%
Clearance Prune	13	0.7%
Crown Reduce	12	0.6%
Structure Prune	10	0.5%
Crown Raise	5	0.3%

Figure 64 Pruning Needs All Areas

Cabling

Cable inspections are noted on inventory records as "cable." These trees have cables installed or should have them installed. The cabling operations can often be combined with pruning operations. The crown cleaning can be incorporated into cyclic pruning operations with a priority for pruning of dead wood and broken or hanging branches in areas of higher traffic prioritized for work first.

Removals

It is not uncommon after a system-level tree inventory to have the number of removals range from 1.3 to 2 percent of the population. The number of trees identified for removal on the Seaside Park is above this norm (98) or 8.3% of the park's population. Removals should be prioritized and budgeted separately from cyclic pruning operations. It is recommended that trees that are dead or in extremely poor condition all be removed no later than the first two years of notification.

Of all actions, the identified tree removals should be considered first for action. The trees can be dead, in poor condition, or a healthy tree in fair or good condition with a structural defect leading to potential instability. Trees that are in woodland areas or forested areas away from foot or vehicular traffic are not usually recommended for removal. Trees that are near roads, sidewalks, or paths and have been

identified as hazardous should be removed after evaluation and discussion with the proper Bridgeport authority and company/staff performing the removals. Removals are not considered part of a pruning cycle.

Other Work		
TREE WORK-OTHER	COUNT	PERCENTAGE
Not Specified	995	83.8%
Remove	98	8.3%
Stump Grind	94	7.9%

Figure 65 Removals All Areas

Plantings

To guarantee the long-term health and perpetuation of the urban forest, a good program must continue to plant trees on regular basis. An essential element of a planting program is species diversification. The emerald ash borer is an example of how disaster can destroy poorly diversified urban forests.

Current plant vulnerabilities exist due to increases in seasonal temperature. The temperatures then increase the likelihood of drought conditions due to increased evaporation. This puts added stress on the tree increasing its susceptibility to pests and pathogens. Not all species will most likely thrive, however, and a broader selection of species with varying degrees of resistance to climate swings will increase the depth of an urban forest.

As with any ecosystem, species diversity within Seaside Park insures against a single disease or blight destroying large sections of the urban forest. The number of different high-quality species should be greatly increased and perpetuated to maximize benefits and minimize hazards. The following guidelines provide direction for developing a diverse, healthy, low-maintenance, and aesthetically improved urban forest:

- Long-term (i.e., 20-year) population targets for high-quality species should hover around 5 percent of the current tree population. The trees should be distributed over time: planted in small numbers on a regular basis. Adjustments to tree size such as selecting a smaller size and planting by in house crews will lower costs. It is important to be aware that often, even with ideal initial years care, trees may be lost to unanticipated pests, disease, drought, storm damage and vandalism. It is critical to the urban forest to have a steady stream of new plantings to maintain the benefits the trees provide lower-quality species should have targets of less than 5 percent.

- The urban forest at Seaside Park often has a need for numerous smaller trees that take up less space than larger ideal trees like the white oak. The trees occupy less space and contribute less overall to tree value and benefit given their considerably smaller canopy. Planting quantities can be adjusted on a case-by-case basis though an established and maintained minimum tree fund is always recommended.

- Young tree training, through pruning, selects branches for dominance and reducing codominance, crossing branches, and competition for the same resource (light, nutrients, ability to produce and maintain productive foliage.)

- Stake new plantings to achieve stability in the windy coastal zone.

- Provide trunk protection from mechanical and deer damage with loose fencing to height of first lower branches.

- Mulch covering over the root ball area is recommended at two to three inches with nothing adjacent or against the trunk.

- Trees should be chosen based on their moisture, soil, and light requirements and their growth rate.

- Inspect nursery stock before planting and avoid any trees with damaged trunks, poor form, or girdled roots. Explore on-site growing possibilities at Seaside Park.

- Planting sites should always be selected that maximize tree growth and health and minimize long-term infrastructure conflicts. Soil content, climate, and site size, and surrounding obstacles should be taken into consideration.

- Several species should be avoided when selecting street trees because they may have a high maintenance cost, short life expectancy, high storm damage potential, and/or a high hazard potential.

- If a uniform visual appearance is desired, choose varied species that have similar forms. When selecting trees for their visual effect, consider the tree's size, texture, form, and coloring.

- Species concentrations should be monitored both at the overall Areas A, B and C as well as individual Areas depending on need.

- Watering at time of planting is three gallons per trunk-inch caliper.

- Basic rule of initial planting care is one year per one-inch caliper DBH.

- Maintain soil moisture during the growing season the first year or two, depending on size and soil conditions. This may be every day or once a week, depending on moisture level in the planting medium.

- Usually fertilizer and other additives (bio-stimulants, anti-transpirants are not recommended unless analysis determines otherwise.

- Recommended coastal tree planting species would be:

Tupelo (*Nyssa sylvatica*),
Northern Red Oak (*Quercus rubra*),
White oak (Quercus alba),
Pin oak Quercus palustris,
Sweetgum (*Liquidambar styraciflua*),
Amelanchier (in variety),
Sweetbay magnolia (*Magnolia virginiana*),
Hackberry (*Celtis occidentalis*),
Malus Species,
Honeylocust (*Gleditsia tricanthos*),
and evergreens (though few on Seaside Park campus currently):
Eastern Redcedar (*Juniperus species),* and American holly *(Ilex opaca).*

London Planetree (Platanus x acerifolia) is a good coastal tree though there are too many currently at 171 total park count, thus disrupting species biodiversity and not recommended.

After a certain age, all trees decline and require greater maintenance. When large numbers of trees are planted within a brief time, they become expensive and difficult to manage all at once. Multiple-aged stands are more desirable because they will disperse maintenance costs.

Slower-growing, longer-living trees minimize maintenance costs. Planting trees that live three times as long means spending approximately one third as much in removal costs over the same number of years. In general, the same slower-growing trees are higher quality and demand less pruning over their lifetime.

Seaside Park would benefit from a balanced list of non-natives as well as native planting options. Recommended planting suggestions vary from source to source and depend on existing population diversity, present pest problems, and degree of varying climatic conditions. The consultants recommended a broader range of species for increased biodiversity as identified by University of Massachusetts in their 2019 publication, *Planting for Resilience: Selecting Urban Trees in Massachusetts,* by Ashley M. McElhinney and Richard Harper.

Regular, annually scheduled tree plantings with target goals will assist in maintaining healthy canopy conditions for the future. Unforeseen events like storms, pathogens, and insect infestations can devastate an existing urban park canopy. A broad, diverse, and healthy planting will offer some insurance against such events. There is often flexibility in size of trees at time of planting, giving some leeway on budgetary options. First-year care is critical and should provide and maintain watering options such as Gator bags with regular fillings, staking due to coastal winds and protection from mechanical damage (mowers) and the adjacent deer population. A target number for new annual park-wide plantings would be 50 trees.

Finally, most urban trees have little utilization potential after their removal. Some underused species, such as swamp white oak, provide an opportunity to divert wood from the waste stream when the tree is removed. There are growing opportunities for converting resilient hardwood trees into high-

quality firewood or low- and medium-grade lumber for the large secondary-wood industry in the Connecticut area. This activity also introduces a possibility of generating revenue.

The following plants are listed as invasive and should not be planted. The benefits of a large, existing invasive tree producing environmental benefits such as cooling, pollution capture, oxygen production, stormwater capture, and carbon storage and sequestration, can outweigh the negative aspect of invasive plants, including their having a competitive advantage over desirable trees, and often too self-propagating.

Connecticut Invasive Tree List

Amur maple (*Acer ginnala*)

Norway maple (*Acer platanoides*)

Sycamore maple (*Acer pseudoplatanus*)

Tree-of-Heaven (*Ailanthus altissima*)

Princess tree (*Paulownia tomentosa*)

White poplar (*Populus alba*)

GLOSSARY

10-20-30 guideline for planting a diverse urban forest wherein a single species should make up no more than 10 percent of the tree population, a single genus no more than 20 percent, and a single family no more than 30 percent (Santamour, 1990)

abiotic disorder – plant malady caused by nonliving, environmental, or fabricated agents. (ISA, 2010).

absorbing roots – fine, fibrous roots that take up water and minerals. Most absorbing roots are within the top 12 inches (30cm) of soil. (ISA, 2010).

acceptable risk – a degree of risk that is within the tolerance or threshold of the owner, manager, or controlling authority. (ISA, 2011).

access route – defined entrance and exit route for a property during construction, tree work, or landscape operations. (ISA, 2010).

action threshold – pest population or plant damage level that requires action to prevent irreversible or unacceptable physiological and/or aesthetic harm. (ISA, 2010).

acute – disorder or disease that occurs suddenly or over a brief period of time. Contrast with *chronic*. (ISA, 2010).

adaptability – genetic ability of plants and other living organisms to adjust or acclimate to different environments. (ISA, 2010).

air-excavation device, air excavator – device that directs a jet of highly compressed air to excavate soil. Used within the root zone of trees to avoid or minimize damage to the roots, or near underground structures such as pipes and wires to avoid or minimize damage to them. (ISA, 2010).

anaerobic – without oxygen. Process that occurs in the absence of oxygen. (ISA, 2010).

ANSI A300 – in the United States, industry-developed, national consensus standards of practice for tree care. (ISA, 2010).

ANSI Z133.1 – in the United States, industry-developed, national consensus standards of practice for tree care. (ISA, 2010).

approved – in the contest of guidelines, standards, and specifications, that which is acceptable to federal, state, provincial, or local enforcement authorities or is an accepted industry practice. (ISA, 2010).

arboriculture – practice and study of the care of trees and other woody plants in the landscape. (ISA, 2010).

available water – water remaining in the soil after gravitational water has drained and before the permanent wilting point has been reached. Compare to *field capacity*, *gravitational water*, and *permanent wilting point*. (ISA, 2010).

balled and burlapped (B&B) – tree or other plant dug and removed from the ground for replanting, with the roots and soil wrapped in burlap or a burlap -like fabric. Contrast with *bare root*, *container grown*, and *containerized*. (ISA, 2010).

basic assessment (Level 2) - detailed visual inspection of a tree and surrounding site that may include the use of simple tools. It requires that the assessor inspect completely around the tree trunk looking at the visible aboveground roots, trunk, branches, and site.

best management practices (BMPs) – best-available, industry-recognized courses of action, in consideration of the benefits and limitations, based on scientific research and current knowledge. (ISA, 2010).

biological control – method of managing plant pests using natural predators, parasites, or pathogens. (ISA, 2010).

biorational control product – (1) control product or pesticide formulated from naturally occurring plant extracts, microbes, or microbial by-products that poses exceptionally low risk to nontarget organisms. (2) control product or pesticide that has limited environmental persistence and poses an exceptionally low risk to nontarget organisms. (ISA, 2010).

biotic disorder – disorder caused by an infectious living agent. (ISA, 2010).

botanical pesticide – pesticide derived from plants. (ISA, 2010).

buttress roots – roots at the trunk base that help support the tree and equalize mechanical stress. (ISA, 2010).

cambium – thin layer(s) of meristematic cells that give rise (outward) to the phloem and (inward) to the xylem, increasing stem and root diameter. (ISA, 2010).

canker – localized disease area on stems, roots, and branches. Often shrunken and discolored. (ISA, 2010).

carbon sequestration – capturing and long-term storage of carbon. Most often used about the capturing of atmospheric carbon dioxide through biological, chemical, or physical processes. Trees sequester carbon through photosynthesis. (ISA, 2010).

cavity – open or closed hollow within a tree stem, usually associated with decay. (ISA, 2010).

chronic – disorder or disease occurring over a long period of time. Contrast to *acute.* (ISA, 2010).

CODIT – acronym for Compartmentalization of Decay In Trees. See *compartmentalization.* (ISA, 2010).

codominant stems – forked stems nearly the same size in diameter, arising from a common junction and lacking a normal branch union. (ISA, 2010).

compaction – see *soil compaction*. (ISA, 2010).

compartmentalization (compartmentalisation, in British English) – natural defense process in trees by which chemical and physical boundaries are created that act to limit the spread of disease and decay organisms. See *CODIT*. (ISA, 2010).

composting – subjecting organic matter to decay and decomposition processes. (ISA, 2010).

conk – fruiting body or nonfruiting body (sterile conk) of a fungus. Often associated with decay. (ISA, 2010).

consequences – outcome of an event affecting objectives (ISO, 2018). Effects or outcome of an event. In tree risk assessment, consequences include personal injury, property damage, or disruption of activities or services due to the event (ISA, 2011).

containerized – field grown plant placed into a container for a time and then sold as a potted plant. Term does not include a plant initially grown in a container. Contrast with *balled and burlapped, bare root*. (ISA, 2010).

Council of Tree and Landscape Appraiser (CTLA) – group of representatives of several tree care and landscape associations that works to research and compile the *Guide for Plant Appraisal*. (ISA, 2010).

crown cleaning – in pruning, the selective removal of dead, dying, diseased, and broken branches from the crown. (ISA, 2010).

data – facts and statistics collected for reference or analysis

data point – an identifiable element in a data set

diameter at breast height (dbh) – a U.S. custom means of expressing a diameter of a tree, as measured 4.5 feet (or 1.37 m) above the ground. (ISA 2019).

diameter tape – a diameter tape (D-tape) is used by foresters to measure the diameter of a tree. Since trees are swelled at the base, measurements are made 4.5 feet above the ground to give an average diameter estimate.

decay – (1) (*noun*) an area of wood that is undergoing decomposition. (2) (*verb*) decomposition of organic tissues by fungi or bacteria. (ISA, 2010).

deciduous – tree or other plant that sheds all its leaves according to a genetically scheduled cycle as impacted by climate factors (usually during the cold season in temperate zones). Contrast with *evergreen*. (ISA, 2010).

defoliation – loss of leaves from a tree or other plant by biological or mechanical means. (ISA, 2010).

degree day – difference between the daily average temperature and a given temperature base. (ISA, 2010).

dieback – condition in which the branches in the tree crown die from the tips toward the center. (ISA, 2010).

drought– A period of abnormally dry weather long enough to cause a serious hydrological imbalance. Drought is a relative term (see Box 3-3), therefore any discussion in terms of precipitation deficit must refer to the precipitation-related activity that is under discussion. For example, shortage of precipitation during the growing season impinges on crop production or ecosystem function in general (due to soil moisture)

duty of care – legal obligation that requires an individual to use a reasonable standard of care when performing tasks that may potentially harm others. (ISA, 2010).

ecosystem – complex system of living organisms and their abiotic environment. (ISA, 2010).

emergency response – predetermined set of procedures by which emergency situations are assessed and handled. (ISA, 2010).

eradication – total removal of a species from an area. May refer to pathogens, insect pests, or unwanted plants. (ISA, 2010).

evapotranspiration (ET) – loss of water by evaporation from the soil surface and transpiration by plants. (ISA ,2010).

event – occurrence of a set of circumstances (ISA, 2018).

failure potential – in tree risk assessment, the professional assessment of the likelihood for a tree to fail within a defined period. (ISA, 2010).

fertilizer (fertiliser, in British English) analysis – percentage of primary elements (nitrogen (N), phosphorus (P), and potassium (K) in a fertilizer. (ISA, 2010).

field capacity – maximum soil moisture content following the drainage of water due to the force of gravity. Compare to *available water*, *gravitational water*, and *permanent wilting point*). (ISA, 2010).

foliage – leaves of a plant. (ISA, 2010).

frass – fecal material and/or wood shavings produced by insects. (ISA, 2010).

frost crack – vertical split in the wood of the tree, generally near the base of the bole, caused by internal stresses and low temperatures. Radial shake. (ISA, 2010).

fruiting body – reproductive structure of a fungus. The presence of certain species may indicate decay in a tree. See *conk*. (ISA, 2010).

fungicide – chemical compound that is toxic to fungi. (ISA, 2010).

gall – abnormal swelling of plant tissues caused by gall wasps, mites, nematodes, and various insects and less commonly by fungi or bacteria. (ISA, 2010).

genus – taxonomic group, composed of species having similar fundamental traits. Botanical classification under the family level and above the specific epithet level. (ISA, 2010).

geographic information system (GIS) – computer application used to store, view, and analyze geographic information typically maps. (ISA, 2010).

girdling roots – root that encircles all or part of the trunk of a tree or other roots and constricts the vascular tissue and inhibits secondary growth and the movement of water and photosynthates. (ISA, 2010).

greenhouse effect – rise in temperature that the Earth experiences because certain gases in the atmosphere trap energy from the sun. (ISA, 2010).

growth rate – speed at which something grows. (ISA, 2010).

habit – characteristic form or manner of growth. (ISA, 2010).

hardiness – genetically determined ability of a plant to survive low temperatures. (ISA, 2010).

hardscape – constructed inanimate elements of a landscape, such as walls, pathways, and seats made of wood, stone, and/or other materials. (ISA, 2010).

hazard – a situation or condition that is likely to lead to a loss, personal injury, property damage, or disruption of activities or services; a likely source of harm. In relation to trees, a hazard is the tree part(s) identified as a likely source of harm (ISA, 2011).

hazard tree – a tree, or tree part, identified as a likely source of significant harm (ISA, 2011).

herbicide – chemical compound that kills vegetation. (ISA, 2010).

horizon – layer of soil within the soil profile. (ISA, 2010).

hybrid – plant resulting from a cross between two or more other plants that are alike. (ISA, 2010).

inspection interval – time between inspections (ISA, 2011).

i- Tree – suite of software products and management tools that allows the user to inventory the urban forest and analyze its costs, benefits, and management needs. (ISA, 2010).

included bark – bark that becomes embedded in a crotch (union) between branch and trunk or between codominant stems. Causes a weak structure. (ISA, 2010).

increment boring – the process of extracting pencil-like pieces of wood, usually extracted perpendicular to the long axis of the tree; the core is used to determine age, growth rate evaluation of wood properties, and decay detection. (Maeglin, 1979)

infectious – capable of being spread to plants from other plants or organisms. (ISA, 2010).

injection – method of putting liquid fertilizer or pesticide directly into the soil or a plant's tissues. (ISA, 2010).

integrated pest management (IPM) – method of controlling plant pests by combining biological, cultural, mechanical, physical, and/or chemical management strategies. (ISA, 2010).

job briefing – brief meeting of a tree crew at the start of every job to communicate the work plan, responsibilities and requirements, and any potential hazards. (ISA, 2010).

leaf spot – patches of disease or other damage on plant foliage. (ISA, 2010).

liability – something for which one is responsible. Legal responsibility. (ISA, 2010).

likelihood – chance of something happening (ISO, 2018). Within the ISO narrative, the word "likelihood" is used "to refer to the chance of something happening, whether defined, measured or determined objectively or subjectively, qualitatively or quantitatively, and described using general terms or mathematically." The term "probability" while often having a narrower definition in English is considered an equivalent term for the purposes of the ISO narrative.

limited visual assessment (Level 1) – a visual assessment from a specified perspective such as foot, vehicle, or aerial patrol of an individual tree or a population of trees near specified targets to identify conditions or obvious defects of concern (ISA, 2017).

lion tailing (lion's tailing) – poor pruning practice in which an excessive number of branches are thinned from the inside and lower part of specific limbs or a tree crown, leaving mostly terminal foliage. Results in poor branch taper, poor wind load distribution, and a higher risk of branch failure. (ISA, 2010).

load – (1) general term used to indicate the magnitude of a force, bending movement, torque, pressure, etc. applied to a substance or material. (2) cargo; weight to be borne or conveyed. (ISA, 2010).

macronutrient – essential element that is required by plants in relatively large quantities. Contrast with *micronutrients*. (ISA, 2010).

microinjection – trunk injection technique using a small-diameter trunk penetration to introduce chemicals directly to the xylem. Contrast with *implant*. (ISA, 2010).

micronutrient – essential element that is required by plants in relatively small quantities. Contrast to macronutrients. (ISA, 2010).

mitigation – in tree risk management, reducing, alleviating, or minimizing risk of harm (damage or injury). (ISA, 2010).

monitoring – keeping a close watch. Performing regular checks or inspections. (ISA, 2010).

monoculture – cultivation or planting of a single species on agricultural land, in a forest setting or within an urban landscape. (ISA, 2010).

native species – plants indigenous to a region. Naturally occurring and not introduced by man. (ISA, 2010).

negligence – failure to exercise due care. (ISA, 2010). (1) The failure to exercise the standard of care that a reasonably prudent person would have exercised in a similar situation (Black, 2009).

negligence, gross (Willful and Wanton) – (1) a lack of even slight diligence or care. (2) a conscious, voluntary act or omission in reckless disregard of a legal duty and of the consequences to another party.

notice – legal notification required by law or agreement or imparted by operation of law because of some fact (Black, 2009).

notice, actual – notice given directly to, or received personally by, a person (Black, 2009).

notice, constructive – notice arising by presumption of law from the existence of facts and circumstances that a party had a duty to take notice of (Black, 2009).

organic – in chemistry, a substance containing carbon. In an applied arboricultural context, a substance, especially a fertilizer or pesticide, of animal or vegetable origin. Contrast with *inorganic*. (ISA, 2010).

organic layer – layer of organic matter at the soil surface. (ISA, 2010).

parasite – organism living in or on another living organism (host) from which it derives nourishment to the detriment of the host, sometimes killing the host. (ISA, 2010).**pathogen** – causal agent of disease. Usually refers to microorganisms. (ISA, 2010).

permit – written order granting permission to do something. (ISA, 2010).

pest resistance – in plants, the tendency to withstand or to not develop certain pest problems. (ISA, 2010).

pesticide – any chemical used to control or kill unwanted pests such as weeds, insects, or fungi. (ISA, 2010).

phloem – plant vascular tissue that transports photosynthates and growth regulators. Situated on the inside of the bark, just outside the cambium. Is bidirectional (transports up and down). Contrast with *xylem*. (ISA, 2010).

photosynthate – general term for the sugars and other carbohydrates produced during photosynthesis. (ISA, 2010).

photosynthesis – process in green plants (and in algae and some bacteria) by which light energy is used to form glucose (chemical energy) from water and carbon dioxide. (ISA, 2010).

