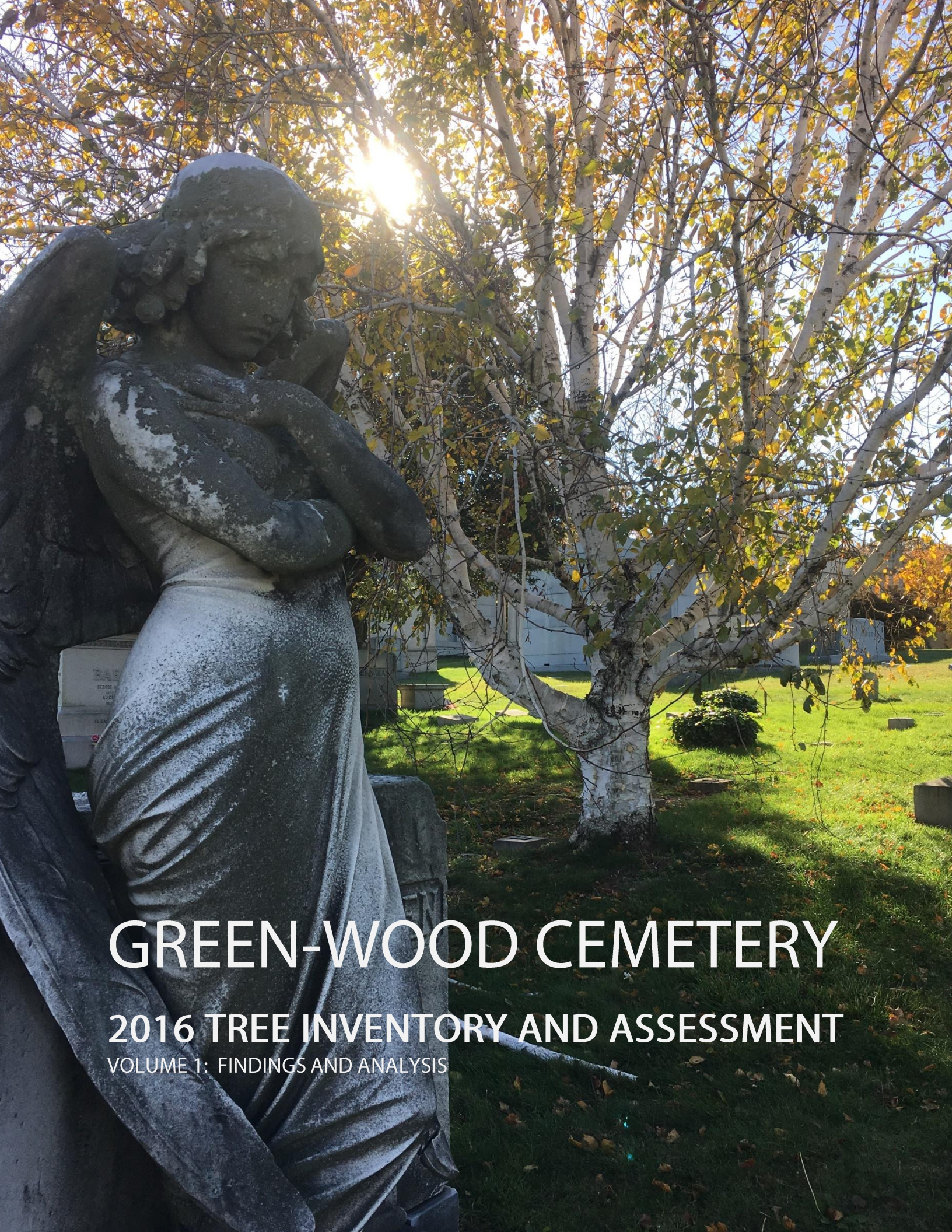

GREEN-WOOD CEMETERY

2016 TREE INVENTORY AND ASSESSMENT

VOLUME 1: FINDINGS AND ANALYSIS

GREEN-WOOD CEMETERY

2016 TREE INVENTORY AND ASSESSMENT

All Maps Prepared by Paul Cowie and Associates, Inc.

Map data sources:

False- and true-color aerial imagery courtesy of the USDA National Agricultural Imagery Program (NAIP) (2015).

2005 tree locations and island boundaries courtesy of Green-Wood Cemetery.

2016 woodlot boundaries and most new trees locations generated by Paul Cowie and Associates in-the-field via digitization utilizing NAIP imagery; remaining new trees locations courtesy of Green-Wood Cemetery.

Roads data courtesy of the US Census Bureau TIGER/Line program, 2014.

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INTRODUCTION

PROJECT OVERVIEW

As part of the Rhodeside & Harwell team preparing a Cultural Landscape Report for the Green-Wood Cemetery in Brooklyn, New York, Paul Cowie and Associates (PC+A) conducted an inventory and assessment of the Cemetery's existing shade and ornamental trees.

This inventory and assessment followed and served to update a similar inventory by PC+A, which was completed as part of a Master Plan Study by Quennell Rothschild and Partners in 2005.

The 2016 Tree Inventory and Assessment included:

1. Field verification and reconciliation of 9,880 trees and tree stumps including:
    a. The individual inventory and evaluation of 7,135 existing shade and ornamental trees.
    b. The tagging and mapping of 2,235 trees that were added to the collection since 2005, including 1800 new and replacement plantings, 435 trees not inventoried in 2005 due to their being volunteers below the established size threshold for inclusion in woodlot areas, changes in size or form that resulted in their being defined as trees versus shrubs, etc.
    c. Field verification and reconciliation of the current status of 1,765 trees that were included in the 2005 Inventory Assessment and subsequently lost to Hurricane Sandy and other significant storms, or removed for other reasons.
    d. The individual inventory of 670 new stumps remaining from trees removed since 2005, and field reconciliation of the current status of the 729 preexisting stumps that were inventoried in 2005.
2. General characterization of dense stands of trees in Semi-maintained "woodlots" and semi-maintained landscape areas.
3. General characterization of site conditions relevant to the growth and management of the tree resource.
4. Analysis of changes in the tree population from 2005 to 2016 and identification of significant trends.
5. Development of current maintenance and management recommendations on individual tree and forest level bases.