Plant Health Care (PHC) – comprehensive program to manage the health, structure, and appearance of plants in the landscape. (ISA, 2010).

prevention – proactive process intended to guard against adverse impact by avoiding or reducing the risk of its occurrence. (ISA, 2010).

raising – selective pruning to provide vertical clearance. (ISA, 2010).

reduction – pruning to decrease height and/or spread of a branch or crown. (ISA, 2010).

reduction cut – pruning cut that reduces the length of a branch or stem back to a lateral branch large enough to assume apical dominance. (ISA, 2010).

replacement cost – method to appraise the monetary value of trees considered replaceable with nursery- or field-grown stock. Based on the cost of replacement with the same comparable species of the same size in the same place, subject to depreciation for various factors. Contrast with *trunk formula method.* (ISA, 2010).

restoration – (1) pruning to improve the structure, form, and appearance of trees that have been improperly trimmed, vandalized, or damaged. (2) management and planting to restore altered or damaged ecosystems or landscapes. (ISA, 2010).

risk – (1) The uncertainty of a result, happening, or loss; the chance of injury, damage, or loss (Black, 2009). - effect of uncertainty on objectives (ISO, 2018).

The ISO provides several relevant considerations to this definition. These include: "An effect is a deviation from the expected. It can be positive, negative or both, and can address, create or result in opportunities and threats." And "risk is usually expressed in terms of risk sources, potential events, their consequences and their likelihood. the combination of the likelihood of an event and the severity of the potential consequences." (ISA, 2011).

risk, inherent – (2) A common risk that people bear whenever they decide to engage in a certain activity (Black, 2009).

risk analysis – the systematic use of information to identify sources and to estimate risk exposure (ISA, 2011).

risk assessment – process of evaluating what unexpected things could happen, how likely they are to happen, and what the likely outcomes are. In tree management, the systematic process to determine the level of risk posed by a tree, tree part, or group of trees. (ISA, 2010) and/or the process of risk identification, analysis, and evaluation (ISA, 2011).

risk evaluation – the process of comparing the assessed risk against given risk criteria to determine the significance of the risk (ISA, 2011).

risk management – coordinate activities to direct and control an organization about risk (ISO, 2018). The application of policies, procedures, and practices used to identify, evaluate, mitigate, monitor, and communicate risk (ISA, 2011).

root ball – soil containing all (e.g., containerized) or a portion (e.g., B&B) of the roots that are moved with a plant when it is planted or transplanted. (ISA, 2010).

root collar/root crown excavation – process of removing soil to expose and assess the root collar (root crown) of a tree. (ISA, 2010).

root crown – area where the main roots join the plant stem, usually at or near ground level. Root collar. (ISA, 2010).

runoff – that part of precipitation that does not evaporate and is not transpired but flows through the ground or over the ground surface and returns to bodies of water.

rust – disease caused by a certain group of fungi and characterized by reddish brown spots on the foliage and/or the formation of stem galls. (ISA, 2010)

sapwood – outer wood (xylem) is active in longitudinal transport of water and minerals. (ISA, 2010).

scaffold branches – permanent or structural branches that form the scaffold architecture or structure of a tree. (ISA, 2010).

shall – word that designates a mandatory requirement within the ANSI standards or contract documents. Contrast with *should.* (ISA, 2010).

should – word that designates an advisory recommendation in the ANSI standards or contract documents. Contrast with *shall.* (ISA, 2010).

sign – physical evidence of a causal agent (e.g., insect eggs, borer hole, frass). Contrast with *symptoms.* (ISA, 2010).

site considerations – factors that must be considered when assessing a site for planting, tree conservation, or preservation or any operation. (ISA, 2010).

soil analysis – analysis of soil to determine pH, mineral composition, structure, salinity, and other characteristics. (ISA, 2010).

soil compaction – compression of the soil, often because of vehicle or heavy-equipment traffic, which breaks down soil aggregates and reduces soil volume and total pore space, especially macropore space. (ISA, 2010).

soil moisture - water stored in or at the land surface and available for evapotranspiration. (ISA, 2010)

soil profile – vertical section through the soil and all the soil horizons. (ISA, 2010).**species** – taxonomic group of organisms composed of individuals of the same genus that can reproduce among themselves and have similar offspring. (ISA, 2010).

species diversity – measure of the number and variety of different species found in each area. (ISA, 2010).

specifications – detailed plans, requirements, and statements of procedures and/or standards used to define and guide work. (ISA, 2010).

stakeholder – person or organization that can affect, be affected by, or perceive themselves to be affected by a decision or activity (ISO, 2018).

standard of care – in the law of negligence, the degree of care that a reasonable person should exercise (Black, 2009).

stormwater runoff – water originating from precipitation (rain or melting snow and ice) that flows above ground rather than infiltrating into the soil. May occur if soils are frozen or saturated or if the rate at which precipitation falls is greater than the infiltration rate of a soil. (ISA, 2010).

structural defects – any naturally occurring or secondary conditions such as cavities, poor branch attachments, cracks, or decayed wood in the trunk, crown, or roots of a tree root growth. (ISA, 2010).

structural pruning – pruning to establish a strong arrangement or system of scaffold branches. (ISA, 2010).

sustainability – the ability to maintain ecological, social, and economic benefits over time. (ISA, 2010).

symptom – plant reaction to disease or disorder (e.g., wilting, dieback). Contrast to *sign*. (ISA, 2010).

systemic – (1) substance that moves throughout an organism after it is absorbed. (2) any condition, disease, disorder, pest that affects the entire organism. (ISA, 2010).

systemic pesticide – pesticide that moves throughout a tree after it has been injected or absorbed (often by roots or foliage). (ISA, 2010).

taper – change in diameter over the length of trunks, branches, and roots. (ISA, 2010).

thinning – in pruning, the selective removal of live branches to provide light or air penetration through the tree or to lighten the weight of the remaining branches. (ISA, 2010).

threshold – (1) in Integrated Pest Management, pest population levels requiring action. (2) in hazard assessment, risk assessment, and risk management, levels of risk requiring action. (ISA, 2010).

topping – inappropriate pruning technique to reduce tree size. Cutting back a tree to predetermined crown limit, often at internodes. (ISA, 2010).

tree inventory – record of each tree within a designated population; typically includes species, size, location, condition, and maintenance requirements. (ISA, 2010).

tree protection zone (TPZ) – defined area within which certain activities are prohibited or restricted to prevent or minimize potential injury to designated trees, especially during construction or development. (ISA, 2010).

tree risk assessment – a systematic, technical process used to identify, analyze, and evaluate the risk associated with a singular tree (ISA, 2011).

trenching – linear, open excavation, often used to install utilities or structural footings. Can cause tree root damage. (ISA, 2010).

trunk flare – transition zone from trunk to roots where the trunk expands into the buttress or structural roots. Root flare. (ISA, 2010).

urban forestry – management of naturally occurring and planted trees and associated plants in urban areas. (ISA, 2010).

urban heat island - the relative warmth of a city compared with surrounding rural areas, associated with changes in runoff, the concrete jungle effects on heat retention, changes in surface albedo, changes in pollution and aerosols, and so on.

vigor – overall health. Capacity to grow and resist stress. Sometimes limited to reference to genetic capacity. (ISA, 2010).

visual tree assessment (VTA) – method of assessing the structural integrity of trees using external symptoms of mechanical stress (such as bulges, reactive growth, etc.) and defects (cracks, cavities, etc.). (ISA, 2010).

vitality – overall health. Ability of a plant to deal effectively with stress. (ISA, 2010)

water sprout – upright, epicormic shoot arising from the trunk or branches of a plant above the root graft or soil line. Incorrectly called a sucker. (ISA, 2010).

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APPENDICES

APPENDIX 1. AREAS A, B, C REPORT

APPENDIX 2. AREA A REPORT

APPENDIX 3. AREA B REPORT

APPENDIX 3. AREA C REPORT

APPENDIX 4: TREE PRESERVATION

APPENDIX 5: RECOMMENDED PLANTINGS (UMASS PLANT LIST)

TREEFOIL

CONSULTING ARBORISTS

SEASIDE PARK AREAS A, B, C

January 3, 2022

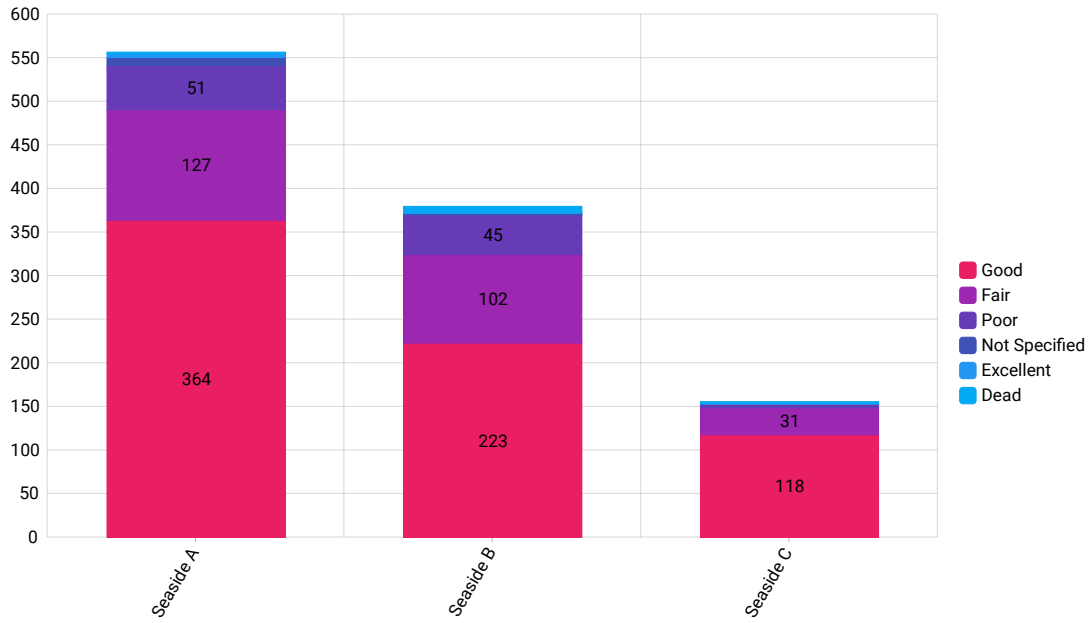
Filters Applied

Filters for the Trees Inventory:
Tree Filter: Client Site = ('Seaside A' or
'Seaside B' or
'Seaside C')

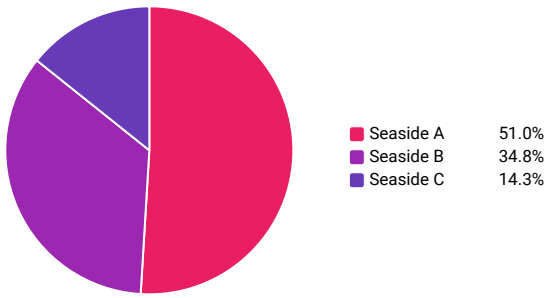
Total Trees: 1,093

By Project Charts

Condition by Project - Top 10



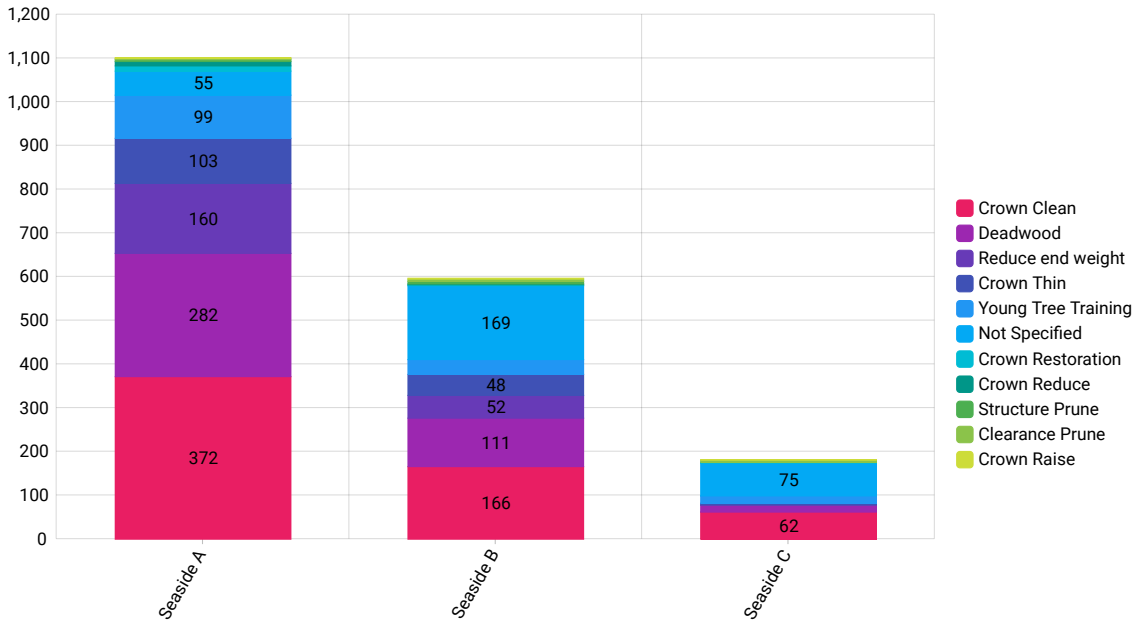
Trees by Project - Top 10



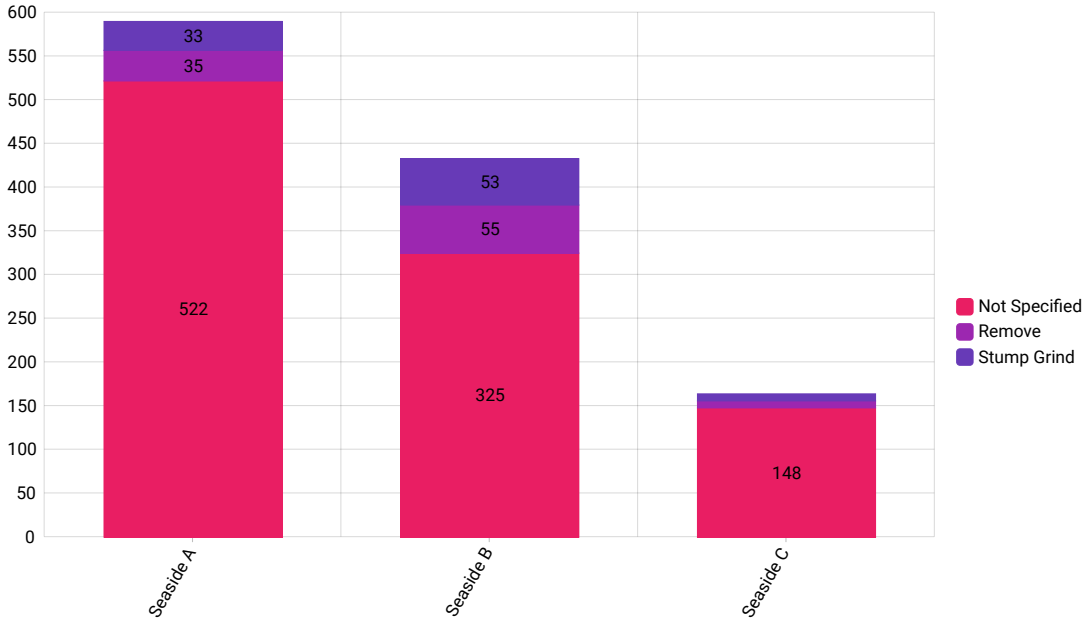
Trees by Project - Top 10

CLIENT SITE	COUNT	PERCENTAGE
Seaside A	557	51.0%
Seaside B	380	34.8%
Seaside C	156	14.3%

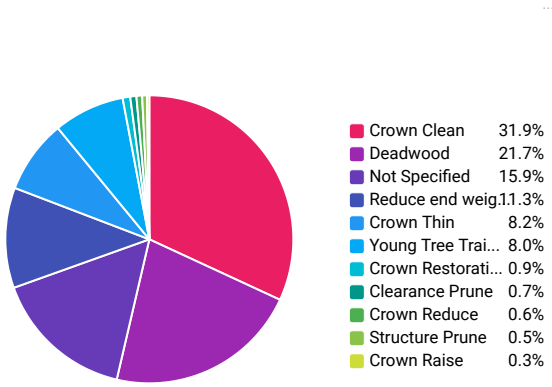
Pruning by Project - Top 10



Other Work by Project - Top 10



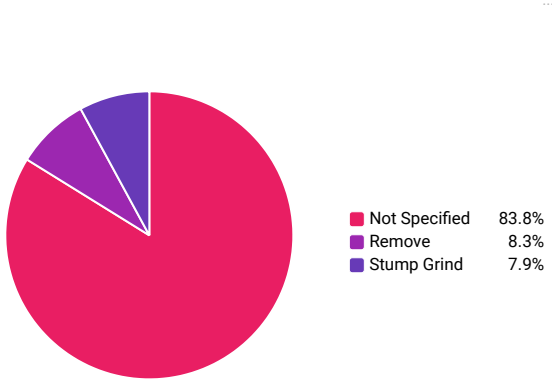
Pruning Work



Pruning Work

TREE WORK-PRUNING	COUNT	PERCENTAGE
Crown Clean	600	31.9%
Deadwood	409	21.7%
Not Specified	299	15.9%
Reduce end weight	212	11.3%
Crown Thin	155	8.2%
Young Tree Training	150	8.0%
Crown Restoration	16	0.9%
Clearance Prune	13	0.7%
Crown Reduce	12	0.6%
Structure Prune	10	0.5%
Crown Raise	5	0.3%

Other Work

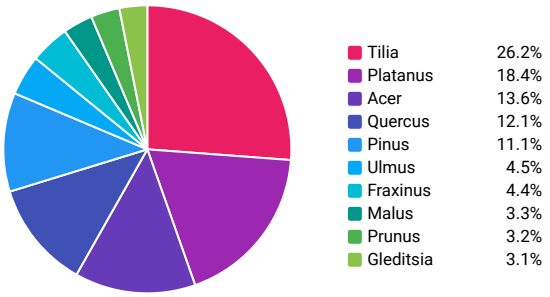


Other Work

TREE WORK-OTHER	COUNT	PERCENTAGE
Not Specified	995	83.8%
Remove	98	8.3%
Stump Grind	94	7.9%

Tree Diversity Charts

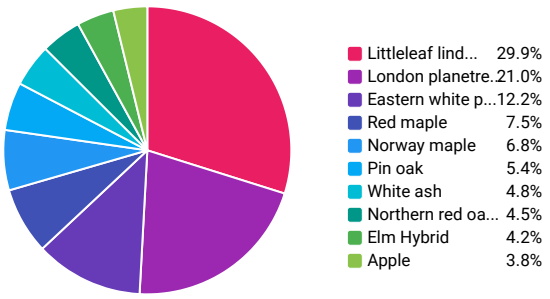
Most Common Genus - Top 10



Most Common Genus - Top 10

GENUS	COUNT	PERCENTAGE
Tilia	243	26.2%
Platanus	171	18.4%
Acer	126	13.6%
Quercus	112	12.1%
Pinus	103	11.1%
Ulmus	42	4.5%
Fraxinus	41	4.4%
Malus	31	3.3%
Prunus	30	3.2%
Gleditsia	29	3.1%

Most Common Species - Top 10

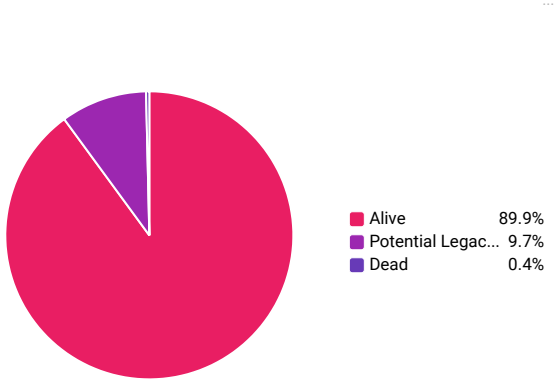


Most Common Species - Top 10

COMMON NAME	COUNT	PERCENTAGE
Littleleaf linden	243	29.9%
London planetree	171	21.0%
Eastern white pine	99	12.2%
Red maple	61	7.5%
Norway maple	55	6.8%
Pin oak	44	5.4%
White ash	39	4.8%
Northern red oak	37	4.5%
Elm Hybrid	34	4.2%
Apple	31	3.8%

Tree Health Charts

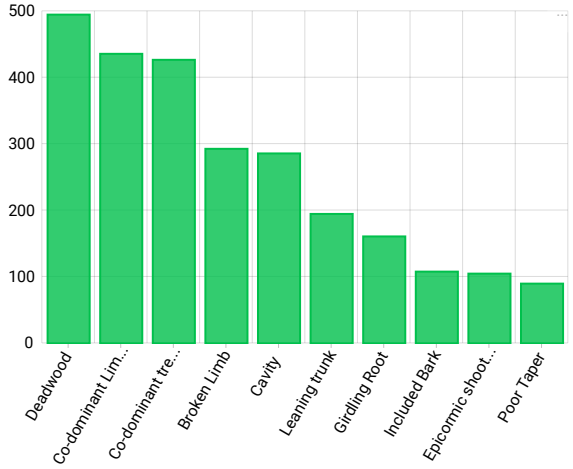
Status



Status

STATUS	COUNT	PERCENTAGE
Alive	983	89.9%
Potential Legacy	106	9.7%
Dead	4	0.4%

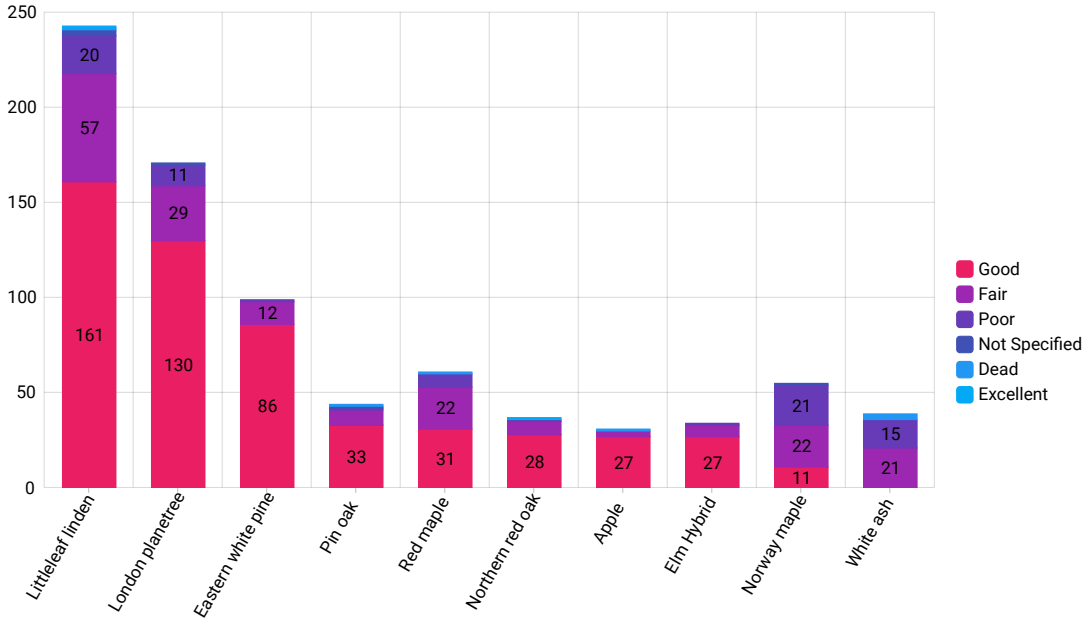
Observations - Characteristics - Top 10



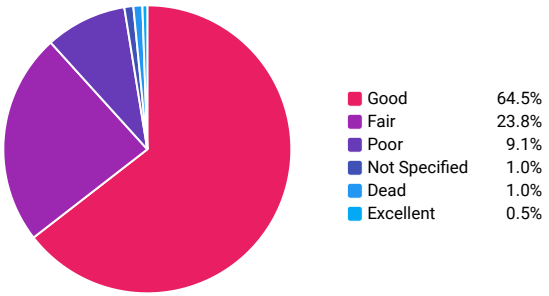
Observations - Characteristics - Top 10

OBSERVATIONS-CHARACTERISTICS	COUNT	PERCENTAGE
Deadwood	495	19.1%
Co-dominant Limbs	436	16.8%
Co-dominant tree	427	16.4%
Broken Limb	293	11.3%
Cavity	286	11.0%
Leaning trunk	195	7.5%
Girdling Root	161	6.2%
Included Bark	108	4.2%
Epicormic shoots	105	4.0%
Poor Taper	90	3.5%

Most Common Species by Condition - Top 10



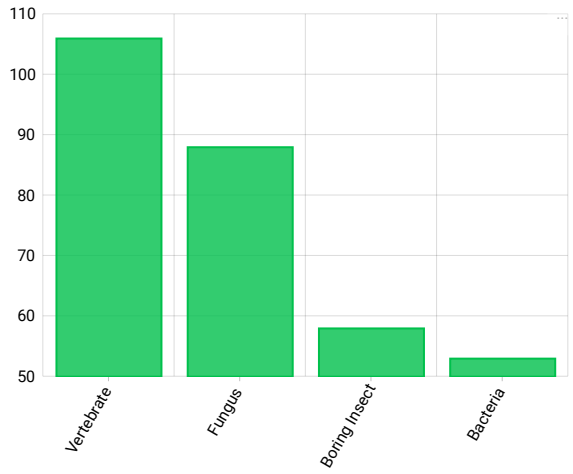
Trees by Condition



Trees by Condition

CONDITION	COUNT	PERCENTAGE
Good	705	64.5%
Fair	260	23.8%
Poor	100	9.1%
Not Specified	11	1.0%
Dead	11	1.0%
Excellent	6	0.5%

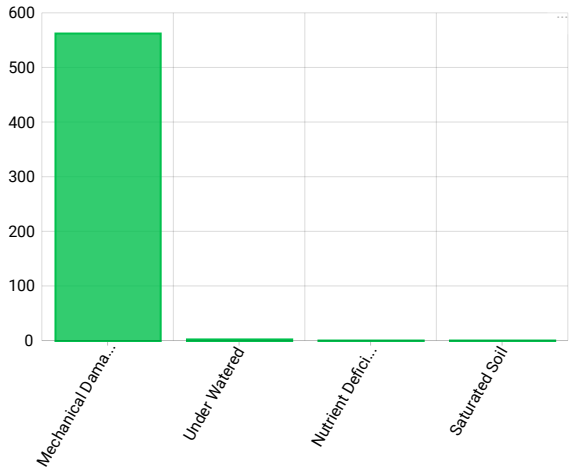
Observations - Biotic - Top 10



Observations - Biotic - Top 10

OBSERVATIONS-BIOTIC PEST	COUNT	PERCENTAGE
Vertebrate	106	34.8%
Fungus	88	28.9%
Boring Insect	58	19.0%
Bacteria	53	17.4%

Observations - Abiotic - Top 10

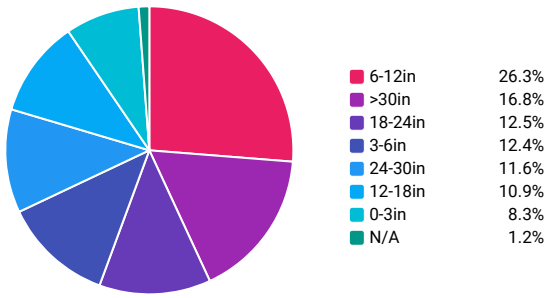


Observations - Abiotic - Top 10

OBSERVATIONS-ABIOTIC	COUNT	PERCENTAGE
Mechanical Damage	563	99.1%
Under Watered	3	0.5%
Nutrient Deficiency	1	0.2%
Saturated Soil	1	0.2%

Tree Size and Composition Charts

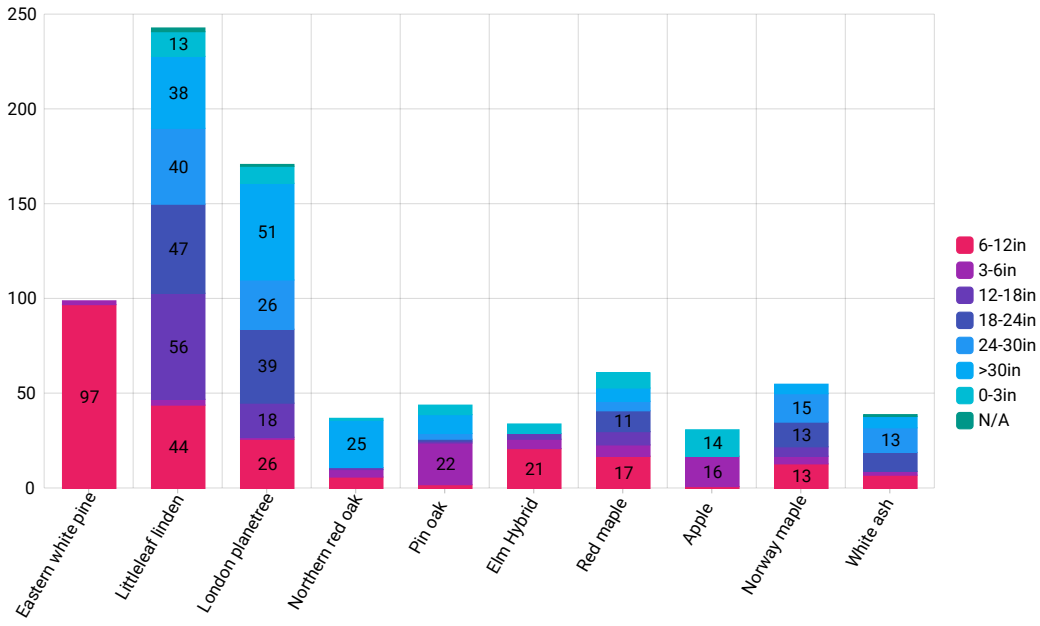
Trees by DBH



Trees by DBH

DBH RANGE	COUNT	PERCENTAGE
6-12in	287	26.3%
>30in	184	16.8%
18-24in	137	12.5%
3-6in	135	12.4%
24-30in	127	11.6%
12-18in	119	10.9%
0-3in	91	8.3%
N/A	13	1.2%

Most Common Species by DBH Range - Top 10



TREEFOIL

CONSULTING ARBORISTS

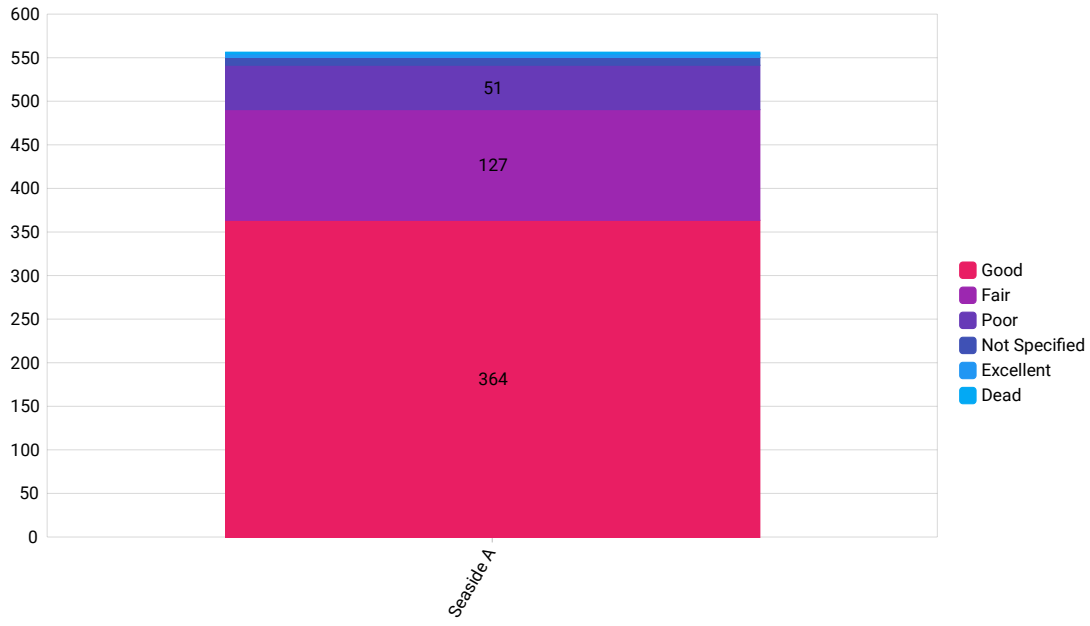
SEASIDE PARK AREA A

January 3, 2022

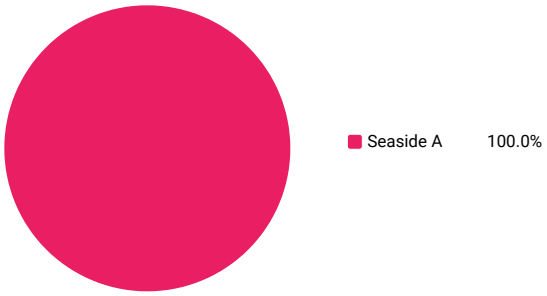
Total Trees: 557

By Project Charts

Condition by Project - Top 10



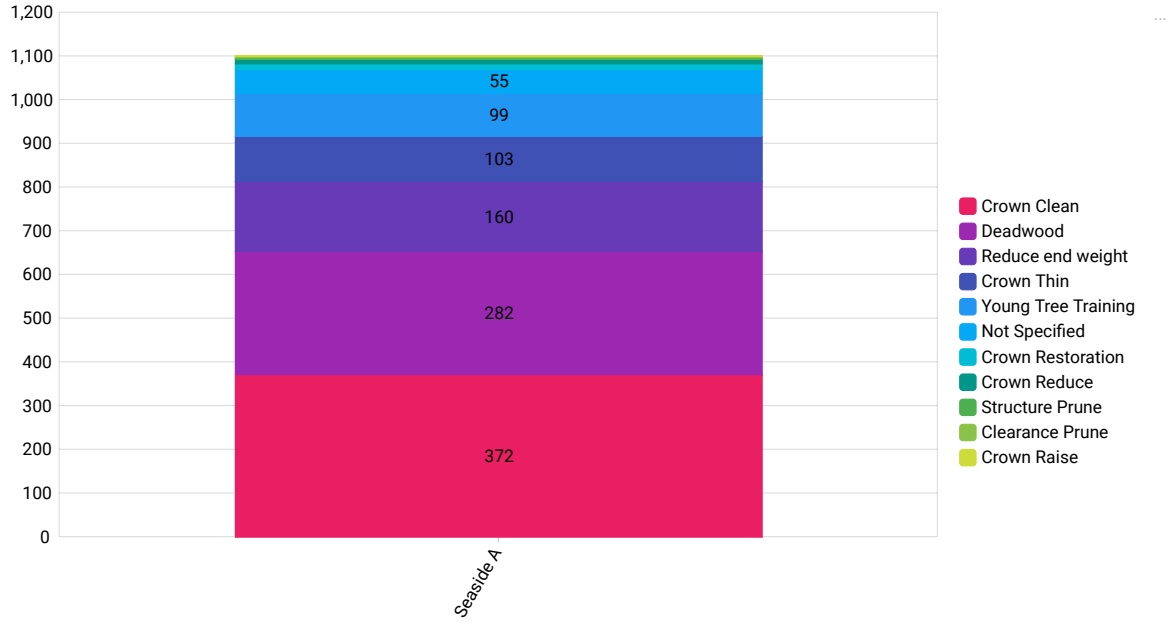
Trees by Project - Top 10



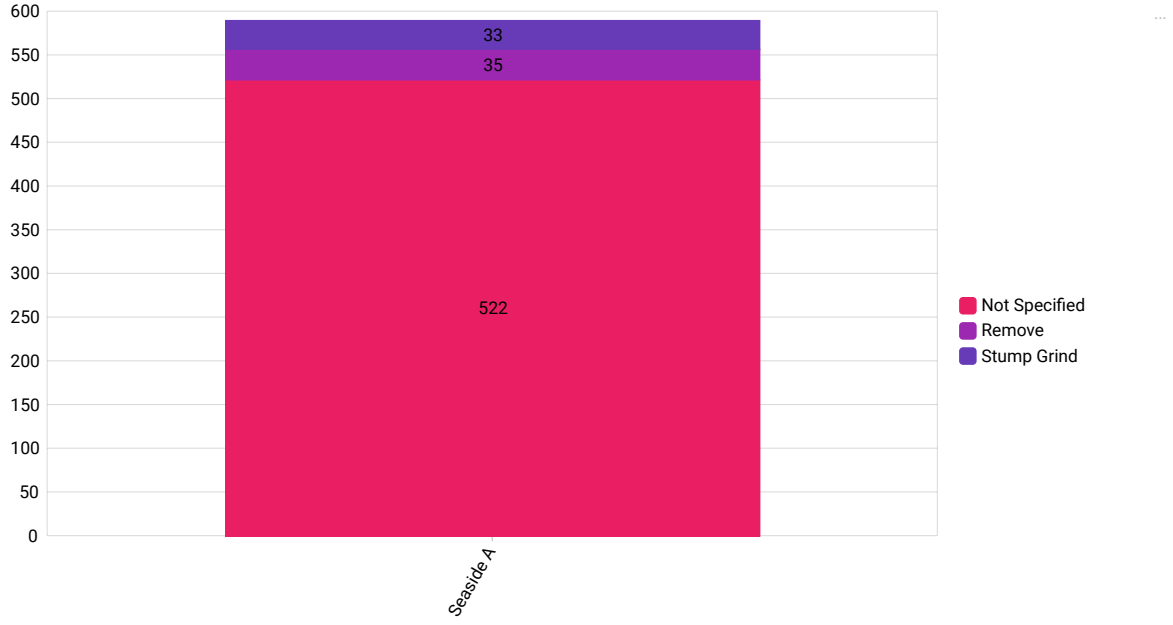
Trees by Project - Top 10

CLIENT SITE	COUNT	PERCENTAGE
Seaside A	557	100.0%

Pruning by Project - Top 10

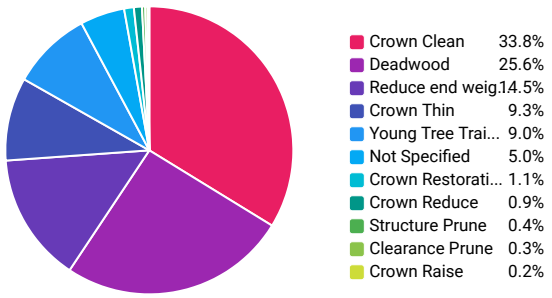


Other Work by Project - Top 10



Management Need Charts

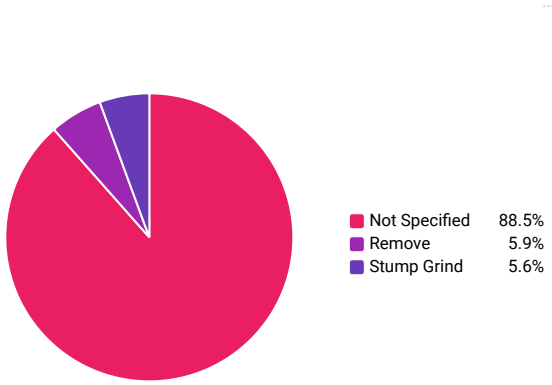
Pruning Work



Pruning Work

TREE WORK-PRUNING	COUNT	PERCENTAGE
Crown Clean	372	33.8%
Deadwood	282	25.6%
Reduce end weight	160	14.5%
Crown Thin	103	9.3%
Young Tree Training	99	9.0%
Not Specified	55	5.0%
Crown Restoration	12	1.1%
Crown Reduce	10	0.9%
Structure Prune	4	0.4%
Clearance Prune	3	0.3%
Crown Raise	2	0.2%

Other Work

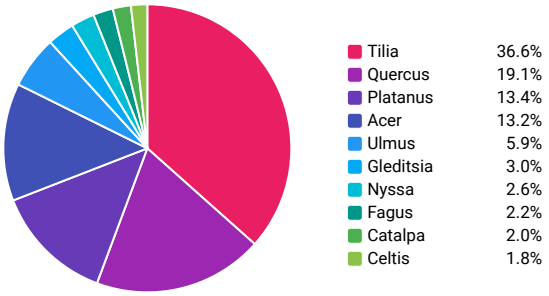


Other Work

TREE WORK-OTHER	COUNT	PERCENTAGE
Not Specified	522	88.5%
Remove	35	5.9%
Stump Grind	33	5.6%

Tree Diversity Charts

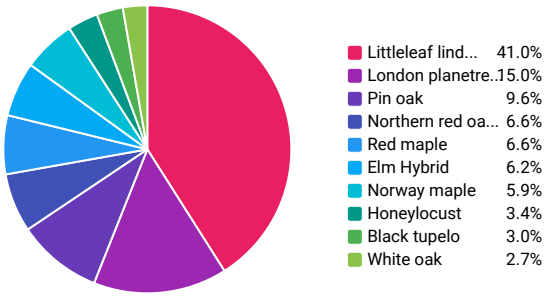
Most Common Genus - Top 10



Most Common Genus - Top 10

GENUS	COUNT	PERCENTAGE
Tilia	180	36.6%
Quercus	94	19.1%
Platanus	66	13.4%
Acer	65	13.2%
Ulmus	29	5.9%
Gleditsia	15	3.0%
Nyssa	13	2.6%
Fagus	11	2.2%
Catalpa	10	2.0%
Celtis	9	1.8%

Most Common Species - Top 10

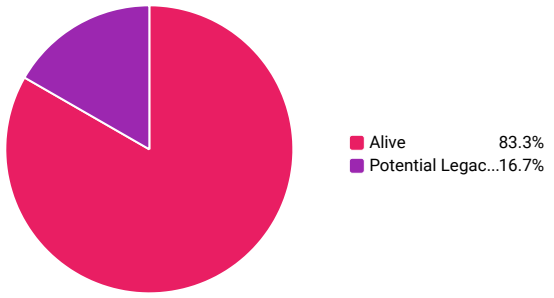


Most Common Species - Top 10

COMMON NAME	COUNT	PERCENTAGE
Littleleaf linden	180	41.0%
London planetree	66	15.0%
Pin oak	42	9.6%
Northern red oak	29	6.6%
Red maple	29	6.6%
Elm Hybrid	27	6.2%
Norway maple	26	5.9%
Honeylocust	15	3.4%
Black tupelo	13	3.0%
White oak	12	2.7%

Tree Health Charts

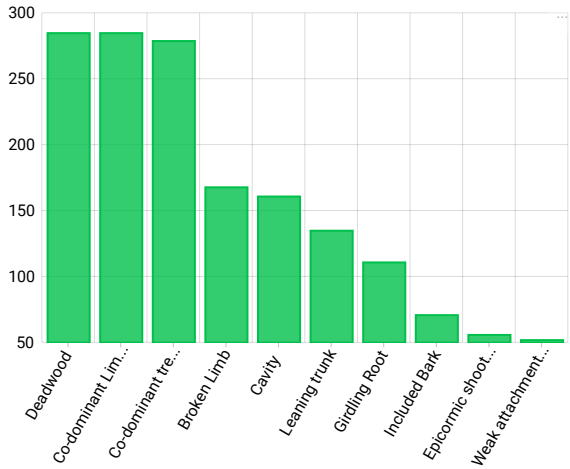
Status



Status

STATUS	COUNT	PERCENTAGE
Alive	464	83.3%
Potential Legacy	93	16.7%

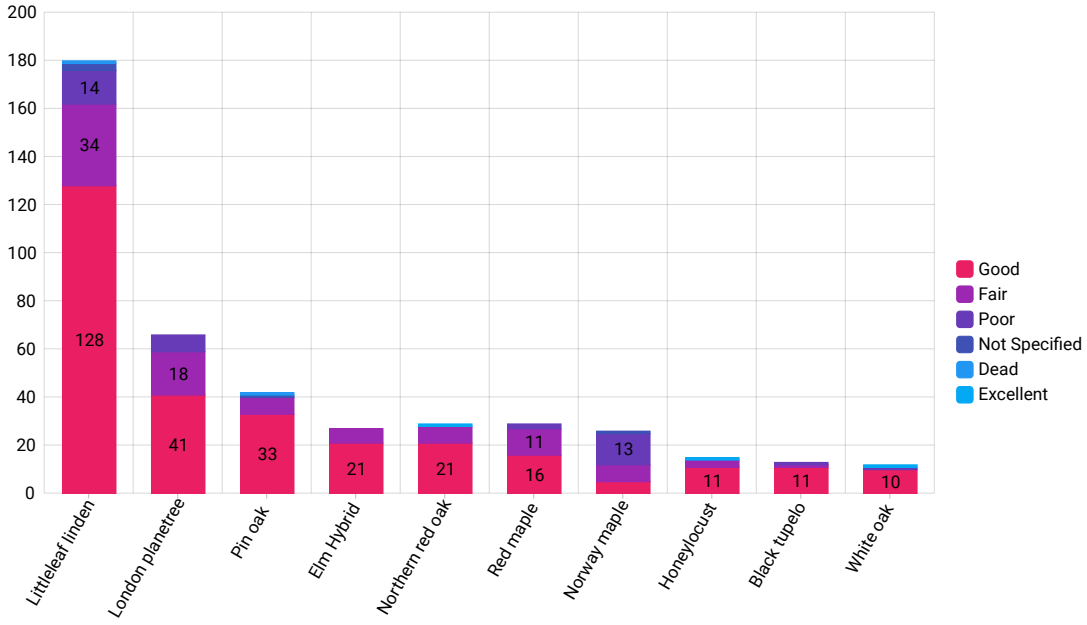
Observations - Characteristics - Top 10



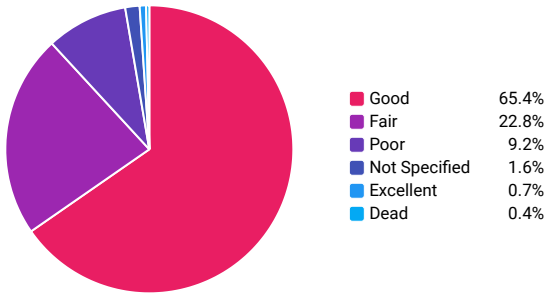
Observations - Characteristics - Top 10

OBSERVATIONS-CHARACTERISTICS	COUNT	PERCENTAGE
Deadwood	285	17.8%
Co-dominant Limbs	285	17.8%
Co-dominant tree	279	17.4%
Broken Limb	168	10.5%
Cavity	161	10.0%
Leaning trunk	135	8.4%
Girdling Root	111	6.9%
Included Bark	71	4.4%
Epicormic shoots	56	3.5%
Weak attachments	52	3.2%