The following sections summarize the findings of this study and provide general recommendations for improving, managing, and perpetuating this valuable resource.

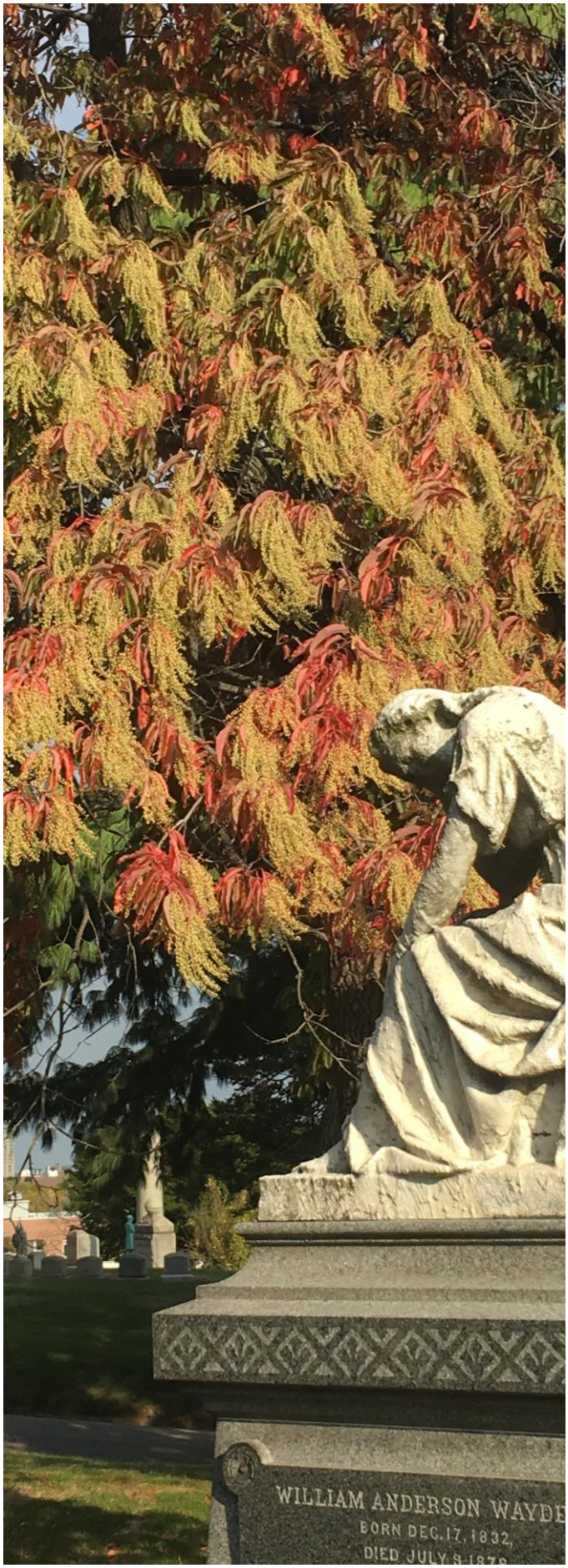
PROJECT GOALS AND OBJECTIVES

The overall goal of this Tree Inventory and Assessment is to provide the Green-Wood Cemetery with thorough and accurate baseline data regarding the existing tree resources for the purpose of:

1. Making technically sound short- and long-term design and management decisions.
2. Facilitating the implementation of a comprehensive shade tree management plan.
3. Ensuring the perpetuation and aesthetic enhancement of a safe and beneficial tree resource over the long term.

The primary objectives of this Tree Inventory and Assessment were to:

1. Provide a complete and accurate accounting of the trees currently occupying Green-Wood Cemetery.
2. Compile a complete and accurate set of data regarding the trees and their characteristics that can be linked to Green-Wood's GIS-based tree mappings, thereby creating a comprehensive, efficient, and updatable information system that can be used to guide long-term management planning and schedule, track, and improve the overall cost-efficiency of proactive day-to-day maintenance.
3. Evaluate the impacts of Hurricane Sandy and other recent storms and provide a factual basis for resiliency plans.
4. Satisfy the requirements of Green-Wood Cemetery's current accreditation as an arboretum through ArbNet (www.arbnet.org) and support its goals for advanced accreditation.
5. Provide information regarding the tree collection that may be of special interest to donors and the public in general.
6. Provide an assessment of the current condition of the existing trees, which may be used in developing tree preservation plans in conjunction with the design and renovation of areas of the Cemetery.
7. Identify and prioritize current tree maintenance needs based on the need to improve and maintain safety, improve tree condition and longevity, and improve aesthetics in a manner that is consistent with the Cemetery's goals.
8. Develop and provide general recommendations and management guidelines for maintaining, protecting, and perpetuating the tree resource over the long term in a manner that maximizes their benefits to the cemetery, its visitors, and the surrounding community.
9. Provide the information necessary for developing future tree maintenance and re-planting needs at a level and in a manner that is appropriate for each area and the Cemetery overall.