Most Common Species by Condition - Top 10



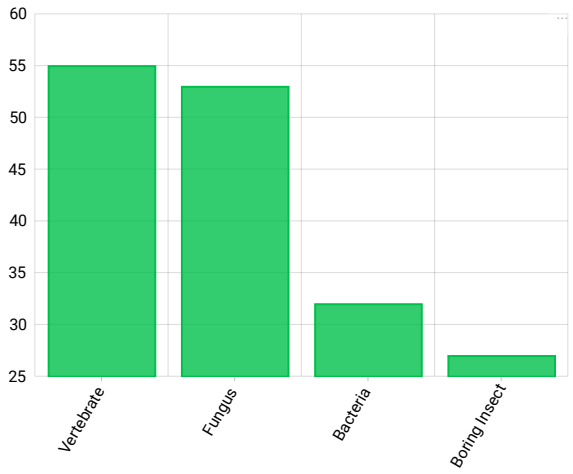
Trees by Condition



Trees by Condition

CONDITION	COUNT	PERCENTAGE
Good	364	65.4%
Fair	127	22.8%
Poor	51	9.2%
Not Specified	9	1.6%
Excellent	4	0.7%
Dead	2	0.4%

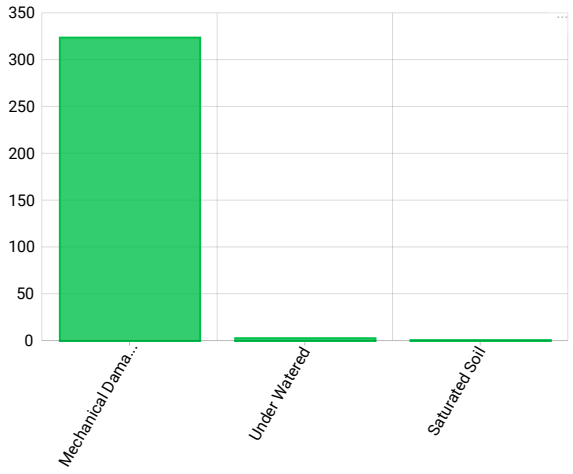
Observations - Biotic - Top 10



Observations - Biotic - Top 10

OBSERVATIONS-BIOTIC PEST	COUNT	PERCENTAGE
Vertebrate	55	32.9%
Fungus	53	31.7%
Bacteria	32	19.2%
Boring Insect	27	16.2%

Observations - Abiotic - Top 10

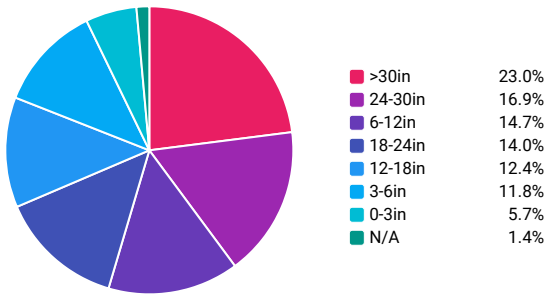


Observations - Abiotic - Top 10

OBSERVATIONS-ABIOTIC	COUNT	PERCENTAGE
Mechanical Damage	324	98.8%
Under Watered	3	0.9%
Saturated Soil	1	0.3%

Tree Size and Composition Charts

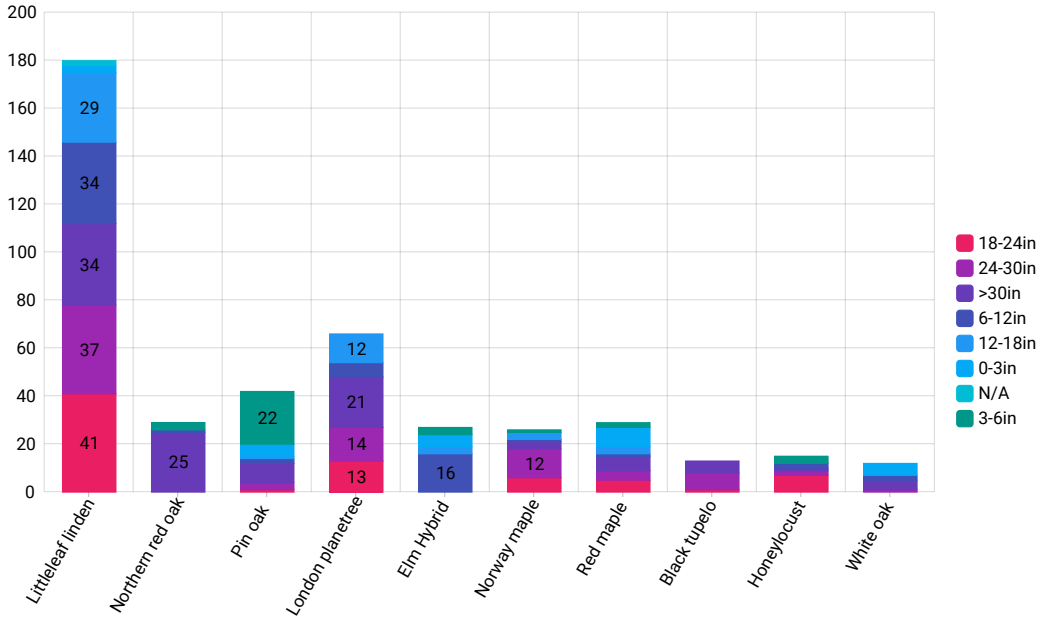
Trees by DBH



Trees by DBH

DBH RANGE	COUNT	PERCENTAGE
>30in	128	23.0%
24-30in	94	16.9%
6-12in	82	14.7%
18-24in	78	14.0%
12-18in	69	12.4%
3-6in	66	11.8%
0-3in	32	5.7%
N/A	8	1.4%

Most Common Species by DBH Range - Top 10



TREEFOIL

CONSULTING ARBORISTS

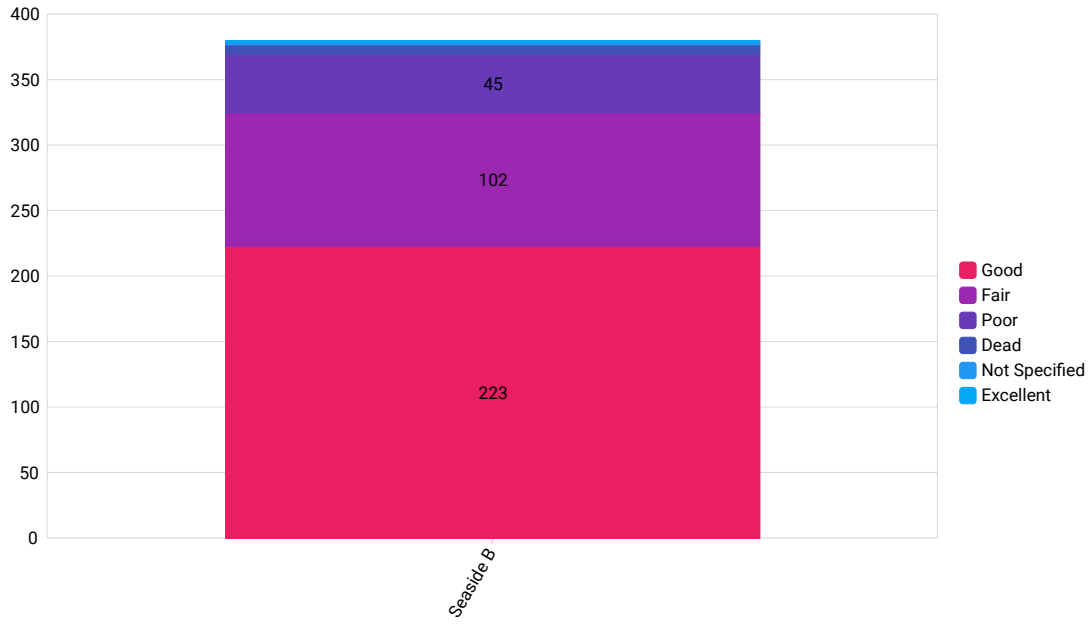
SEASIDE PARK AREA B

January 3, 2022

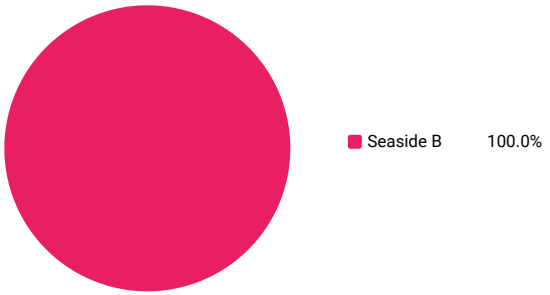
Total Trees: 380

By Project Charts

Condition by Project - Top 10



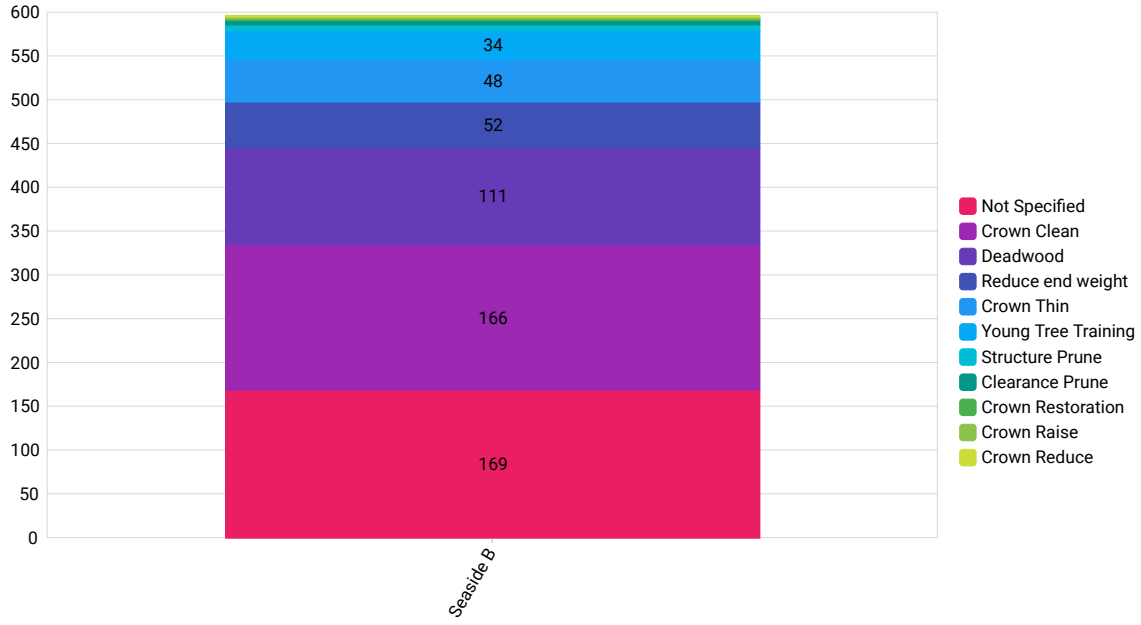
Trees by Project - Top 10



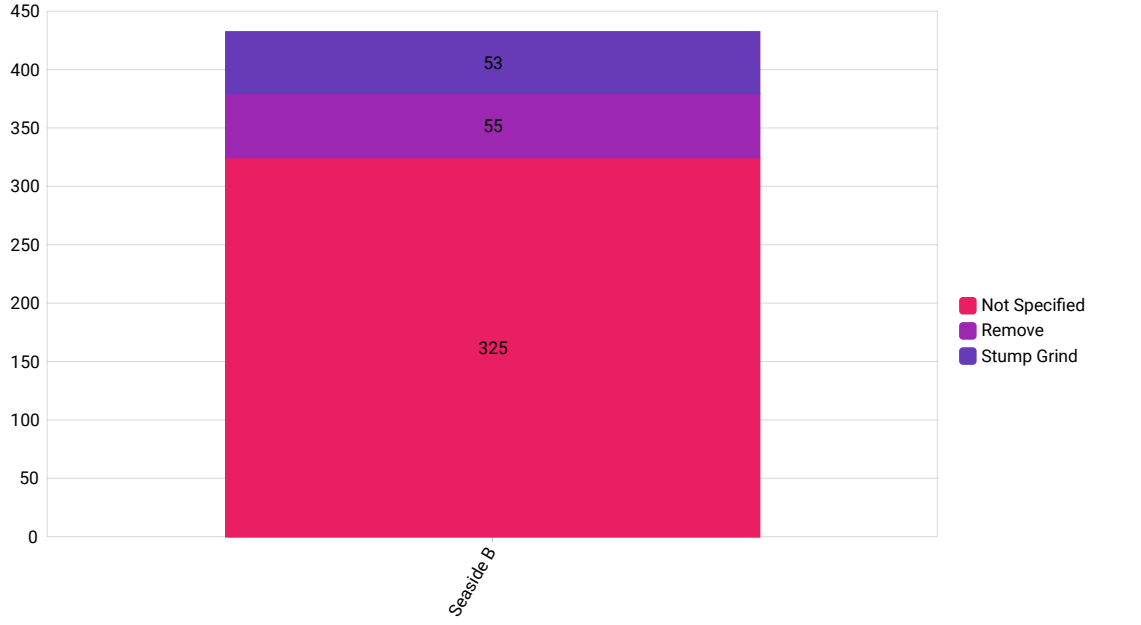
Trees by Project - Top 10

CLIENT SITE	COUNT	PERCENTAGE
Seaside B	380	100.0%

Pruning by Project - Top 10

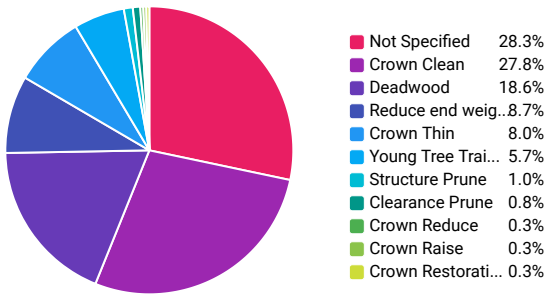


Other Work by Project - Top 10



Management Need Charts

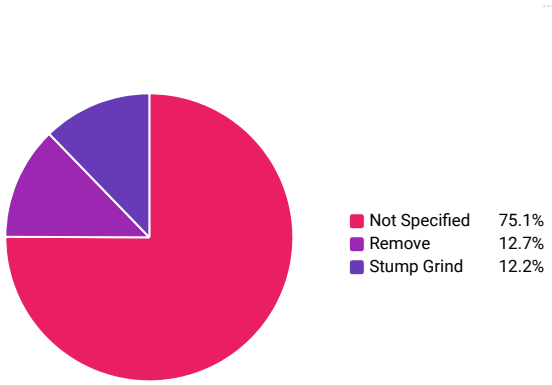
Pruning Work



Pruning Work

TREE WORK-PRUNING	COUNT	PERCENTAGE
Not Specified	169	28.3%
Crown Clean	166	27.8%
Deadwood	111	18.6%
Reduce end weight	52	8.7%
Crown Thin	48	8.0%
Young Tree Training	34	5.7%
Structure Prune	6	1.0%
Clearance Prune	5	0.8%
Crown Reduce	2	0.3%
Crown Raise	2	0.3%
Crown Restoration	2	0.3%

Other Work

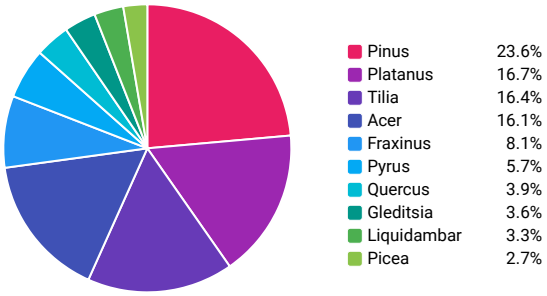


Other Work

TREE WORK-OTHER	COUNT	PERCENTAGE
Not Specified	325	75.1%
Remove	55	12.7%
Stump Grind	53	12.2%

Tree Diversity Charts

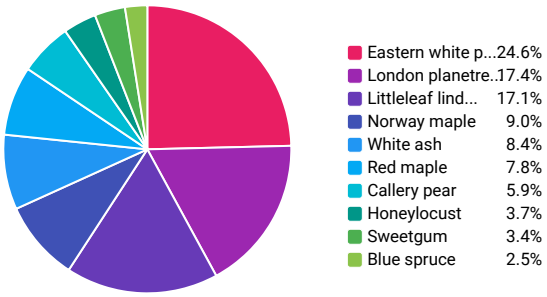
Most Common Genus - Top 10



Most Common Genus - Top 10

GENUS	COUNT	PERCENTAGE
Pinus	79	23.6%
Platanus	56	16.7%
Tilia	55	16.4%
Acer	54	16.1%
Fraxinus	27	8.1%
Pyrus	19	5.7%
Quercus	13	3.9%
Gleditsia	12	3.6%
Liquidambar	11	3.3%
Picea	9	2.7%

Most Common Species - Top 10

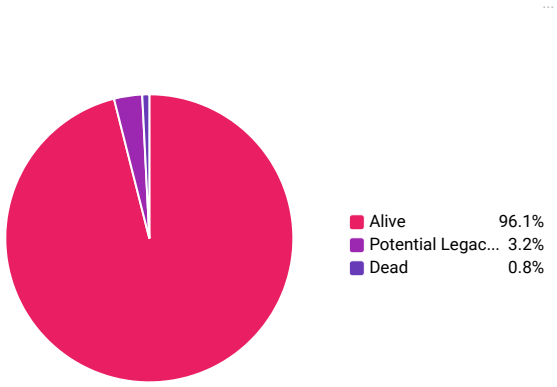


Most Common Species - Top 10

COMMON NAME	COUNT	PERCENTAGE
Eastern white pine	79	24.6%
London planetree	56	17.4%
Littleleaf linden	55	17.1%
Norway maple	29	9.0%
White ash	27	8.4%
Red maple	25	7.8%
Callery pear	19	5.9%
Honeylocust	12	3.7%
Sweetgum	11	3.4%
Blue spruce	8	2.5%

Tree Health Charts

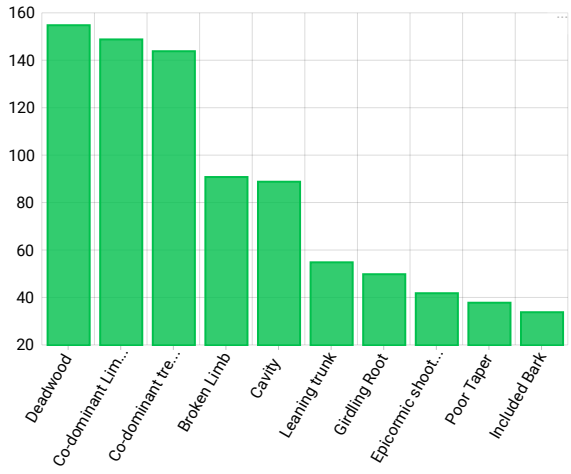
Status



Status

STATUS	COUNT	PERCENTAGE
Alive	365	96.1%
Potential Legacy	12	3.2%
Dead	3	0.8%

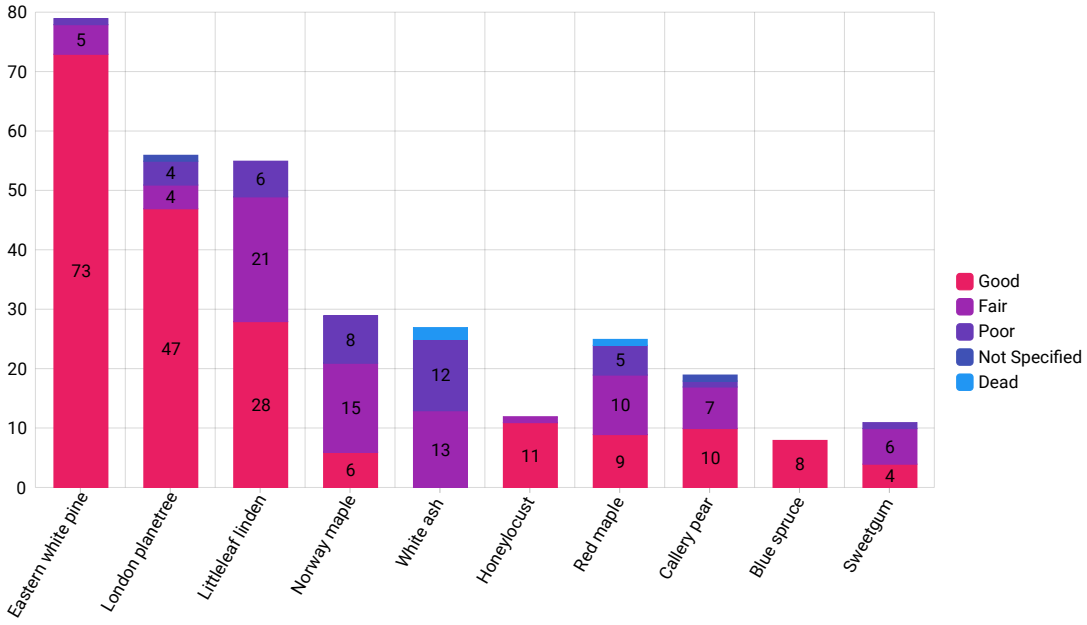
Observations - Characteristics - Top 10



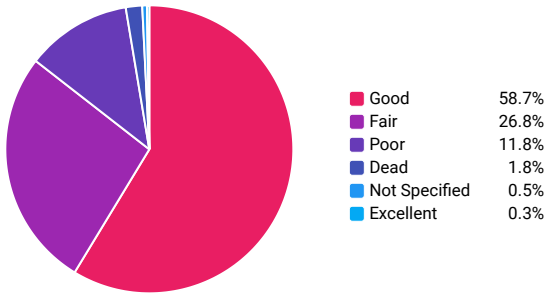
Observations - Characteristics - Top 10

OBSERVATIONS-CHARACTERISTICS	COUNT	PERCENTAGE
Deadwood	155	18.3%
Co-dominant Limbs	149	17.6%
Co-dominant tree	144	17.0%
Broken Limb	91	10.7%
Cavity	89	10.5%
Leaning trunk	55	6.5%
Girdling Root	50	5.9%
Epicormic shoots	42	5.0%
Poor Taper	38	4.5%
Included Bark	34	4.0%

Most Common Species by Condition - Top 10



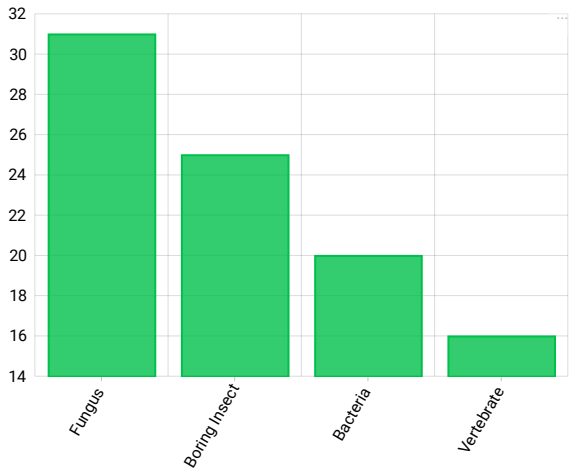
Trees by Condition



Trees by Condition

CONDITION	COUNT	PERCENTAGE
Good	223	58.7%
Fair	102	26.8%
Poor	45	11.8%
Dead	7	1.8%
Not Specified	2	0.5%
Excellent	1	0.3%

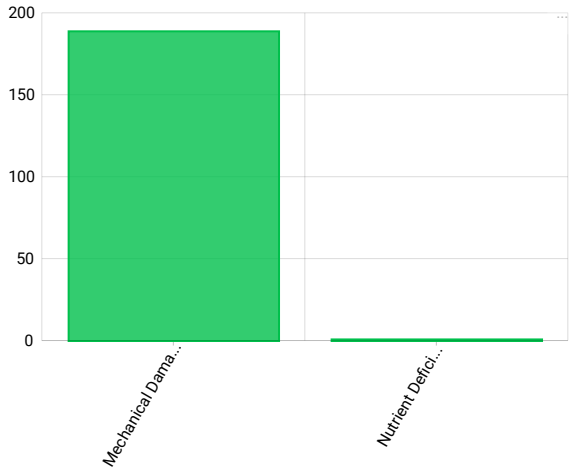
Observations - Biotic - Top 10



Observations - Biotic - Top 10

OBSERVATIONS-BIOTIC PEST	COUNT	PERCENTAGE
Fungus	31	33.7%
Boring Insect	25	27.2%
Bacteria	20	21.7%
Vertebrate	16	17.4%

Observations - Abiotic - Top 10

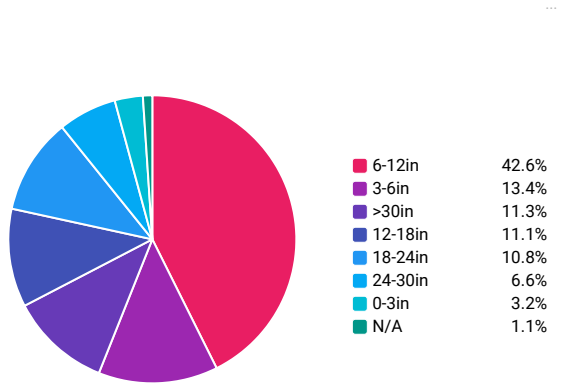


Observations - Abiotic - Top 10

OBSERVATIONS-ABIOTIC	COUNT	PERCENTAGE
Mechanical Damage	189	99.5%
Nutrient Deficiency	1	0.5%

Tree Size and Composition Charts

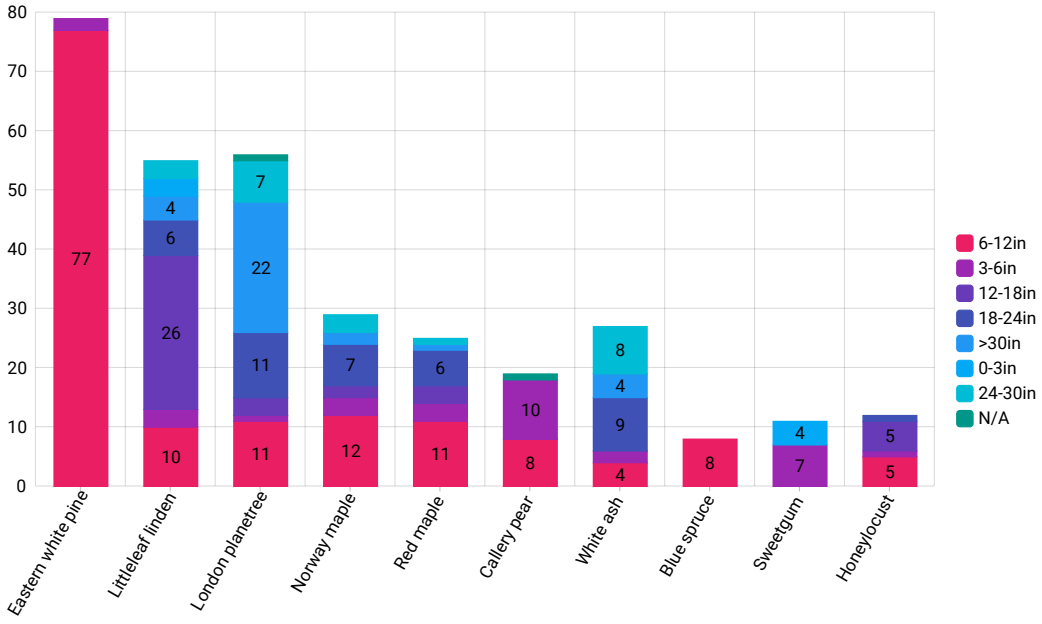
Trees by DBH



Trees by DBH

DBH RANGE	COUNT	PERCENTAGE
6-12in	162	42.6%
3-6in	51	13.4%
>30in	43	11.3%
12-18in	42	11.1%
18-24in	41	10.8%
24-30in	25	6.6%
0-3in	12	3.2%
N/A	4	1.1%

Most Common Species by DBH Range - Top 10



TREEFOIL

CONSULTING ARBORISTS

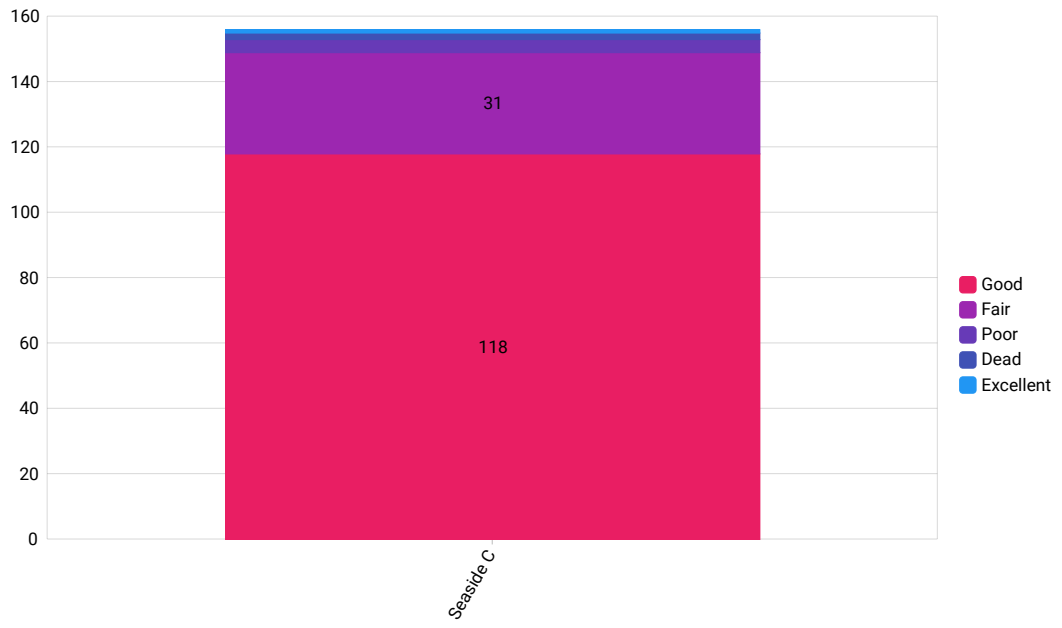
SEASIDE PARK AREA C

January 3, 2022

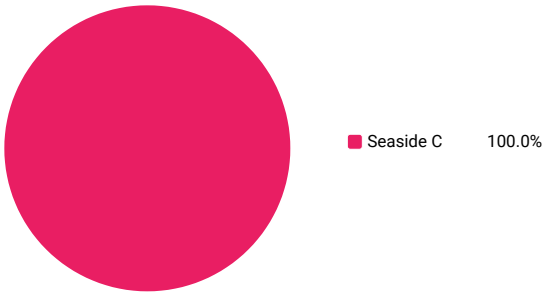
Total Trees: 156

By Project Charts

Condition by Project - Top 10



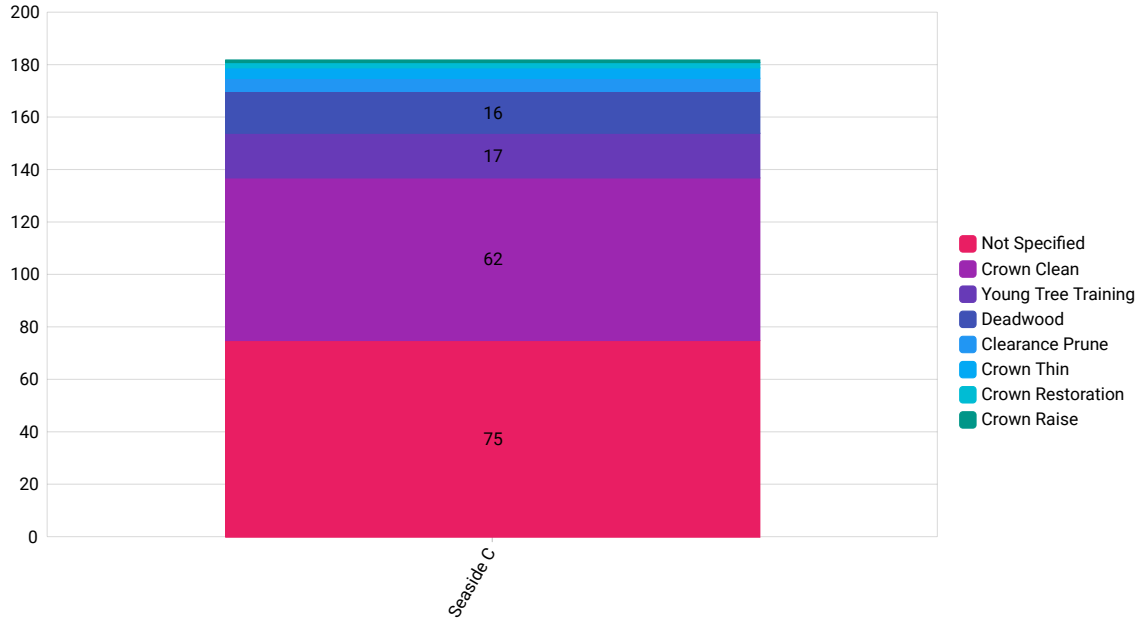
Trees by Project - Top 10



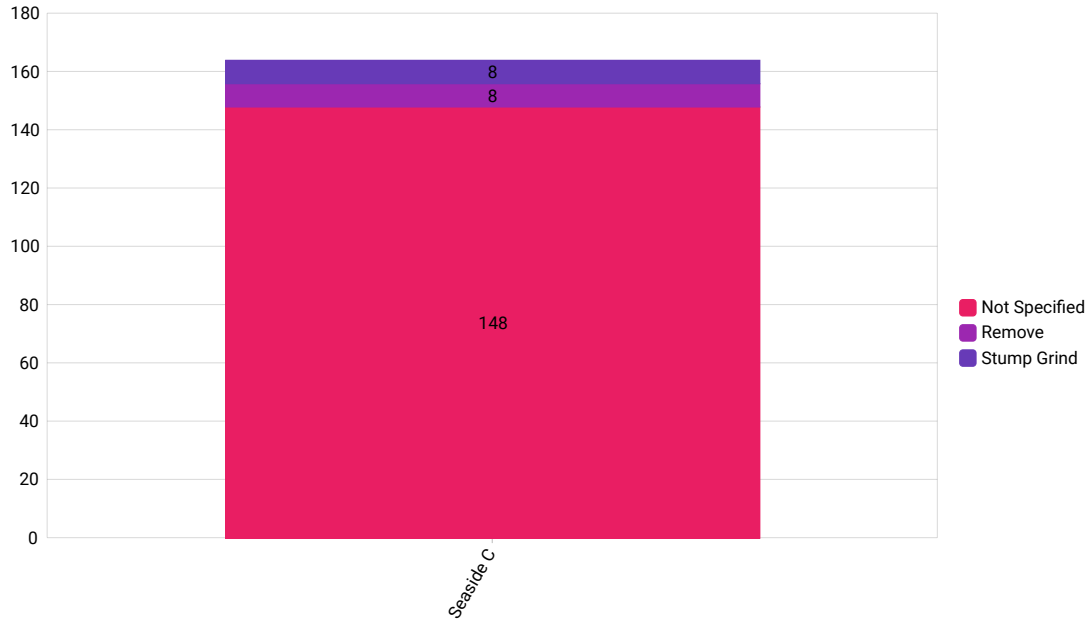
Trees by Project - Top 10

CLIENT SITE	COUNT	PERCENTAGE
Seaside C	156	100.0%

Pruning by Project - Top 10

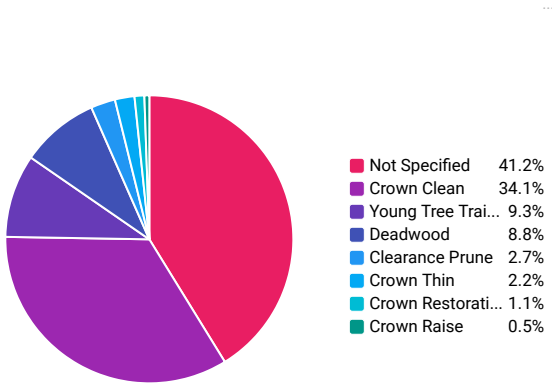


Other Work by Project - Top 10



Management Need Charts

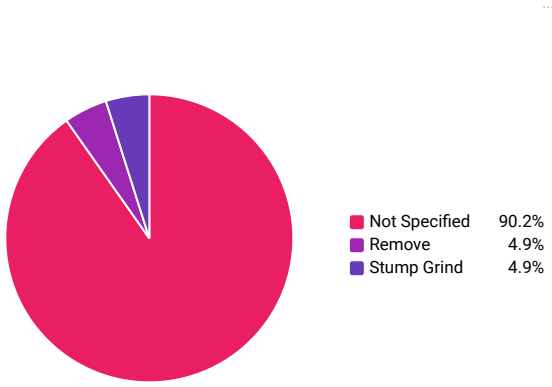
Pruning Work



Pruning Work

TREE WORK-PRUNING	COUNT	PERCENTAGE
Not Specified	75	41.2%
Crown Clean	62	34.1%
Young Tree Training	17	9.3%
Deadwood	16	8.8%
Clearance Prune	5	2.7%
Crown Thin	4	2.2%
Crown Restoration	2	1.1%
Crown Raise	1	0.5%

Other Work

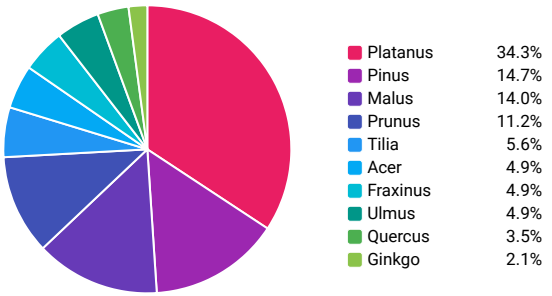


Other Work

TREE WORK-OTHER	COUNT	PERCENTAGE
Not Specified	148	90.2%
Remove	8	4.9%
Stump Grind	8	4.9%

Tree Diversity Charts

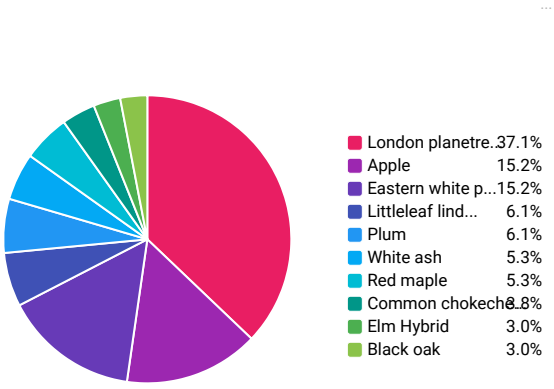
Most Common Genus - Top 10



Most Common Genus - Top 10

GENUS	COUNT	PERCENTAGE
Platanus	49	34.3%
Pinus	21	14.7%
Malus	20	14.0%
Prunus	16	11.2%
Tilia	8	5.6%
Acer	7	4.9%
Fraxinus	7	4.9%
Ulmus	7	4.9%
Quercus	5	3.5%
Ginkgo	3	2.1%

Most Common Species - Top 10

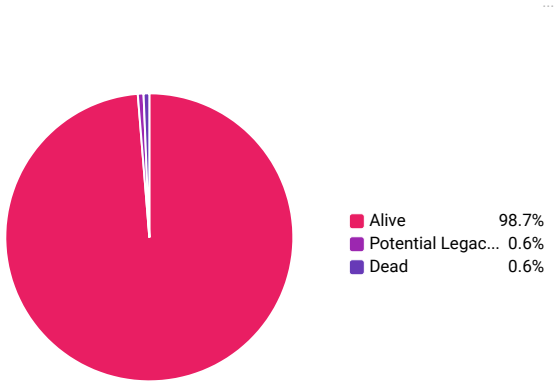


Most Common Species - Top 10

COMMON NAME	COUNT	PERCENTAGE
London planetree	49	37.1%
Apple	20	15.2%
Eastern white pine	20	15.2%
Littleleaf linden	8	6.1%
Plum	8	6.1%
White ash	7	5.3%
Red maple	7	5.3%
Common chokecherry	5	3.8%
Elm Hybrid	4	3.0%
Black oak	4	3.0%

Tree Health Charts

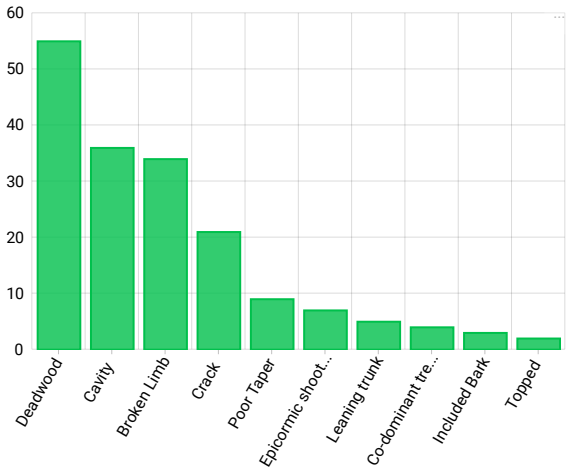
Status



Status

STATUS	COUNT	PERCENTAGE
Alive	154	98.7%
Potential Legacy	1	0.6%
Dead	1	0.6%

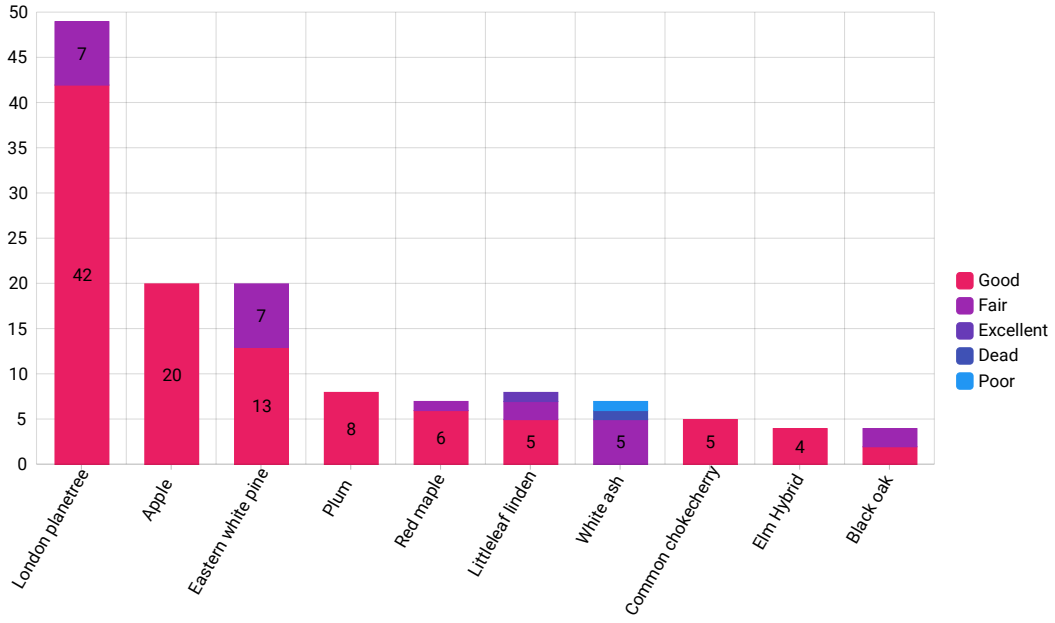
Observations - Characteristics - Top 10



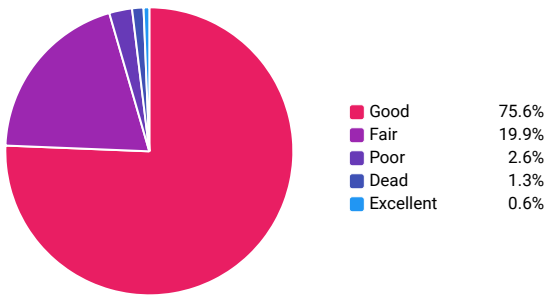
Observations - Characteristics - Top 10

OBSERVATIONS-CHARACTERISTICS	COUNT	PERCENTAGE
Deadwood	55	31.3%
Cavity	36	20.5%
Broken Limb	34	19.3%
Crack	21	11.9%
Poor Taper	9	5.1%
Epicormic shoots	7	4.0%
Leaning trunk	5	2.8%
Co-dominant tree	4	2.3%
Included Bark	3	1.7%
Topped	2	1.1%