EXECUTIVE SUMMARY

OVERVIEW

1. As of December 2016, Green-Wood Cemetery's tree resource consisted of:
    a. 7,135 individually inventoried shade and ornamental trees. These trees are generally individual, free-standing native and exotic trees growing on large expanses of lawn.
    b. A few hundred additional uninventoried volunteer trees growing among inventoried trees in semi-maintained "woodlots" and steeply-sloped landscape areas. These trees are primarily volunteer saplings of native and exotic invasive species.
2. The stocking of trees in the Cemetery overall is good and appropriate for the 478-acre site and its design. Local density of trees varies widely from sparse to over-crowded due to several factors including intended landscape design, the localized impacts of Hurricane Sandy and other severe storms in recent years, and reduced maintenance in some areas.
3. Nearly all existing trees are in or near areas of high-use and/or high-value hardscape elements. As such, a high level of maintenance is required to ensure the safety of life and property.
4. Soils in most areas are sufficiently well-drained, aerated, and fertile to support the growth of a wide range of native and introduced species. Many species have performed extremely well and apparently lived significantly longer than similar trees elsewhere in the New York City region.
5. The rolling, hill-and-valley topography found throughout much of Green-Wood Cemetery creates a wide range of microclimates that have a profound effect on the performance and longevity of different species in different areas.
6. A significant number of trees are in conflict with, and in numerous cases have caused damage to, roads, walking paths, headstones, monuments, and mausolea.

SPECIES COMPOSITION

1. Green-Wood Cemetery's tree population is comprised of 260 different species and hybrids representing 43 different taxonomic families and 89 different genera.

2. As a genus, *Acer* (maple) comprises a disproportionately large segment of the tree population at 15%, though the quantity is dramatically reduced from 21.3% in 2005. Other prominent genera include *Quercus* (oak) at 9.3%, *Prunus* (cherry and other stone fruit species) at 7.4%, *Taxus* (yew) at 5.8%, *Tilia* (linden) at 5.5%, and *Cornus* (dogwood) at 4.9%.
3. As a species, *Acer platanoides* (Norway maple) comprises a disproportionately large segment of the tree population at 10.2% versus 16.3% in 2005. The next most common species include *Quercus palustris* (pin oak) at 4.2%, *Prunus serotina* (black cherry) at 4.0%, *Cornus florida* (flowering dogwood) at 3.3%, *Thuja occidentalis* (American arborvitae) at 3.2%, *Quercus rubra* (northern red oak) at 2.7%, and *Tilia cordata* (littleleaf linden) at 2.6%.
4. 230 different species each comprise less than 1% of the tree population. Many of these minor types are highly desirable and performing well in Green-Wood Cemetery.
5. 24% of Green-Wood Cemetery's trees are evergreen species and 76% are deciduous.
6. The quantity of exotic invasive species in the tree population has been reduced by nearly half since 2005 (12.9% versus 21.3%), with species other than *Acer platanoides* (Norway maple) largely eliminated from maintained lawn and landscape areas. Exotic invasives remain the predominant species in woodlot areas.

DIAMETER AND AGE DISTRIBUTION

1. Overall, Green-Wood Cemetery's tree population is irregular uneven-aged, containing substantial but somewhat uneven numbers of trees in all young, middle, and older age classes.
2. As a result of the generally uneven age structure, Green-Wood's tree collection should remain relatively stable and sustainable for many more years, but will be subject to periods of higher removal and replacement needs due to groups of trees reaching over-maturity at the same time.
3. An even-aged age structure exists within several species. This will result in marked changes in the species composition and character of certain areas as large numbers of trees of the same species approach the limit of their life expectancy together.
4. Currently, with regard to size:
    a. 2,083 (29.2%) trees are in the 0"-6" diameter class.
    b. 1,446 (20.3%) trees are in the 7"-12" diameter class.
    c. 905 (12.7%) trees are in the 13"-18" diameter class.
    d. 619 (8.7%) trees are in the 19"-24" diameter class.
    e. 740 (10.4%) trees are in the 25"-30" diameter class.
    f. 562 (7.9%) trees are in the 31"-36" diameter class.
    g. 366 (5.1%) trees are in the 37"-42" diameter class.
    h. 241 (3.4%) trees are in the 43"-48" diameter class.
    i. 173 (2.4%) trees are in the 49"+ diameter class.
5. Currently, with regard age classification:
    a. 26.9% are young, having expended 20% or less of the species typical service life expectancy.
    b. 57.3% are mature, having expended 20% - 80% of the species typical service life expectancy.
    c. 15.8% are over-mature, having expended over 80% of the species typical service life expectancy.
6. Since 2005, the age structure of the tree population has shifted toward the younger age classes as a result of large numbers of trees lost and replaced within a relatively short period of time.
7. Since 2005, new and replacement plantings have favored species classified as small and medium size at a significantly higher rate than historic plantings, resulting in a significant reduction in the number of potentially large trees and their contribution to canopy coverage.

TREE CONDITION

1. Green-Wood Cemetery's tree population is in fair condition overall, with more trees currently rated in Good or Fair versus Poor condition than in 2005. While substantial segments of the population are in good to very good condition, others are deteriorating due to advanced age, environmental stresses, insect and disease pressures, and/or certain maintenance practices.
2. 36.7% of the trees were rated in 'Good' condition, 45.3% in 'Fair' condition, 17.0% in 'Poor' condition, and 1.0% were dead at the time the inventory was completed.
3. Of major species, *Acer platanoides* (Norway maple), *Prunus serotina* (black cherry), *Cornus florida* (flowering dogwood), *Acer pseudoplatanus* (sycamore maple), *Morus alba* (white mulberry), *Ailanthus altissima* (Ailanthus or Tree-of-Heaven), and *Pinus nigra* (Austrian pine) were performing poorly in most areas of the Cemetery.
4. Of the major species, *Acer palmatum* (Japanese maple), *Ginkgo biloba* (Ginkgo), *Gleditsia triacanthos* (honeylocust), *Liquidambar styraciflua* (sweetgum), *Liriodendron tulipifera* (tulip), *Platanus x acerifolia* (London planetree), *Picea abies* (Norway spruce), *Pinus strobus* (White pine), *Quercus palustris* (pin oak), *Quercus rubra* (northern red oak), *Thuja occidentalis* (American arborvitae), and *Tilia cordata* (littleleaf linden), along with a number of minor species, were regularly found to be performing well in most areas of the Cemetery.
5. Green-Wood Cemetery's trees are at high or moderate risk to several major forest health issues including oak wilt *(Ceratocystis fagacearum)*, Southern pine beetle *(Dendroctonus frontalis)*, bacterial leaf scorch *(Xylella fastidiosa)*, canker stain of planetrees *(Ceratocystis fimbriate f. sp. platani)*, and bleeding canker *(Phytophthora spp.)*. The threat of emerald ash borer *(Agrilus planipennis)* and Asian longhorned beetle *(Anoplophora glabripennis)* is currently considered to be low.