Most Common Species by Condition - Top 10



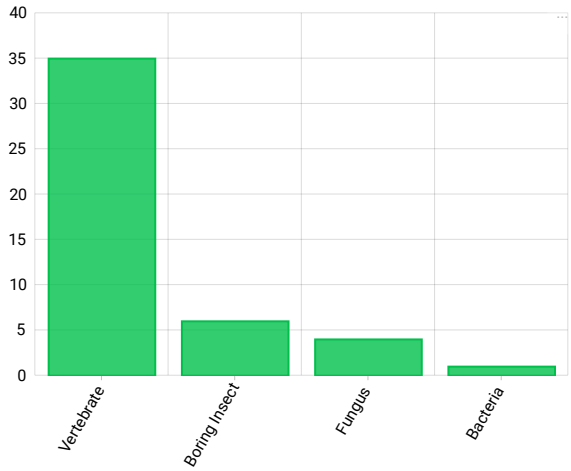
Trees by Condition



Trees by Condition

CONDITION	COUNT	PERCENTAGE
Good	118	75.6%
Fair	31	19.9%
Poor	4	2.6%
Dead	2	1.3%
Excellent	1	0.6%

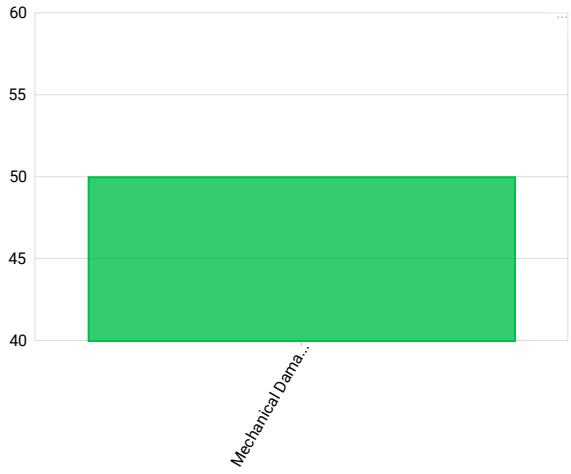
Observations - Biotic - Top 10



Observations - Biotic - Top 10

OBSERVATIONS-BIOTIC PEST	COUNT	PERCENTAGE
Vertebrate	35	76.1%
Boring Insect	6	13.0%
Fungus	4	8.7%
Bacteria	1	2.2%

Observations - Abiotic - Top 10

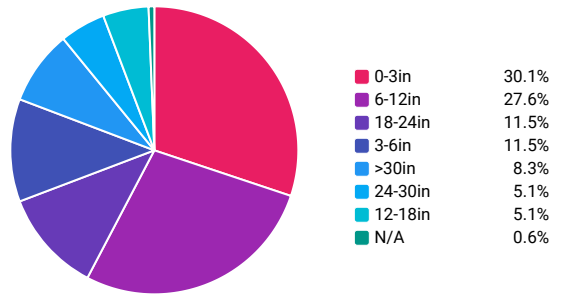


Observations - Abiotic - Top 10

OBSERVATIONS-ABIOTIC	COUNT	PERCENTAGE
Mechanical Damage	50	100.0%

Tree Size and Composition Charts

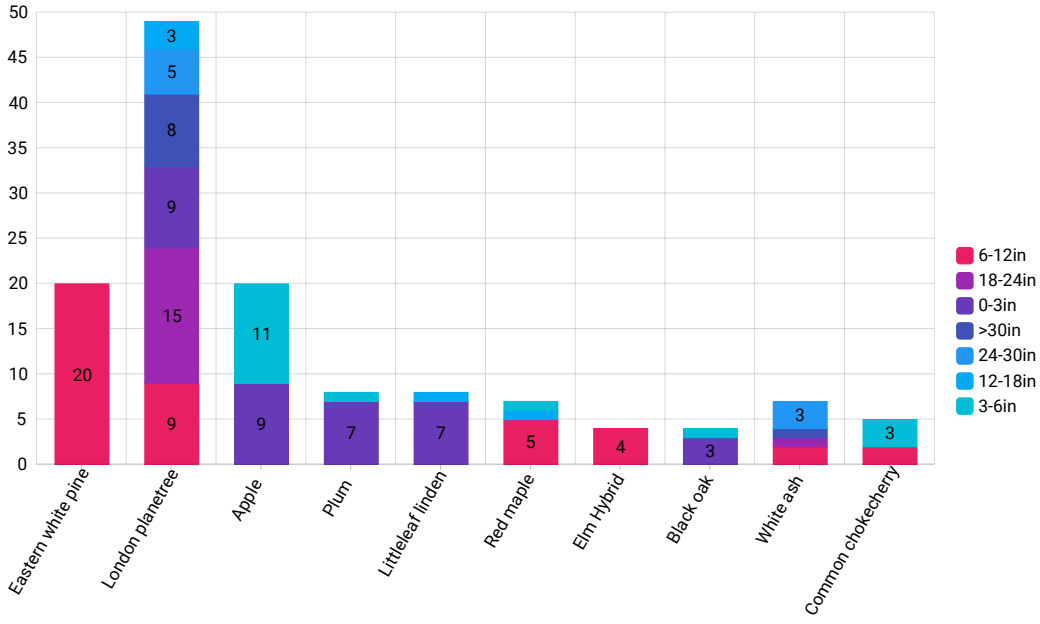
Trees by DBH



Trees by DBH

DBH RANGE	COUNT	PERCENTAGE
0-3in	47	30.1%
6-12in	43	27.6%
18-24in	18	11.5%
3-6in	18	11.5%
>30in	13	8.3%
24-30in	8	5.1%
12-18in	8	5.1%
N/A	1	0.6%

Most Common Species by DBH Range - Top 10



Seaside Park

Tree Protection and Preservation

INTRODUCTION

The Seaside tree canopy is made up of large, inherently historic specimens to small newly planted trees. The recognition, protection and preservation of these trees is an often unrealized though significant process resulting in a positive experience.

Planned construction projects are potentially disruptive to the health of trees while the proper planning and protection of trees can greatly minimize most negative impacts to the tree canopy. Construction damage to trees is largely avoidable. Underground root damage is often unseen. Crushed, torn, shredded and scarred roots are very susceptible to root decay that leads to irreversible tree damage that can go unnoticed for years and lead to significant demise or death of the tree. Compacted soils resulting from pedestrian, vehicular or equipment travel over root systems can restrict or prevent vital gas exchange between the roots and the atmosphere.

The purpose of these specifications is for the protection and stress reduction of existing trees and plants, to bring awareness and action to the role of preserving the trees and the significant value they bring to Seaside Park.

Part 1 – GENERAL

56.1.1 SUMMARY

A. The scope of work includes all labor, materials, tools, equipment, facilities, transportation and services necessary for, and incidental to performing all operations in connection with protection of existing trees and other plants as shown on the drawings or certified arborist tree preservation plan and as specified herein.

1. Provide preconstruction evaluations by Connecticut licensed arborist or ISA certified arborist if not already provided by owner.
2. Identify and establish area to be denoted as "Tree Protection Zone" (TPZ)
3. Provide temporary tree protection.
4. Confirm identity of any trees to be removed with Owner's Representative and spray with orange paint an "X". Removal by Arborist (RBA)
5. Support vehicles and equipment are not permitted within Tree Protection Zone without permission and /or required tree protection preparation.
6. Provide tree and plant protection fencing and associated signage.
7. Provide protection of Critical Root Zones (CRZ) and above ground tree and plants.
8. Provide required hand excavation and/or air spade work within Tree Protection Zone.
9. Provide any Crown Pruning and clearance pruning of existing trees and plants by Connecticut licensed arborist.
10. Provide any supportive tree cabling by Connecticut licensed arborist.
11. Coordinate with the requirements of Section Planting Soil (if included in scope of documents) for modifications to the soil within the root zone of existing trees and plants.
12. Provide all required insect and disease control by Connecticut licensed arborist with approval and coordination with Owner's Representative.
13. Provide maintenance of existing trees and plants during the construction period as recommended by the arborist report in coordination with Owner's Representative.
14. Provide any maintenance and monitoring of existing trees and plants including irrigation during the post construction plant maintenance period.
15. Remove tree protection fencing and other protection from around and under trees and plants.
16. Clean up and proper disposal of all excess and surplus material.

56.1.2 CONTRACT DOCUMENTS

A. Shall consist of specifications and general conditions and the drawings. The intent of these documents is to include all labor, materials, and services necessary for the

proper execution of the work. The documents are to be considered as one. Whatever is called for by any parts shall be as binding as if called for in all parts.

B. It is the intent of this section that the requirements apply to all sections of the project specification such that any subcontractor must comply with the restrictions on work within designated Tree Protection Zone.

56.1.3 RELATED DOCUMENTS AND REFERENCES

A. Related Documents

1. Drawings and general provisions of contract including general and supplementary conditions and Division I specifications apply to work of this section.
2. Section - Planting Soil
3. Section - Irrigation
4. Section - Planting
5. Section - Lawn

B. References: The following specifications and standards of the organizations and documents listed in this paragraph form a part of the specification to the extent required by the references thereto. In the event that the requirements of the following referenced standards and specification conflict with this specification section the requirements of this specification shall prevail. In the event that the requirements of any of the following referenced standards and specifications conflict with each other the more stringent requirement shall prevail.

1. ANSI A 300 (Part 5) – 2019 (or most current)– Standard Practices for Tree, Shrub and other Woody Plant Maintenance, most current editions.
2. Pruning practices shall conform with recommendations "Structural Pruning: A Guide For The Green Industry"; Published by Urban Tree Foundation, Visalia, California; most current edition.
3. Glossary of Arboricultural Terms, International Society of Arboriculture, Champaign Il, most current edition.
4. The requirements of Connecticut licensed arborists by the state of Connecticut most current regulations.

56.1.4 VERIFICATION

A. All scaled dimensions on the drawings are approximate. Before proceeding with any work, the Contractor shall carefully check and verify all dimensions and quantities, and shall immediately inform the Owner's Representative of any discrepancies between the information on the drawings and the actual conditions, refraining from doing any work in said areas until given approval to do so by the Owner's Representative.

56.1.5 PERMITS AND REGULATIONS

A. The Contractor shall obtain and pay for all City of Bridgeport permits/State of Connecticut permits related to this section of the work unless previously excluded under provision of the contract or general conditions. The Contractor shall comply with all laws and ordinances bearing on the operation or conduct of the work as drawn and specified. If the Contractor observes that a conflict exists between permit requirements and the work outlined in the contract documents, the Contractor shall promptly notify the Owners Representative in writing including a description of any necessary changes and changes to the contract price resulting from changes in the work.

B. Wherever references are made to standards or codes in accordance with which work is to be performed or tested, the edition or revision of the standards and codes current on the effective date of this contract shall apply, unless otherwise expressly set forth.

C. In case of conflict among any referenced standards or codes or between any referenced standards and codes and the specifications, the more restrictive standard shall apply or Owner's Representative shall determine which shall govern.

56.1.6 PROTECTION OF WORK, PROPERTY AND PERSON

A. The Contractor shall protect the work, adjacent property, and the public, and shall be responsible for any damages or injury due to their actions. Industry standard safety and protection zones and methods shall be followed at all times by all contractors and subcontractors.

56.1.7 CHANGES IN THE WORK

A. The Owner's Representative may order changes in the work, and the contract sum should be adjusted accordingly. All such orders and adjustments plus claims by the Contractor for extra compensation must be made and approved in writing before executing the work involved.

B. The Contractor shall re-execute any work that fails to conform to the requirements of the contract and shall remedy defects due to faulty materials or workmanship upon written notice from the Owner's Representative, at the soonest possible time that can be coordinated with other work and seasonal weather demands.

56.1.8 DEFINITIONS

All terms in this specification shall be as defined in the "Glossary of Arboricultural Terms" or as modified below.

A. Owner's Representative: The person appointed by the Owner to represent their interest in the review and approval of the work and to serve as the contracting authority with the Contractor. The Owner's Representative may appoint other persons to review and approve any aspects of the work.

B. Reasonable and reasonably: When used in this specification it is intended to mean that the conditions cited will not affect the establishment or long-term stability, health or growth of the plant. This specification recognizes that plants are not free of defects, and that plant conditions change with time. This specification also recognizes that some decisions cannot be totally based on measured findings and that profession judgment is required. In cases of differing opinion, the Owner's Representative expert shall determine when conditions within the plant are judged as reasonable.

C. Shrub: Woody plants with mature height approximately less than 25 feet.

D. Tree: Single and multi-stemmed plants, with anticipated mature height approximately greater than 25 feet *or* any plant identified on the plans as a tree.

E. Tree Protection Zone (TPZ): Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction, and defined by a circle centered on the trunk with each tree with a *minimum* radius equal to 1' (one foot) for every 1" (one inch) of tree diameter (at 4.5' height), or preferred at 1.5' for every 1" unless indicated otherwise by the Owner's Representative.

F. Air Excavation Tool: Handheld tool designed to focus highly compressed air (90-125 psi) provided from a large air compressor (185-375 cfm) at speeds close to 1400 mph at the tip of the tool. Widely used by arboricultural firms and consultants for multiple purposes including but not limited to: root collar investigation, CRZ investigation, root pruning (especially large roots > 1.5" diameter or were existing underground cables or conduits are located, radial mulching and restoration of compacted soils, excavation for utilities within protected CRZs to minimize root damage from construction.

G. Tree Removal by Arborist: Action whereby the Connecticut licensed Arborist removes trees designated for "Removal by Arborist" selected from inside the TPZs. Trees shall be taken down by hand sectionally, or directionally felled to minimize damage to adjacent tree canopies, root systems, or adjacent structures.

H. Crown Pruning: Action by the Connecticut licensed arborist of pruning specific tree limbs to improve tree health, reduce hazard, and / or provide construction clearance.

I. Supportive Cabling: Installation by Connecticut licensed Arborist of supportive supplemental cabling for designated tree branches due to weak branch attachments.

J. Root Pruning: Action indicated on Drawings to provide a more suitable cut for protected tree roots to minimize ripped or torn roots during excavations and grading with standard construction equipment. Various methods may be used.

K. Mulching of Trees: Application of a wood mulch product to areas surrounding designated trees. Mulch increases moisture-holding capacity, helps mitigate soil compaction, and increases needed soil organic composition.

L. Soil Amendments: Various product components applied to existing soil environment of protected trees, as indicated on Plan Notes.

M. Tree Growth Regulator (*Paclobutrazol)*: Products applied to designated trees used to regulate plant growth in such a way as to restrict canopy growth and free stored or produced energy for other uses in the tree. For highly impacted trees, more energy may be available for fibrous root growth (to combat root loss), thicker darker leaves (allowing for increased photosynthesis, and increased drought tolerance), and pest tolerance (often an issue with construction stressed trees); among other potential benefits.

N. Limits of Disturbance (LOD) (also called Limits of Construction): Specific outer limits of all construction activities for the entire project.

O. DBH (Diameter at Breast Height): Tree trunk diameter measured at 4.5 feet above grade.

56.1.9 SUBMITTALS

A. ARBORIST REPORT: Prior to the start of construction, submit, for approval by the Owner's Representative, the report of a consulting arborist who is a registered Consulting Arborist® (RCA) with American Society of Consulting Arborists or an ISA Board Certified Master Arborist, which details the following information for all trees to remain within the area designated on the drawings as the Tree Protection Zone unless one has already been provided by the Owner. The report shall include the following:

1. A description of each tree to remain indicating:

    a. Genus and species
    b. Condition including any visible damage to the root zone
    c. Tree diameter at breast height (4.5 dbh) above grade.
    d. Tree height
    e. Crown width
    f. Any visible disease and/or insect infestations
    g. branch and/or trunk structural deficiencies.

2. The report shall note all trees or parts of trees, which are considered a hazard or significant or extreme risk level. Include the International Society of Arboriculture hazard evaluation sheet for each tree, which may reasonably be identified as a potential hazard tree.
3. Recommendations as to treatment of all insect, disease and structural problems encountered
4. A plan of the site showing the location of all trees included in the report.
5. Provide documenting photos.

B. PRODUCT DATA: Submit manufacturer product data and support literature describing all products required by this section to the Owner's Representative for approval. Provide submittal four weeks before the start of any work at the site.

C. QUALIFICATIONS SUBMITTAL: For each applicable person expected to work on the project, provide copies of the qualifications and experience of the Consulting arborist, proof of either the registered Consulting Arborist® (RCA) with American Society of Consulting Arborists or an ISA Board Certified Master Arborist and any required Herbicide/Pesticide license (Connecticut Arborist license) to the Owner's Representative, for review prior to the start of work.

56.1.10 OBSERVATION OF THE WORK

A. The Owner's Representative may inspect the work at any time.

56.1.11 PRE-CONSTRUCTION CONFERENCE

A. Schedule a pre - construction meeting with the Owner's Representative at least seven (7) days before beginning work to review any questions the Contractor may have regarding the work, administrative procedures during construction and project work schedule.

A. The following Contractors shall attend the preconstruction conference:

1. General Contractor.
2. Landscape Architect.
3. Consulting Arborist.
4. Subcontractor assigned to install Tree and Plant Protection measures.
5. Sitework Contractor.
6. All site utility Contractors that may be required to dig or trench into the soil.
7. Landscape subcontractor.
8. Irrigation subcontractor.

B. Prior to this meeting, mark all trees and plants to remain and or be removed as described in this specification for review and approval by the Owner's Representative.

56.1.12 QUALITY ASSURANCE

A. Contractor qualifications:

1. All pruning, branch tie back, tree removal, root pruning, and fertilizing required by this section shall be performed by or under the direct supervision of Connecticut licensed arborist. Submit aforementioned individual's qualifications for approval by the Owner's Representative.
2. All applications of pesticide or herbicide shall be performed by a person maintaining a current Connecticut state arborist license to apply chemical pesticides valid in the jurisdiction of the project. Submit copies of all current required state license certificates.

PART 2 – PRODUCTS

56.2.1 MULCH

A. Mulch shall be coarse, ground, from tree and woody brush sources. The minimum range of fine particles shall be 3/8 inch or less in size and a maximum size of individual pieces shall be approximately 1 to 1-1/2 inch in diameter and maximum length of approximately 4 to 8 inches. No more that 25% of the total volume shall be fine particles and no more than 20% of total volume be large pieces.

1. It is understood that Mulch quality will vary significantly from supplier to supplier and region to region. The above requirements may be modified to conform to the source material from locally reliable suppliers as approved by the Owner's Representative.

B. Submit supplier's product data that product meets the requirements and on gallon sample for approval.

56.2.2 WOOD CHIPS:

A. Wood Chips from an arborist chipping operation with less than 20% by volume green leaves. Chips stockpiled from the tree removal process may be used.

56.2.3 TREE PROTECTION FENCING:

A. CHAIN LINK FENCE: 6 feet tall metal chain link fence set on 2" galvanized posts secured minimum 1.5' in ground or on metal frame panels on movable core drilled concrete blocks of sufficient size to hold the fence erect in areas of existing paving to remain. Fence to have signage declaring Tree Protection Zone.

B. GATES: For each fence type and in each separate fenced area, provide a minimum of one 3-foot-wide gate. Gates shall be lockable. The location of the gates shall be approved by the Owner's Representative.

C. Submit supplier's product data that product meets the requirements for approval.

D. Prohibited Activities in Tree Protection Zone:

E. Permitted Activities: Permitted/Required within TPZ

a. Mulching. During construction, spread wood chips within the TPZ 4" to 6" deep, leaving the trunk itself clear and without contact with mulch. Mulching helps prevent inadvertent compaction and moisture loss from occurring. 2- inch unpainted, untreated wood chips or equivalent is recommended for mulch material.

b. Root Buffer. When areas under the tree canopy cannot be fenced, create a temporary buffer to cover the root zone (such as wood chips and plywood) that remain in place until final grading.

c. Trunk Protection. During construction activities in tight spaces, it will be necessary to protect the trunk and buttress roots without the advantage of a standard Tree Protection Zone. Protective planking on the trunk as well as sandbags at the base of the tree would be required. Contractor to coordinate with the Owner's Representative.

d. Irrigation, soil aeration with an air spade, fertilizing or other beneficial practices.

A. Tree Protection Zone (TPZ) is a restricted activity zone where no soil disturbance is permitted unless coordinated with Owner's Representative. Site work planned near the critical root zone (CRZ) of a single tree or groups of trees to be preserved, requires a TPZ, TPZ fencing should be in place before undertaking any activities that might involve trenching or other disturbance to the tree's roots, such as:

1. Access roads
2. Staging, storage, and temporary parking areas
3. Paving or other impervious surfaces
4. Temporary utility lines
5. Installation of pipe drainage, irrigation or other services.

6. Stormwater management devices
7. Grading that requires cut and fill
8. Storage or parking of vehicles, building materials, refuse, excavated spoils or dumping of poisonous materials on or around trees and roots such as paint, petroleum products, concrete or stucco mix, dirty water
9. The use of tree trunks as a winch support, anchorage, as a temporary power pole, sign posts or other similar function.
10. Cutting of tree roots by utility trenching, foundation digging, placement of curbs and trenches and other miscellaneous excavation or erosion control. If a tree is adjacent to or near a steep slope or other critical area, approved erosion control or silt barriers may be necessary to prevent siltation and/or erosion within the TPZ. **Do not install silt fence within the Tree Protection Zone**. Far too often contractors trench through a tree's root zone to meet requirements for silt fence installation, causing more harm than good. Protective mulch (above) and permeable erosion control blankets can substantially reduce runoff within the TPZ.
11. Soil disturbance or grade change and drainage changes.

Site visit by a Tree Professional (Owners Representative) is needed if —advance planning fails and a trench must pass through the TPZ. Depending on specific site conditions, tree species, health, and position of any potential targets, trenching may be approved. If not, it could require risk mitigation and payment of a bond by the contractor. Alternative remedies can include tunneling (lateral boring) or re-routing utilities, and relocating or re-engineering walls to avoid roots of important trees. Walls and pipes can be moved, but a damaged tree cannot be repaired or readily replaced.

56.2.4 TREE PROTECTION SIGN

A. Heavy-duty laminated cardboard signs, 8.5 inches x 11 inches, white colored background with black 2 inch high or larger letters block letters. The signs shall be attached to the tree protection fence every 50 feet on center. The tree protection sign shall read:

"Tree Protection Zone - Keep Out
Species_____, DBH ____,
Environmental Contribution $___"

56.2.5 TREE GROWTH REGULATOR (TGR)

1. Active ingredient Paclobutrazol, product used to limit canopy growth in order to free up energy resources for the tree
2. Submit supplier's product data that meets the requirements for approval.

56.2.6 MATTING

1. Matting for vehicle and work protection shall be heavy duty matting designed for vehicle loading over tree roots, Alturnamats as manufactured by Alturnamats, Inc. Franklin, PA 16323 or approved equal.
2. Submit supplier's product data that product meets the requirements for approval.

56.2.7 GEOGRID (Geo textile)

A. Geogrid shall be woven polyester fabric with PVC coating, Uni-axial or biaxial geogrid, inert to biological degradation, resistant to naturally occurring chemicals, alkalis, acids.

1. Geogrid shall be Miragrid 2XT as manufactured by Ten Cate Nicholson, Norcross, GA. http://www.tencate.com or approved equal

2. Submit suppliers product data that product meets the requirements for approval.

56.2.8 FILTER FABRIC

A. Filter Fabric shall be nonwoven polypropylene fibers, inert to biological degradation and resistant of naturally occurring chemicals, alkalis and acids.

1. Mirafi 135 N as manufactured by Ten Cate Nicolon, Norcross, GA. http://www.tencate.com or approved equal.
Submit suppliers product data that product meets the requirements for approval.

PART 3 – EXECUTION

56.3.1 SITE EXAMINATION

A. Examine the site, tree, plant and soil conditions. Notify the Owner's Representative in writing of any conditions that may impact the successful Tree Protection that is the intent of this section.

56.3.2 COORDINATION WITH PROJECT WORK

A. The Contractor shall coordinate with all other work that may impact the completion of the work.

B. Prior to the start of Work, prepare a detailed schedule of the work for coordination with other trades.

C. Coordinate the relocation of any irrigation lines currently present on the irrigation plan, heads or the conduits of other utility lines or structures that are in conflict with tree locations. Root balls shall not be altered to fit around lines. Notify the Owner's Representative of any conflicts encountered.

56.3.3 TREE PROTECTION ZONE

A. The Tree Protection Zone is defined as all areas indicated on the tree protection plan. Where no limit of the Tree Protection Zone is defined on the drawings, the limit shall be the drip line (outer edge of the branch crown) of each tree or minimum 1' radius from trunk for every 1" DBH whichever is greater and subject to approval by the Owner's Representative.

3.4 PREPARATION:

1. Prior to the preconstruction meeting, layout the limits of the Tree Protection Zone and then alignments of required Tree Protection Fencing and any root pruning. Obtain the Owner's Representative's approval of the limits of the protection area and the alignment of all fencing and root pruning.
2. Flag all trees and shrubs to be removed by wrapping orange plastic ribbon around the trunk and obtain the Owner's Representative's approval of all trees and shrubs to be removed prior to the start of tree and shrub removal. After approval, mark all trees and shrubs to be removed with orange paint in a band completely around the base of the tree or shrub 4.5 feet above the ground.
3. Flag all trees and shrubs to remain with white plastic ribbon tied completely around the trunk or each tree and on a prominent branch for each shrub. Obtain the Owner's Representative's approval of all trees and shrubs to be remain prior to the start of tree and shrub removal.
4. Prior to any construction activity at the site including utility work, grading, storage of materials, or installation of temporary construction facilities, install all tree protection fencing, filter Fabric, silt fence, tree protection signs, Geogrid, mulch and or wood chips as shown on the drawings.

3.5 SOIL MOISTURE

A. Volumetric soil moisture level, in all soils within the Tree Protection Zone shall be maintained above permanent wilt point to a depth of at least 8 inches. No soil work or other activity shall be permitted within the Tree Protection Zone when the volumetric soil moisture is above field capacity. The permanent wilt point and field capacity for each type of soil texture shall be defined as follows (numbers indicate percentage volumetric soil moisture).

1. Volumetric soil moisture shall be measured with a digital, electric conductivity meter. The meter shall be the Digital Soil Moisture Meter, DSMM500 by General Specialty Tools and Instruments, or approved equivalent meter.

B. The Contractor shall confirm the soil moisture levels with a moisture meter. If the moisture is too high, suspend operations until the soil moisture drains to below field capacity.

Soil type	**Permanent wilt point v/v**	**Field capacity v/v**
Sand, Loamy sand, Sandy loam	5-8%	12-18%
Loam, Sandy clay, Sandy clay loam	14-25%	27-36%
Clay loam, Silt loam	11-22%	31-36%
Silty clay, Silty clay loam	22-27%	38-41%

3.6 ROOT PRUNING:

A. Prior to any excavating into the existing soil grade within 25 feet of the limit of the Tree Protection Zone or trees to remain, root prune all existing trees to a depth of 24 inches below existing grade in alignments following the edges of the Tree Protection And/ or as directed by the

Owner's Representative. Root pruning shall be in conformance with ANSI A300 (part 8) latest edition.

1. Using a rock saw, chain trencher or similar trenching device, make a vertical cut within 2 feet of the limit of grading.
2. After completion of the cut, make clean cuts with a lopper, saw or pruner to remove all torn root ends on the tree side of the excavation, and backfill the trench immediately with existing soil, filling all voids.

3.7 INSTALLATION OF GEOGRIDS, FILTER FABRIC, MATTING, WOOD CHIPS AND OR MULCH.

A. Install Geogrids, Filter Fabric, matting, Wood Chips and or Mulch in areas and depths shown on the plans and details or as directed by the Owner's representative. In general, it is the intent of this specification to provide the following levels of protection:

1. All areas within the Tree and Plant Protection area provide a minimum of 8 inches of Wood Chips or Mulch.
2. Areas where foot traffic or storage of lightweight materials (upon approval by Owner's Representative) is anticipated to be unavoidable provide a layer of Filter Fabric under the 8 inches of Wood Chips or Mulch.
3. Areas where occasional light vehicle traffic is anticipated to be unavoidable provide a layer of Geogrids under 8 inches of Wood Chips or Mulch.
4. Areas where heavy vehicle traffic is unavoidable provide a layer of Geogrids under 8 - 12 inches of Wood Chips or Mulch and a layer of matting over the Wood Chips or Mulch such as AlturnaMat, ¾" plywood or ¼" steel plating.

B. The Owner's Representative shall approve the appropriate level of protection.

C. In the above requirements, light vehicle is defined as a track skid steer with a ground pressure of 4 psi or lighter. A heavy vehicle is any vehicle with a tire or track pressure of greater than 4 psi. Lightweight materials are any packaged materials that can be physically moved by hand into the location. Bulk materials such as soil, or aggregate shall never be stored within the Tree and Plant Protection Area.

3.8 PROTECTION:

A. Protect the Tree and Plant Protection Area at all times from compaction of the soil; damage of any kind to trunks, bark, branches, leaves and roots of all plants; and contamination of the soil, bark or leaves with construction materials, debris, silt, fuels, oils, and any chemicals substance. Notify the Owner's Representative of any spills, compaction or damage and take corrective action immediately using methods approved by the Owner's Representative.

3.9 GENERAL REQUIREMENTS AND LIMITATIONS FOR OPERATIONS WITHIN THE TREE AND PLANT PROTECTION AREA:

A. The Contractor shall not engage in any construction activity within the Tree Protection Zone without the approval of the Owner's Representative including: operating, moving or storing equipment; storing supplies or materials; locating temporary facilities including trailers or portable toilets and shall not permit employees to traverse the area to access adjacent areas of the project or use the area for lunch or any other work breaks. Permitted activity, if any, within the Tree and Plant Protection Area maybe indicated on the drawings along with any required remedial activity as listed below.

B. In the event that construction activity is unavoidable within the Tree Protection Zone, notify the Owner's Representative and submit a detailed written plan of action for approval. The plan shall include: a statement detailing the reason for the activity including why other areas are not suited; a description of the proposed activity; the time period for the activity, and a list of remedial actions that will reduce the impact on the Tree Protection Zone from the activity. Remedial actions shall include but shall not be limited to the following:

1. In general, demolition and excavation within the drip line of trees and shrubs shall proceed with extreme care either by the use of hand tools, directional boring and or Air Knife excavation where indicated or with other low impact equipment that will not cause damage to the tree, roots or soil.
2. When encountered, exposed roots, 1 inch and larger in diameter shall be worked around in a manner that does not break the outer layer of the root surface (bark). These roots shall be covered in Wood Chips and shall be maintained above permanent wilt point at all times. Roots one inch and larger in diameter shall not be cut without the approval of the Owner's Representative. Excavation shall be tunneled under these roots without cutting them. In the areas where roots are encountered, work shall be performed and scheduled to close excavations as quickly as possible over exposed roots.

C. Tree branches that interfere with the construction may be tied back or pruned to clear only to the point necessary to complete the work. Other branches shall only be removed when specifically indicated by the Owner's Representative. Tying back or trimming of all branches and the cutting of roots shall be in accordance with accepted arboricultural practices (ANSI A300, part 8) and be performed under supervision of the Connecticut state licensed arborist.

D. Matting: Install temporary matting over the Wood Chips or Mulch to the extent indicated. Do not permit foot traffic, scaffolding or the storage of materials within the Tree Protection Zone to occur off of the temporary matting.

E. Trunk Protection: Protect the trunk of each tree to remain by covering it with a ring of 6 foot long 2-inch x 4 - inch planks loosely banded onto the tree with 3 steel bands. Wire (12 gauge galvanized or other approved method) the planks as necessary to hold them securely in place. Trunk protection must be kept in place no longer than 12 months. If

construction requires work near a particular tree to continue longer than 12 months, the wire shall be inspected every six months and loosened if it is found to have become tight.

F. Air Excavation Tool: If excavation for footings or utilities is required within the Tree and Plant Protection Area, air excavation tool techniques shall be used where practical or as designed on the drawings.

1. Remove the Wood Chips from an area approximately 18 inches beyond the limits of the hole or trench to be excavated. Cover the Wood Chips for a distance of not less than 15 feet around the limit of the excavation area with Filter Fabric or plastic sheeting to protect the Wood Chips from silt. Mound the Wood Chips so that the plastic slopes towards the excavation.
2. Using a sprinkler or soaker hose, apply water slowly to the area of the excavation for a period of at least 4 hours, approximately 12 hours prior to the work so that the ground water level is at or near field capacity at the beginning of the work. For excavations that go beyond the damp soil, rewet the soil as necessary to keep soil moisture near field capacity.
3. Using an air excavation tool specifically designed and manufactured for the intended purpose, and at pressures recommended by the manufacturer of the equipment, fracture the existing soil to the shape and the depths required. Work at rates and using techniques that do not harm tree roots. Air pressure shall be a maximum of 90-100 psi.
   1.) The air excavation tool shall be "Air-Spade" as manufactured by Concept Engineering Group, Inc., Verona, PA (412) 826-8800, or Air Knife as manufactured by Easy Use Air Tools, Inc. Allison Park, Pa (866) 328-5723 or approved equal.
4. Using a commercial, high-powered vacuum truck if required, remove the soil from the excavation produced by the Air Knife excavation. The vacuum truck should generally operate simultaneously with the hose operator, such that the soil produced is picked up from the excavation hole, and the exposed roots can be observed and not damaged by the ongoing operation. Do not drive the vacuum truck into the Tree Protection Zone unless the area is protected from compaction as approved in advance by the Owner's Representative.
5. Remove all excavated soil and excavated Wood Chips, and contaminated soil at the end of the excavation.
6. Schedule the work so that foundations or utility work is completed immediately after the excavation. Do not let the roots dry out. Mist the roots several times during the day. If the excavated area must remain open overnight, mist the roots and cover the excavation with black plastic.
7. Dispose of all soil in a manner that meets local laws and regulations.
8. Restore soil within the trench as soon as the work is completed. Utilize soil of similar texture to the removed soil and lightly compact with hand tools. Leave soil mounded over the trench to a height of approximately 10% of the trench depth to account for settlement.
9. Restore any Geogrids, Filter Fabric, Wood Chips or Mulch and or matting that was previously required for the area.

3.10 TREE REMOVAL

A. Remove all trees indicated by the drawings and specifications, as requiring removal, in a manner that will not damage adjacent trees or structures or compact the soil.

B. Remove trees that are adjacent to trees or structures to remain, in sections, to limit the opportunity of damage to adjacent crowns, trunks, ground plane elements and structures.

C. Do not drop trees with a single cut unless the tree will fall in an area not included in the Tree Protection Zone. No tree to be removed within 50 feet of the Tree Protection Zone shall be pushed over or up-rooted using a piece of grading equipment or otherwise.

D. Protect adjacent paving, soil, trees, shrubs, ground cover plantings and understory plants to remain from damage during all tree removal operations, and from construction operations. Protection shall include the root system, trunk, limbs, and crown from breakage or scarring, and the soil from compaction.

E. Remove stumps and immediate root plate from existing trees to be removed. Grind trunk bases and large buttress roots to a depth of the largest buttress root or at least 18 inches below the top most roots whichever is less and over the area of three times the diameter of the trunk (DBH) unless directed otherwise by the Owners Representative.

1. For trees where the stump will fall under new paved areas, grind roots to a total depth of 18 inches below the existing grade. If the sides of the stump hole still have greater than approximately 20% wood visible, continue grinding operation deeper and or wider until the resulting hole has less than 20% wood. Remove all wood chips produced by the grinding operation and back fill in 8-inch lift layers with controlled fill of a quality acceptable to the site engineer for fill material under structures, compacted to 95% of the maximum dry density standard proctor. The Owner's Representative shall approve each hole at the end of the grinding operation.
2. In areas where the tree location is to be a planting bed or lawn, remove all woodchips and backfill stump holes with planting soil as defined in Specification Section Planting Soil, in maximum of 12-inch layers and compact to 80 - 85% of the maximum dry density standard proctor.

3.11 PRUNING

A. Within six months of the estimated date of substantial completion, have Connecticut licensed arborist prune all dead or hazardous branches larger than 2 inch in diameter from all trees to remain.

B. Implement all pruning recommendations found in the arborist report.

C. Prune any low, hanging branches and vines from existing trees and shrubs that overhang walks, streets and drives, or parking areas as follows:

1. Walks - within 8 feet vertically of the proposed walk elevation.
2. Parking areas - within 12 feet vertically of the proposed parking surface elevation.
3. Streets and drives - within 14 feet vertically of the proposed driving surface elevation.

D. All pruning shall be done by a Connecticut licensed arborist in accordance with ANSI A300 (part 1), ISA BMP Tree Pruning (latest edition, and the "Structural Pruning: A Guide for the Green Industry", Edward Gilman, Brian Kempf, Nelda Matheny and Jim Clark, 2013 Urban Tree Foundation, Visalia, CA.

E. Perform other pruning task as indicated on the drawings or requested by the Owner's Representative.

F. Where tree specific disease vectors require, sterilize all pruning tools between the work in individual trees.

3.12 TREE GROWTH REGULATOR INJECTION (TGR)

A. Unless otherwise directed by the Owners Representative, at the start of the construction contract period, treat all trees, indicated on the Plan, with Tree Growth Regulator at recommended rates, time of year and methods indicated by the product distributor. Applicator to be a Connecticut licensed arborist or under the supervision of one.

3.13 WATERING

A. The Contractor shall be fully responsible to ensure that adequate water is provided to all plants to be preserved during the entire construction period. Adequate water is defined to be maintaining soil moisture above the permanent wilt point to a depth of 8 inches or greater.

B. The Contractor shall adjust the automatic irrigation system, if available, and apply additional water, using hoses or water tanks as required.

C. Periodically test the moisture content in the soil within the root zone to determine the water content.

3.14 WEED REMOVAL

A. During the construction period, control any plants that seed in and around the fenced Tree and Plant Protection area at least three times a year. Coordinate any weed eradication with the owner’s representative.

1. All plants that are not shown on the planting plan or on the Tree and Plant Protection Plan to remain shall be considered as weeds.

B. At the end of the construction period provide one final weeding of the Tree and Plant Protection Area.

3.15 INSECT AND DISEASE CONTROL

A. Monitor all plants to remain for disease and insect infestations during the entire construction period. Provide all disease and insect control required to keep the plants in a healthy state using the principles of Integrated Plant Management (IPM). All pesticides shall be applied by a Connecticut licensed pesticide applicator after approval of Owners Representative

3.16 CLEAN-UP

A. During tree and plant protection work, keep the site free of trash, pavements reasonably clean and work area in an orderly condition at the end of each day. Remove trash and debris in containers from the site no less than once a week.

1. Immediately clean up any spilled or tracked soil, fuel, oil, trash or debris deposited by the Contractor from all surfaces within the project or on public right of ways and neighboring property.
2. Once tree protection work is complete, wash all soil from pavements and other structures. Ensure that Mulch is confined to planting beds.
3. Make all repairs to grades, ruts, and damage to the work or other work at the site.
4. Remove and dispose of all excess Mulch, Wood Chips, packaging, and other material brought to the site by the Contractor.

3.17 REMOVAL OF FENCING AND OTHER TREE AND PLANT PROTECTION

A. At the end of the construction period or when requested by the Owner's Representative remove all fencing, Wood Chips or Mulch, Geogrids and Filter Fabric, trunk protection and or any other Tree and Plant Protection material.

3.18 DAMAGE OR LOSS TO EXISTING PLANTS TO REMAIN

A. Any trees or plants designated to remain and which are damaged by the Contractor shall be replaced in kind by the Contractor at their own expense. Trees shall be replaced with an approved tree of similar species and of equal size or 6-inch caliper -whichever is less. If applicable, shrubs shall be replaced with a plant of similar species and equal size or the

largest size plants reasonably available - whichever is less. Where replacement plants are to be less than the size of the plant that is damaged, the Owner's Representative shall approve the size and quality of the replacement plant.

B. High value heritage (veteran, priority, specimen) trees will be identified by the Owners Representative and will have an individually assessed above and beyond above replacement process. This would be in the form of a bonding requirement over a period of five years at which time an assessment would be made of the condition of the heritage tree by the Owners Representative.

1. All trees and plants shall be installed per the requirements of Specification Section Planting.

C. Plants that are damaged shall be considered as requiring replacement or appraisal in the event that the damage affects more than 25 % of the crown, 25% of the trunk circumference, or root protection area, or the tree is damaged in such a manner that the tree could develop into a potential hazard. Trees and shrubs to be replaced shall be removed by the Contractor at his own expense.

1. The Owner's Representative may engage an independent arborist to assess any tree or plant that appears to have been damaged to determine their health or condition.

D. Any tree that is determined to be dead, damaged or potentially hazardous by the Owner's arborist and upon the request of the Owner's Representative shall be immediately removed by the Contractor at no additional expense to the owner. Tree removal shall include all clean-up of all wood parts and grinding of the stump to a depth sufficient to plant the replacement tree or plant, removal of all chips from the stump site and filling the resulting hole with topsoil.

1. Any remedial work on damaged existing plants recommended by the consulting arborist shall be completed by the Contractor at no cost to the owner. Remedial work shall include but is not limited to: soil compaction remediation and vertical mulching, pruning and or cabling, insect and disease control including injections, compensatory watering, additional mulching, and could include application tree growth regulators (TGR) upon request by the Owners Representative.
2. Remedial work may extend up to two years following the completion of construction to allow for any requirements of multiple applications or the need to undertake applications at required seasons of the year.

END OF SECTION 01-5640

TREE PROTECTION GRAPHICS

Tree protection barrier encloses the Tree Protection Zone and is at least 4' tall, highly visible, sturdy, permanent and has warning signs on or near it for the duration of any construction activities.

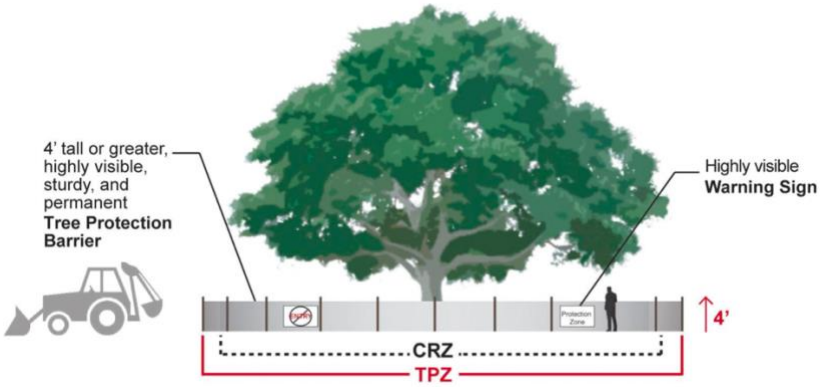


Figure 1 Tree Protection Barrier, International Society of Arboriculture

Critical Root Zone (CRZ) is the area of soil extending from the tree trunk where roots required for future tree health and survival are located. This area can also be defined as a circle with a *minimum radius* of 1' for every 1" in trunk diameter at 4.5" above ground.

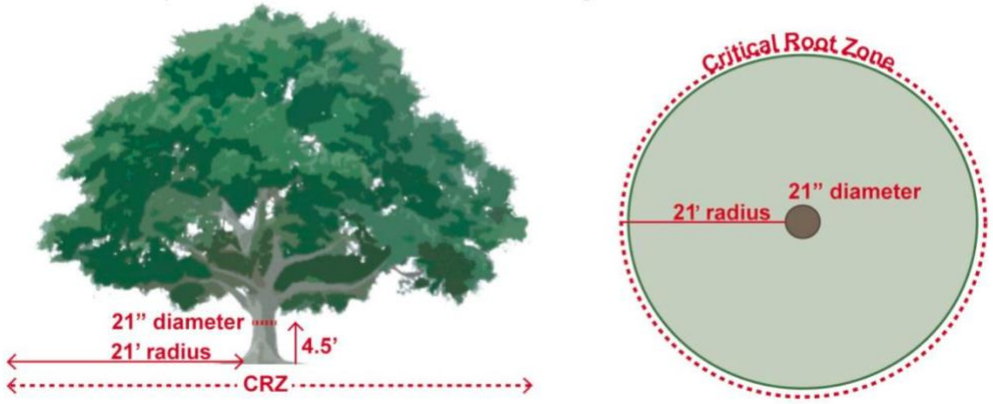


Figure 2 Critical Root Zone (CRZ), International Society of Arboriculture

Tree Protection Zone (TPZ) is an area where construction activities are prohibited or restricted to prevent injury to preserved trees, especially during pre- construction and construction, and includes the Critical Root Zone and/or beyond.