MAINTENANCE NEEDS

1. 1,413 (19.8%) of the individually inventoried trees were identified a requiring high priority pruning, removal, or other treatments to mitigate potentially hazardous conditions.
2. 1,641 (23.0%) of the individually inventoried trees were identified as requiring medium priority pruning, removal, or other treatments to mitigate less potentially hazardous conditions.
3. 606 (9.2%) trees were recommended for removal:
    a. 202 (8.5%) on a high priority basis because they are dead or so structurally unsound that they represent imminent hazard risks.
    b. 211 (3.0%) on a medium priority basis because they are dead or structurally unsound to the extent that they represent moderate hazard risks.
    c. 79 (1.1%) on a low priority basis.
4. 2,541 (35.6%) trees are recommended for crown cleaning to remove dead, dying, diseased, and damaged branches:
    a. 1,030 (14.4%) on a high priority basis because they contain potentially hazardous dead, structurally unsound, or interfering limbs.
    b. 1,221 (17.1%) on a medium priority basis because they contain moderately hazardous dead, structurally unsound, or interfering limbs.
    c. 290 (4.1%) on a low priority basis.
5. 980 existing stumps from trees previously removed were inventoried and 956 are recommended for stump removal on a low priority basis.
6. Deep planting remains a significant, widespread issue for trees planted from 2005 through 2014 that may compromise their long-term performance. Root collar excavation was recommended for 787 (11.0%).

2016 TREE POPULATION SUMMARY
BY SPECIES AND STEM DIAMETER CLASS

SPECIES	0"-6"	7"-12"	13"-18"	19"-24"	25"-30"	31"-36"	37"-42"	43"-48"	49"+	TOTAL
A										
Abies spp.	3									3
Abies balsamea		1								1
Abies concolor				1		1				2
Abies nordmanniana	1	1	8	12	2					24
Acer spp.	1									1
Acer buergerianum	5									5
Acer campestre			1							1
Acer cappadocicum				1	1					2
Acer crataegifolium	1									1
Acer davidii ssp. Grosseri	1									1
Acer griseum	2									2
Acer palmatum	38	44	16	3	1	1				103
Acer platanoides	41	215	95	104	166	81	23	1	1	727
Acer pseudoplatanus	8	32	18	14	34	5			1	112
Acer pseudosieboldianum ssp. Takesimense	1									1
Acer rubrum	8	9	9	3	6	4	3	2	1	45
Acer rubrum var. trilobum	3									3
Acer saccharinum							1	3	2	6
Acer saccharum	15			1	4	14	14			48
Acer sempervirens	5									5
Acer triflorum	5									5
Aesculus spp.	4									4
Aesculus hippocastanum	2	2	2	26	48	34	12	4		130
Aesculus pavia	3	1								4
Aesculus x carnea				1	3					4
Ailanthus altissima	2	20	11	4	2					39
Albizia julibrissin	1									1
Amelanchier spp.	13									13
Amelanchier canadensis	12									12
Amelanchier x grandiflora	11									11
Asimina triloba	8									8
B										
Betula spp.	1									1
Betula lenta		1	1	6	4	1				13
Betula nigra	18	7	4							29
Betula papyrifera				2						2
Betula pendula		1	1	1						3
Betula szechuanica	5									5
Betula utilis var. jacquemontii	10	2	1							13
Buxus sempervirens	13	4								17
C										
Carpinus betulus	71	2								73

SPECIES	0"-6"	7"-12"	13"-18"	19"-24"	25"-30"	31"-36"	37"-42"	43"-48"	49"+	TOTAL
Carpinus caroliniana	6			1	2					9
Carpinus japonica	2									2
Carya cordiformis		1	2	5	10	6	1			25
Carya glabra				6	3	2				11
Carya laciniosa			1	2	2	1				6
Carya ovata		1	9	12	5					27
Carya tomentosa				4	2					6
Castanea dentata	4									4
Catalpa speciosa	6	5	1				1			13
Cedrus atlantica	6	1	3	1	8	7	7			33
Cedrus deodora	4									4
Cedrus libani							1			1
Celtis occidentalis	6	2	2		4		1		1	16
Celtis tenuifolia	3									3
Cephalotaxus sinensis	2									2
Cercidiphyllum japonicum	19	7							1	27
Cercis spp.	10									10
Cercis canadensis	79	8								87
Cercis canadensis var. alba	1									1
Cercis chinensis	9									9
Cercis reniformis	14									14
Chamaecyparis nootkatensis	7	2								9
Chamaecyparis obtusa	15	6	12	8	1					42
Chamaecyparis pisifera	11	15	41	53	36	23	2			181
Chamaecyparis thyoides			2							2
Chionanthus retusus	8									8
Chionanthus virginicus	4	1								5
Cladrastis kentukea	4	1	5	3			1	2		16
Cornus spp.	17	3								20
Cornus alternifolia	4									4
Cornus controversa		2								2
Cornus florida	62	107	68							237
Cornus florida sub. Urbiniana	1									1
Cornus kousa	38	20	16	2						76
Cornus officinalis	3									3
Cornus wilsoniana	6									6
Cornus x 'Rutdan'		1								1
Cornus x 'Rutgan'	2									2
Cornus x 'Rutlan'	1									1
Corylus colurna	14			2	6	1				23
Cotinus coggygria	2	4								6
Cotinus obovatus	3									3
Crataegus spp.	4									4
Crataegus laevigata	1	8	6	1						16
Crataegus phaenopyrum	1									1
Crataegus viburnifolia	1									1