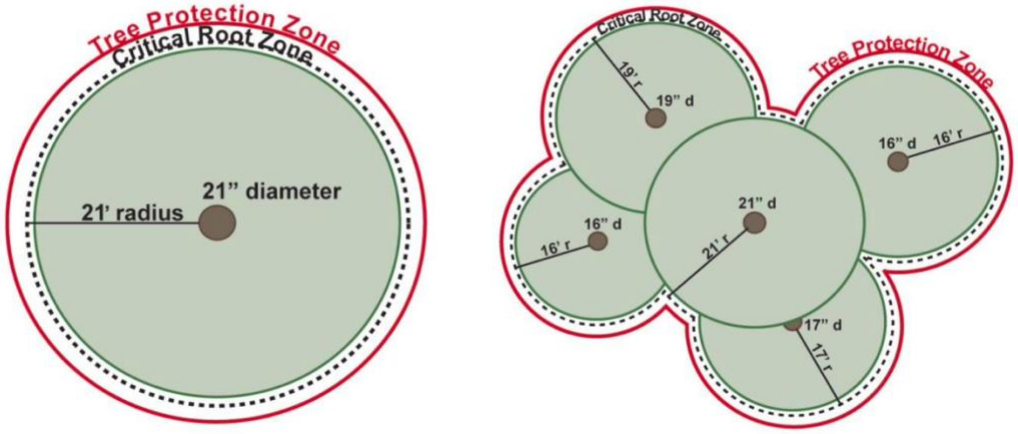


Figure 3 Tree Protection Zone (TPZ), International Society of Arboriculture

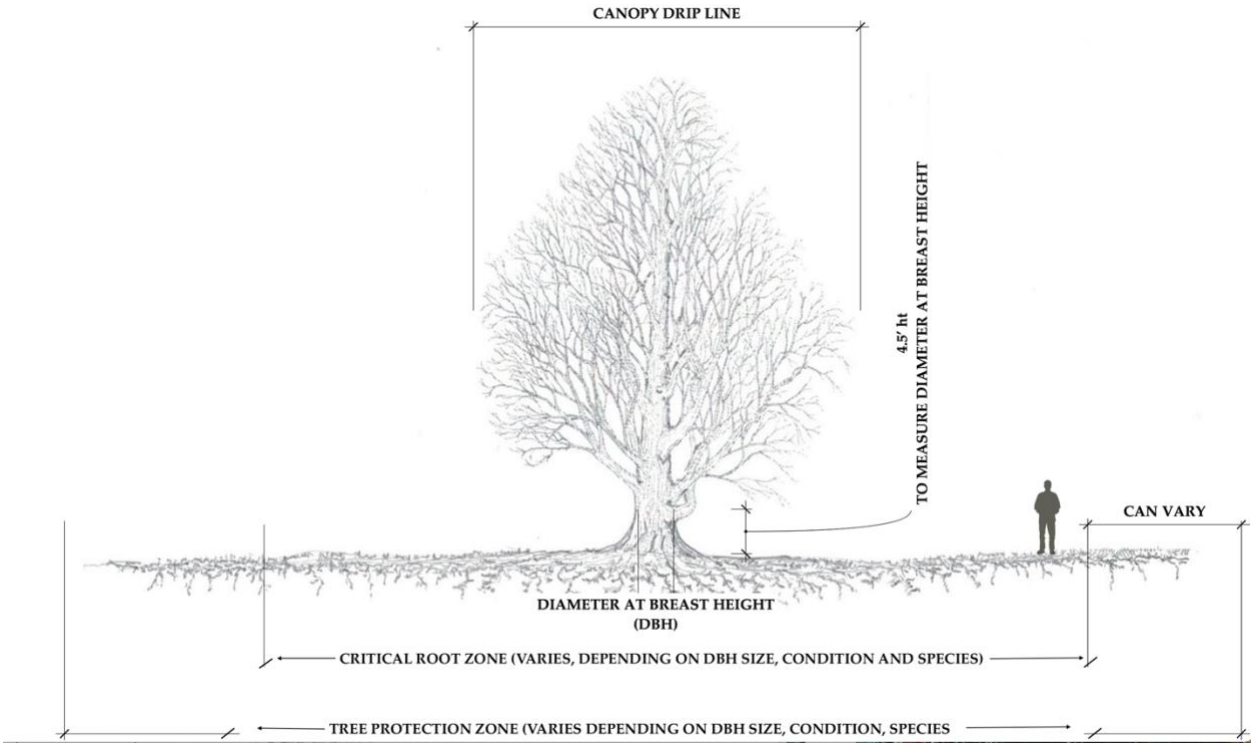


Figure 4 TPZ and CRZ, Width Varies Depending on Condition, Species and DBH (Not to Scale)

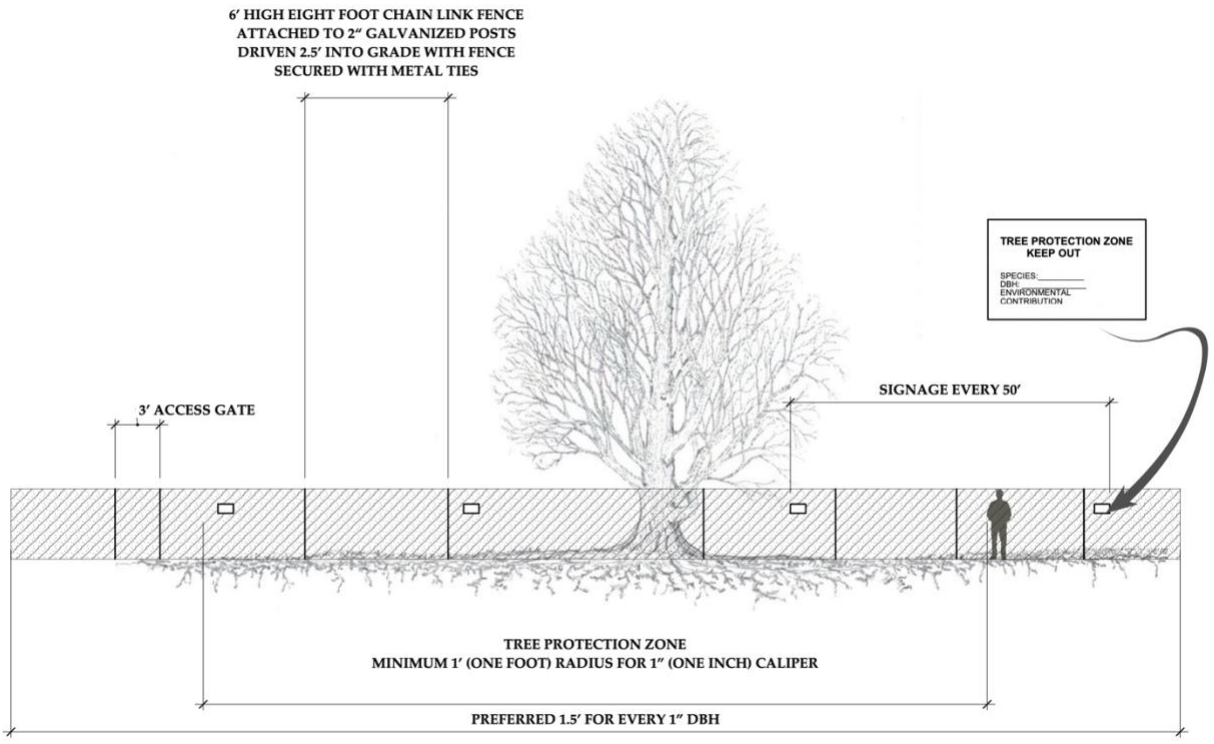


Figure 5 Protective Fencing at TPZ, (Not to Scale)

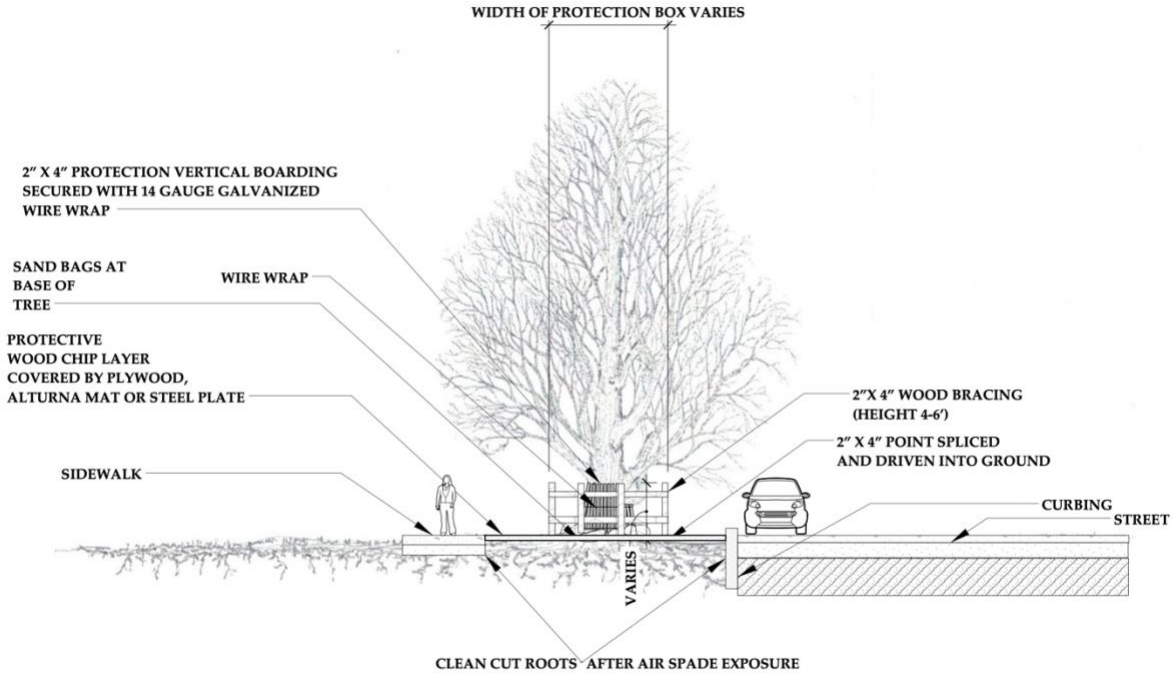


Figure 6 Trees, Sidewalks and Streets - TPZ Varies (Not to Scale)

APPENDIX 7. RECOMMENDED PLANTINGS

Common Name	Scientific Name	Zone	Height (Ft)	Width (Ft)	Native	Utility Line Compatible	Notably Urban	Candidate for Assisted Migration	Page #
White Fir	*Abies concolor*	4A	30-50	15-30	✓				17
Trident Maple	*Acer buergerianum*	5B	20-30	15-25		✓	✓		18
Hedge Maple	*Acer campestre*	5A	25-35	25-35			✓		19
Paperbark Maple	*Acer griseum*	5A	20-30	20-30		✓			20
Miyabe Maple	*Acer miyabei*	4B	30-45	30-40					21
Red Maple	*Acer rubrum*	3B	40-60	30-70	✓		✓		22
Sugar Maple	*Acer saccharum*	3B	60-75	35-50	✓				23
Purpleblow Maple	*Acer truncatum*	4B	25-30	25-30		✓	✓		24
Freeman Maple	*Acer* x *freemanii*	4A	40-75	Varies	✓				25
Red Horsechestnut	*Aesculus* x *carnea*	5A	30-50	30					26
Serviceberry	*Amelanchier* spp.	4A	15-25	15-30	✓	✓			27
River Birch	*Betula nigra*	4A	40-70	40-60	✓				28
Common Hornbeam	*Carpinus betulus*	5A	35-60	30-40					29

American Hornbeam	*Carpinus caroliniana*	3A	20-30	20-30	✓	✓			30
Northern Catalpa	*Catalpa speciosa*	4A	40-60	20-40	✓		✓		31
Sugar Hackberry	*Celtis laevigata*	5A	60-80	50	✓		✓	✓	32
Common Hackberry	*Celtis occidentalis*	3A	40-60	40-60	✓		✓	✓	33
Katsura Tree	*Cercidiphyllum japonicum*	4A	40-60	25-60					34
Eastern Redbud	*Cercis canadensis*	4A	20-30	25-35	✓	✓	✓	✓	35
Atlantic White Cedar	*Chamaecyparis thyoides*	4B	40-60	10-20	✓				36
White Fringetree	*Chionanthus virginicus*	5A	15-25	10-25	✓	✓	✓		37
Yellowwood	*Cladrastis kentukea*	4A	30-50	40-55	✓				38
Japanese Clethra	*Clethra barbinervis*	5B	10-20	10-20		✓			39
Kousa Dogwood	*Cornus kousa*	5A	15-30	15-30		✓			40
Corneliancherry Dogwood	*Cornus mas*	5A	15-25	15-20		✓			41
Dogwood Hybrids	*Cornus* x *rutgersensis*	5A	10-20	10-20		✓		✓	42

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Common Name	Scientific Name	Zone	Height (Ft)	Width (Ft)	Native	Utility Line Compatible	Notably Urban	Candidate for Assisted Migration	Page #
Turkish Filbert	*Corylus colurna*	4A	40-50	15-35			✓		43
American Smoketree	*Cotinus obovatus*	4A	20-30	15-30	✓	✓	✓		44
Thornless Cockspur	*Crataegus crusgalli* var. *inermis*	4A	20-30	20-35	✓	✓	✓		45
'Winter King' Hawthorn	*Crataegus virdis* 'Winter King'	4A	25	25	✓	✓	✓		46
Hardy Rubber Tree	*Eucommia ulmoides*	5A	40-60	40-60			✓		47
Gingko	*Gingko biloba*	4B	50-80	30-40			✓		48
Thornless Honeylocust	*Gleditsia triacanthos* var. *inermis*	4B	40-60	30-70	✓		✓		49
Kentucky Coffeetree	*Gymnocladus dioicus*	3A	50-75	40-50	✓		✓		50
Carolina Silverbell	*Halesia carolina*	5A	20-40	20-35	✓				51
Witchhazel	*Hamamelis virginiana*	4A	10-30	15-20	✓	✓			52
Eastern Red Cedar	*Juniperus virginiana*	3B	40-50	8-20	✓		✓	✓	53
Goldenraintree	*Koelreuteria paniculata*	5A	30-40	30-40			✓		54
American Sweetgum	*Liquidambar styraciflua*	5B	50-75	40-65	✓			✓	55

Tuliptree	*Liriodendron tulipifera*	5A	70-90	35-50	✓			✓	56
Amur Maackia	*Maackia amurensis*	4A	20-30	20-30		✓	✓		57
Thornless Osage Orange	*Maclura pomifera* var. *inermis*	5B	20-50	20-50	✓		✓	✓	58
Flowering Crabapple	*Malus* spp.	4B	10-25	10-25		✓			59
Dawn Redwood	*Metasequoia glyptostroboides*	5A	70-100	25-50					60
Black Gum	*Nyssa sylvatica*	4A	30-60	20-40	✓				61
American Hophornbeam	*Ostrya virginiana*	4A	25-40	20-40	✓				62
Persian Parrotia	*Parrotia persica*	5A	20-30	15-30		✓	✓		63
Serbian Spruce	*Picea omorika*	4B	50-60	20-25					64
Swiss Stone Pine	*Pinus cembra*	4A	30-40	15-25					65
London Planetree	*Platanus* x *acerifolia*	5A	70-100	65-80			✓		66
Accolade Cherry	*Prunus* 'Accolade'	5A	20-30	15-25		✓			67
Common Hoptree	*Ptelea trifoliata*	4A	15-20	15-20	✓	✓			68

Common Name	Scientific Name	Zone	Height (Ft)	Width (Ft)	Native	Utility Line Compatible	Notably Urban	Candidate for Assisted Migration	Page #
White Oak	*Quercus alba*	4A	45-80	45-80	✓			✓	69
Swamp White Oak	*Quercus bicolor*	4A	45-70	45-60	✓		✓		70
Scarlet Oak	*Quercus coccinea*	5A	60-75	40-50	✓			✓	71
Shingle Oak	*Quercus imbricaria*	4A	40-60	40-65	✓			✓	72
Bur Oak	*Quercus macrocarpa*	3A	60-80	60-90	✓		✓	✓	73
Chestnut Oak	*Quercus montana*	5A	60-70	60-70	✓			✓	74
Chinkapin Oak	*Quercus muehlenbergii*	4B	35-50	35-60	✓			✓	75
Pin Oak	*Quercus palustris*	4A	50-70	25-40	✓				76
Willow Oak	*Quercus phellos*	6A	40-60	40-60	✓		✓	✓	77
English Oak	*Quercus robur*	5A	40-60	40-60			✓		78
Northern Red Oak	*Quercus rubra*	4A	60-75	60-75	✓		✓		79
Shumard Oak	*Quercus shumardii*	5B	40-60	45-65	✓		✓		80
Common Sassafras	*Sassafras albidum*	4B	30-60	25-40	✓				81
Japanese Umbrella Pine	*Sciadopitys verticillata*	5B	20-30	15-20		✓			82

Japanese Pagodatree	*Styphnolobium japonicum*	5A	50-70	35-55			✓		83
Japanese Tree Lilac	*Syringa reticulata*	3A	20-30	15-25		✓	✓		84
Bald cypress	*Taxodium distichum*	5A	50-70	20-40	✓		✓	✓	85
Arbor vitae	*Thuja occidentalis*	3A	40-60	10-15	✓		✓		86
American Linden	*Tilia americana*	3A	60-80	20-40	✓				87
Littleleaf Linden	*Tilia cordata*	3B	50-70	30-50					88
Silver Linden	*Tilia tomentosa*	5A	50-70	25-55			✓		89
American Elm Cultivars	*Ulmus americana*	3B-5A	60-80	30-60	✓		✓		90
Lacebark Elm	*Ulmus parvifolia*	5B	40-75	30-75			✓		91
Elms Hybrids	*Ulmus* x spp.	3B-5A	50-70	40-60			✓		92
Siebold Viburnum	*Viburnum sieboldii*	4B	15-20	10-15		✓			93
Japanese Zelkova	*Zelkova serrata*	5A	50-80	40-60			✓		94

1.1 Tree species

A comprehensive, broad-based literature review was undertaken to decide which tree species would be included in Planting for Resilience: Selecting Urban Trees in Massachusetts. This began by determining which trees were recommended in other selection guides produced by university

extension programs, state agencies, and the industry (i.e., nurseries). Once an initial list relevant to growing conditions in the Northeast was composed, characteristics and attributes of each tree (i.e., preferred environmental conditions, site adaptability, optimal growing conditions) were assessed. This information was gathered from not only the aforementioned selection guides, but tree identification books, encyclopedias, and online resources generated from various stakeholders (see pages 104-106).

Individual tree species were carefully scrutinized and eliminated based on invasive potential (i.e., *Robinia pseudoacacia*), pest susceptibility (i.e., *Fraxinus* spp.*, Sorbus* spp.), management considerations (i.e., *Pyrus calleryana*) and overall compatibility to adverse urban environments (i.e., *Acer saccharinum, Pinus strobus*).Tree species' sensitivity and adaptability to common stress factors found in the urban environment (i.e., alkaline soil, drought, heat, salt, pollution, poorly drained soils, mechanical damage), were specifically considered; from there, current and future habitat suitability was analyzed in an attempt to ensure that remaining tree species would be well-adapted to future climate projections of the Northeast (see Methods 1.5).

1.2 Criteria

Tree species data is often anecdotal, based on observations of industry professionals, agency/university specialists and tree enthusiasts from the public. Discrepancies concerning tree attributes and characteristics often occurred between reference materials. Thus, consistency and agreement among sources was an important consideration relevant to determining the information that was deemed acceptable to include. Generally, information presented in this guide has been verified by at least two other references. Though no single claim or piece of information was casually dispensed with, a hierarchy of trust was established where isolated claims and observations in sole sources were not included to conservatively consider discrepancies. For example, the "highest" or most conservative hardiness zone rating found in the literature for each species was listed on their profile, if it could be verified by two or more sources. This was done so that a tree would not be planted in a zone that would be too cold, beyond what it could tolerate. A range was presented regarding each tree species' height and width, that generally included the smallest and largest values found in the literature.

1.3 Limitations

Urban forestry is a relatively new field of study, and unlike traditional forestry where trees have been studied and observed for many centuries, there is a dearth of data concerning the growth and response of trees in our expanding towns and cities. Climatic projections themselves also vary. Being such long-lived organisms, trees may not perform as predicted relative to their response to shifting habitat suitability, over extended periods of time.

1.4 Urban tree suitability

"Urban" tree species must be able to tolerate a host of difficult conditions including soils that often feature extreme pH, prolonged periods of dryness, salt, pollution, and poor drainage. Although not all species here are well-suited for tough, urban sites, we highlight species (using an icon in the top corner of its profile page) that are notably adaptable to these adverse conditions. Some references (Dirr, University of Connecticut, Cornell University) presented a list of species that were recommended to plant in tough, urban sites, which were considered.

APPROACH

1.5 Trees and assisted migration

This table displays our interpretation of data obtained from the US Forest Service10,20. This data set was specific to Massachusetts, and was divided into 1° latitude x 1° longitude sectors, which essentially coincide with what is considered western, central, and eastern Massachusetts. Species marked with * were not included in this data set. but were found in the US Forest Service's Climate Change Tree Atlas. Highlighted species are projected to gain habitat suitability, therefore were chosen as 'Candidates for assisted migration'.

Model reliability

1= most reliable, 3= least reliable.

Current abundance

Tree species abundance varies across the state, due to numerous factors. To determine each species', mean state-wide current abundance, we averaged the data from the three sectors of Massachusetts by assigning a value to each abundance class [0: absent; 1: rare; 2: common; 3: abundant].

Changes in habitat suitability

Possible change in habitat suitability by 2100 according to the ratios of future (2070-2099) suitable habitat for an average of 3 climate models to current (1981-2010) modeled habitat at RCP4.5 (low emissions) and RCP8.5 (high emissions) scenarios. This does not necessarily mean the species' *abundance* will change in the area by 2100, only that the habitat is expected to change in suitability for that species over time. Further, it is important to note that this data is not specific to urban

environments, meaning these projections may differ in the urban forest. To determine each species' mean state- wide change in habitat suitability, we averaged data from the three sectors of Massachusetts by assigning a value to each change class [-3: extirpated; -2: large decrease; -1: small decrease; 0: no change, unknown; +1: small increase; +2: large increase; +3: new habitat].

Adaptability

This score is based on a literature review of 12 disturbance (i.e., disease, drought, pollution) and 9 biological characteristics (i.e., shade tolerance, seedling establishment, environmental habitat specificity) for each species. It aims to account for factors that may affect how a species will respond to climate change that the models do not
take into consideration. Scores have been classified as High (5.2-9.0), Medium (3.4-5.1), and Low (0.1-3.3). However, these scores may differ based on specific location-based factors. (McElhinney, 2019)