SPECIES	0"-6"	7"-12"	13"-18"	19"-24"	25"-30"	31"-36"	37"-42"	43"-48"	49"+	TOTAL
Crataegus viridis	5									5
Cryptomeria japonica	21	11	18	4						54
D										
Diospyros virginiana	5		2	6						13
E										
Eucommia ulmoides		11								11
Euonymus alatus		1								1
Euptelea pleiosperma	3									3
F										
Fagus grandifolia	3						1			4
Fagus sylvatica	23	10	4	2	16	29	37	40	17	178
Franklinia alatamata	5		1							6
Fraxinus americana		5	1		3		2			11
Fraxinus baroniana	1									1
Fraxinus excelsior					1	1	1			3
Fraxinus holotricha							1			1
Fraxinus pennsylvanica	1			1	1	1	1			5
G										
Ginkgo biloba	3	6	6	12	12	11	11	5	4	70
Gleditsia triacanthos var. inermis	43	11	6	5	4	2				71
Gymnocladus dioicus	13	4	1	1	5	8	6			38
H										
Halesia carolina	4									4
Halesia diptera	1									1
Halesia diptera var. magniflora	2									2
Halesia tetraptera			1							1
Hibiscus syriacus	2									2
Hydrangea paniculata	23	12	2							37
I										
Ilex Nellie R. Stevens	1									1
Ilex opaca	4	5	5	2	1					17
Ilex spp.	8	4								12
Ilex x aquipernyi	2									2
J										
Juglans cinerea				1	1					2
Juglans nigra					2					2
Juglans regia					1					1
Juniperus spp.	12									12
Juniperus chinensis	8	9	7	1						25
Juniperus virginiana	2	7	7	8						24
K										
Koelreuteria paniculata	5	2		2						9
L										
Lagerstroemia spp.	12									12
Lagerstroemia indica	18									18
Larix decidua				1	1					2

SPECIES	0"-6"	7"-12"	13"-18"	19"-24"	25"-30"	31"-36"	37"-42"	43"-48"	49"+	TOTAL
Larix kaempferi				2	1	1				4
Liquidambar styraciflua	29	10	4	6	31	34	14	5		133
Liriodendron tulipifera	10	9	3	4	6	8	25	38	51	154
M										
Maackia amurensis	5	4								9
Magnolia spp.	15	1								16
Magnolia acuminata		2	1		2	1	7	4	1	18
Magnolia denudata			8	7	3					18
Magnolia grandiflora	9	4								13
Magnolia stellata	8	2	1							11
Magnolia virginiana	8	1								9
Magnolia x brooklynensis	3									3
Magnolia x soulangiana	16	16	33	6						71
Malus 'Cortland'		1								1
Malus 'Donald Wyman'	7									7
Malus 'Granny Smith'	1	1								2
Malus hupehensis	1									1
Malus 'Indian Magic'	2									2
Malus 'Robinson'	3									3
Malus 'Royal Raindrops'	3									3
Malus 'Snowcloud'			1							1
Malus spp.	48	28	25	8	2					111
Malus 'Strawberry Parfait'		2								2
Malus 'Yellow Delicious'	1		1							2
Metasequoia glyptostroboides	10	13	3	1	1			1		29
Morus alba	3	7	17	6	3	2	1	2		41
Morus australis			1							1
N										
Nyssa sylvatica	23	1		3	2		1			30
O										
Ostrya virginiana	5				1					6
Oxydendrum arboreum		3	2		1					6
P										
Parrotia persica	20	1								21
Parrotia subaequalis	3									3
Phellodendron amurense		5	1		1					7
Picea abies	4	7	15	26	26	5	2			85
Picea glauca	1	5	4	1	1					12
Picea omorika	5	4								9
Picea orientalis	13	1		3						17
Picea pungens	4	18	26	8						56
Pinus spp.	4									4
Pinus bungeana	1									1
Pinus cembra	1	2	6	2						11
Pinus flexilis		9	1	1	2	2				15
Pinus koriensis	2		2							4

SPECIES	0"-6"	7"-12"	13"-18"	19"-24"	25"-30"	31"-36"	37"-42"	43"-48"	49"+	TOTAL
Pinus mugo	2									2
Pinus nigra	2	1	11	11	2					27
Pinus parviflora	6									6
Pinus peuce		1								1
Pinus rigida	1									1
Pinus strobus	43	4	3	18	34	21	8	5		136
Pinus sylvestris		1	1		1					3
Pinus thunbergii	3	1	5	1						10
Pinus wallichiana	3	2	1	5	13	12	9			45
Platanus occidentalis							1			1
Platanus x acerifolia	5	2	4	3	2	14	34	34	17	115
Poliothrysis sinensis	4									4
Populus deltoides					1					1
Populus tremuloides	97									97
Prunus spp.		4								4
Prunus avium				1						1
Prunus cerasifera	4	7								11
Prunus incisa	1									1
Prunus padus	3									3
Prunus sargentii	6									6
Prunus serotina	20	148	70	25	12	3	2	2	2	284
Prunus serrulata	5	45	53	16	13	3	1	1		137
Prunus subhirtilla	4	32	2	1			1			40
Prunus virginiana	8									8
Prunus x Okame	3									3
Prunus x snozofam		1								1
Prunus x yedoensis	3	7	4	5	4	5	3		1	32
Pseudotsuga menziesii			4	8	4					16
Pyrus calleryana	6	6	1	3						16
Q										
Quercus spp.	3	3								6
Quercus acutissima	1	2	1							4
Quercus alba	7	4			2	7	5	4	1	30
Quercus bicolor	8	8								16
Quercus cerris								1		1
Quercus coccinea	3	4				2	2			11
Quercus imbricaria	6	9								15
Quercus macrocarpa	12	6	1							19
Quercus michauxii	2									2
Quercus nutalli	1	1								2
Quercus palustris	10	15	38	13	44	95	63	21	2	301
Quercus phellos	1	6	4					2	2	15
Quercus prinus							1			1
Quercus robur	6	9				1	1			17
Quercus rubra	27	17	8	11	5	11	24	44	48	195
Quercus shumardii	2	1								3

SPECIES	0"-6"	7"-12"	13"-18"	19"-24"	25"-30"	31"-36"	37"-42"	43"-48"	49"+	TOTAL
Quercus velutina		1				1	1	3	9	15
Quercus virginiana	6									6
Quercus x warei	5									5
R										
Rhododendron catawabiense		1								1
Rhus copallinum	1									1
Robinia pseudoacacia	9	8	6	1	1	1				26
S										
Salix alba	1									1
Salix babylonica								1	1	2
Salix matsudana	8									8
Salix nigra									1	1
Sassafras albidum	1	7	9	3	3	1		4		28
Sciadopitys verticillata	1									1
Stewartia monodelpha	2									2
Stewartia pseudocamellia	1									1
Styphnolobium japonicum		5	5	3						13
Styrax americanus	5									5
Styrax japonicus	6	2								8
Styrax obassia	1									1
Syringa reticulata	10	4								14
T										
Taxodium ascendens	3	1								4
Taxodium distichum	6	1		7	5	3				22
Taxus baccata	7	8								15
Taxus spp.	145	146	65	31	5	2				394
Taxus wallichiana var chinensis	3									3
Tetradium daniellii	2	1								3
Thuja occidentalis	182	26	17	4						229
Thuja orientalis	4	3	15	1						23
Thuja plicata	54	4	1	1						60
Tilia spp.	8									8
Tilia americana	22	11		6	18	27	9	2		95
Tilia cordata	20	39	13	9	39	47	13	4		184
Tilia petiolaris					4	4	2	1	1	12
Tilia platyphyllos				3	6	4	1			14
Tilia tomentosa		1				1	3	3	3	11
Tilia x euchlora	3			10	23	2				38
Tilia x europaea			2	6	15	5	2			30
Trochodendron aralioides	1									1
Tsuga canadensis	1	6	5	1	1					14
U										
Ulmus spp.	5									5
Ulmus americana	18	3	1			1	1			24
Ulmus glabra		2		1	2	1	2	2	5	15
Ulmus macrocarpa	1									1

SPECIES	0"-6"	7"-12"	13"-18"	19"-24"	25"-30"	31"-36"	37"-42"	43"-48"	49"+	TOTAL
Ulmus parvifolia	1									1
{Unidentified}	12	2								14
V										
Viburnum prunifolium		2	1							3
X										
X Cupressocyparis leylandii	2	9	2							13
X Gordlinia grandiflora	3									3
Z										
Zelkova serrata	15	14	1	2		2				34
TOTALS	2083	1446	905	619	740	562	366	241	173	7135

INVENTORY METHODS

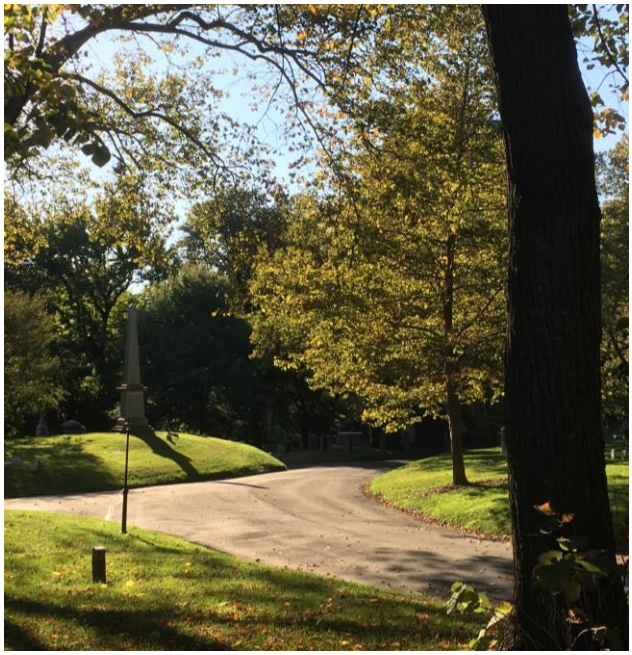
AREA DELINEATION

To facilitate the storage and retrieval of inventory data, and the cost-efficient implementation of future tree management efforts, each of the three established Divisions of the Cemetery were further divided into numerous "Islands," as follows. These Islands are delineated on all sides by paved roads or in-filled roadways, making their boundaries readily discernable in the field.

Within each Division, Islands are consecutively numbered from "01" through the total number of Islands in the Division in accordance with the numbering system previously established by the Cemetery's maintenance staff, as follows:

1. East Division: 42 Islands
2. South Division: 19 Islands
3. West Division: 46 Islands

Within each Island, trees inventoried in 2005 were uniquely identified by consecutive numbers beginning with number "01" through the total number of trees within the Island. During the current inventory, new trees added to the inventory were numbered using a higher sequence of numbers; numbers from trees removed since 2005 were not reused.



TREES INVENTORIED

Trees were inventoried, evaluated, tagged, and mapped, as follows:

1. Scope of Inventory
    a. Green-Wood Cemetery's trees were inventoried and evaluated as part of a Master Plan study in 2005 with various updates made through 2008. In large part, the current 2016 Tree Inventory and Assessment was designed to update the 2005 data. Specifically, the current status of each tree and tree stump included in the 2005 Inventory was field determined and resolved in the database.
        i. Trees found to have been removed or otherwise lost since 2005 were separated from the current inventory data, but retained for future reference.
        ii. Trees remaining from 2005 were remeasured, their condition was reevaluated, current maintenance recommendations were developed, and all resulting database entries were updated accordingly.
        iii. New trees planted since the 2005 Inventory and its subsequent updates were added to the inventory.
        iv. New volunteer (not planted) trees that emerged since 2005, typically in semi-maintained, steep-slope "woodlot" areas, were added to the inventory only if they had attained a threshold size of at least 6" diameter.
2. Time Period Covered
    a. The field inventory and evaluation of trees began at the end of June 2016 and was completed in December 2016.
    b. The inventory data includes all trees that were present at the time each Island was inventoried. Various data adjustments were subsequently made to address trees removed or planted after inventory field work was completed in their respective Islands based on records kept and provided by Green-Wood maintenance staff with limited field verification.
3. Maintained Lawn and Landscape Areas
    a. In maintained lawn and maintained landscape areas throughout the Cemetery, all shade and ornamental trees and tree stumps were individually inventoried and evaluated regardless of their size and whether or not they were planted or emerged as self-seeded volunteers.
4. Semi-maintained "Woodlot" and Landscape Areas
    a. In semi-maintained woodlot and landscape areas, shade, ornamental, and volunteer trees and stumps were individually inventoried and evaluated only if they were above a minimum threshold diameter at the time they were inventoried (generally 6" diameter, depending upon the predominant size of trees in the area).
    b. Trees smaller than the minimum threshold were not individually inventoried, but were considered in characterizing and developing management recommendations for each area.
5. Hedges
    a. Generally, trees within hedges formed by closely-spaced linear rows of trees, each possessing single or a relatively small number of stems, were individually inventoried.
    b. In some cases, hedges or groupings formed by closely-planted trees, particularly those possessing large numbers of stems, were inventoried and evaluated as a single "trees," rather than individuals, to more accurately reflect their intended purpose in the landscape. For example, an arborvitae hedge comprised of ten closely-planted, multi-stemmed trees may have been inventoried as a single "tree" with notations regarding the number of trees within the hedge and their average size and condition.
6. Shrubs
    a. Shrubs were not inventoried or evaluated as part of this Tree Inventory and Assessment.
    b. The differentiation between trees and shrubs for inclusion or exclusion from the inventory was based on established published descriptions for each species. The following clarifications and exceptions were made in differentiating shrubs from small trees where established descriptions are not precise:
        i. *Buxus sempervirens* (common boxwood), which commonly develops a small, multi-stem tree form, was individually inventoried in all cases. All other species of boxwood are considered to be shrubs and were not inventoried.
        ii. *Cotinus coggygria* (smoketree) was inventoried as a small ornamental tree in all cases.
        iii. *Euonymus alatus* (winged Euonymus) is generally considered to be a shrub, but was inventoried in one case where it has attained an unusually large size and decidedly "tree" form.
        iv. *Ilex opaca* (American holly), *Ilex aquifolium* (English holly), and certain hybrid hollies of upright, pyramidal form were individually inventoried as trees. *Ilex crenata* (Japanese holly) and other dwarf and "shrub" forms of holly were not inventoried.
        v. Varieties of *Juniperus virginiana* (eastern red cedar) and *Juniperus chinensis* (Chinese juniper) were inventoried as trees unless they were of a cultivated variety with a decidedly "shrub" form. *Juniperus communis* (common juniper) was considered to be a shrub and not inventoried in all cases.
        vi. *Rhododendron* is universally considered to be a shrub, but was inventoried in one case where it has attained an exceptional size and form.

vii. *Taxus spp.* (yew) is commonly grown as a tree or a shrub depending upon the cultivated variety and/or the manner in which it is pruned. For the purpose of this Tree Inventory and Assessment, *Taxus* were inventoried as trees unless it was apparent that they were being pruned to maintain a shrub form and size. This includes cases where recent pruning to clear adjacent headstones exposed tree-like stems, but the overall size and form was being maintained as a shrub, as shown here.

viii. *Thuja occidentalis* (American arborvitae) was inventoried as a tree, regardless of its current size, unless it was of a cultivated variety with a distinct "shrub" form (e.g. 'Globosa', etc.).

ix. *Platycladus orientalis* (Oriental arborvitae) was only inventoried as a tree if it possessed significant size (15'-20' or large in height) and possessed tree form (limited number of stems versus many stems originating from at or near the ground line) at the time it was inventoried. Oriental arborvitaes lacking tree size and form were not inventoried.

TREE TAGGING

Trees included in the 2005 Tree Inventory and Assessment were tagged at that time with aluminum disks engraved with the Division initial (W, E, or S), Island number and tree number. Together, these letters and numbers uniquely identify each tree. No retagging or repair of embedded or damaged tags from the 2005 Tree Inventory was completed during the current inventory.

All new trees that were planted or that emerged via self-seeding since the 2005 Tree Inventory was completed were added to the inventory and tagged in a similar manner as part of the current effort.

TREE MAPPING

Trees included in the 2005 Tree Inventory and Assessment were previously mapped by others and, as such, were not re-mapped in 2016. The accuracy and completeness of these prior tree mappings were not verified or edited in any way as part of the current inventory effort.

Trees that were planted or emerged via self-seeding since the 2005 Tree Inventory was completed, however, were approximately located by plotting their location on aerial imagery loaded on tablet computers in the field.

All mapping was done in a geographic information system (GIS) via Quantum GIS (QGIS) software (version 2.14.2-Essen) for Microsoft Windows. All imagery and vector shapefiles originated in or were rectified to the New York State Plane, Long Island Zone, 1983 North American Datum coordinate reference system (CRS) (EPSG 2263). This CRS is commonly used in the New York City area, is the standard CRS for municipal and state agencies producing GIS data in New York City, and is suitable for the location of the Cemetery as it presents consistently negligible geographic distortion across all areas of the Cemetery.

Mapping utilized 4-band (blue, green, red, and near-infrared), half-meter resolution aerial imagery acquired in 2015 and obtained through the USDA Farm Service's National Agricultural Imagery Program (NAIP). The NAIP imagery was displayed in the GIS using falsecolor-infrared band arrangement (near infrared displayed in the red band, red in the green band, and green in the blue band) and was utilized to locate new trees in the GIS and then digitize their locations. Digitization of new trees was done directly into a new points shapefile overlaid on top of the NAIP falsecolor-infrared imagery.

Where a new tree was visible on the map (those that were planted prior to the imagery's acquisition date and which were not obscured by overhead foliage or very small size), a point was digitized in the center of its visible foliage.

Where a new tree was not visible, surrounding context and reference objects visible on the map and from the ground were used to approximate the new tree's location on the map.

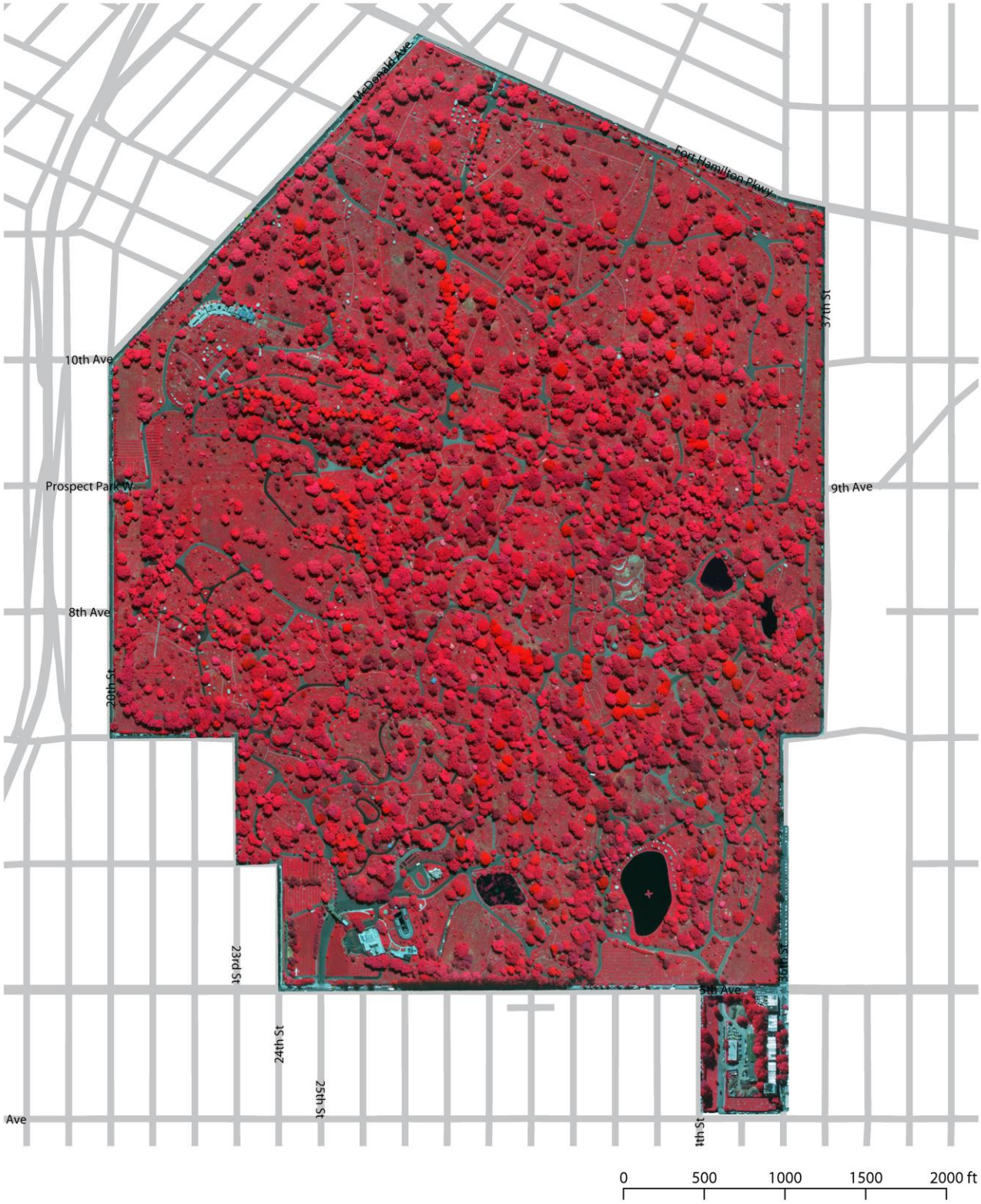
While this method creates a useful approximation of the tree's location that should be sufficient for tree management purposes, it does not utilize survey-grade methodologies, nor were licensed surveyors used to digitize any of the new tree points. Therefore, the tree map should not be considered precise or "survey-grade" and should be used for general reference purposes only.

SITE DATA

The following site data were recorded for each individually inventoried tree and stump:

1. Site Status
    a. "Site Status" indicates whether the specific spot in the field is occupied by a tree or a stump.

FALSECOLOR-INFRARED AERIAL IMAGERY OF GREEN-WOOD CEMETERY, 2015



2. Site Type and Size
    a. "Site Type" briefly describes the ground area in which the tree or stump is primarily rooted.
    b. "Size" indicates the smallest dimension, in feet, where the site is restrictive to root development (e.g. limited area between sidewalk and curb). Size was not recorded where the site is not restrictive (e.g. open lawn areas).
3. Wires
    a. "Wires" indicates the presence (Yes) or absence (No) of pole-to-pole utility wires over or near the tree or stump.
4. Hardscape Conflicts
    a. "Hardscape Conflicts" describes the nature and severity of significant spatial conflicts and damage to hardscape fixtures resulting from tree growth (e.g. displacement of headstones by expanding roots, obstruction of paths or traffic signs by low-hanging branches, etc.).
    b. For this Tree Inventory and Assessment, conflicts and damage were only noted where the obstruction or damage was significant at the time of the inventory.

TREE AND STUMP DATA

The following data describing each individually inventoried tree and stump were collected and recorded:

1. Tag Number
    a. Each individually inventoried tree and stump is uniquely identified by the combination of the Division (West, East and South), the number of the Island in which it is located (numbered 1 through the total number of Islands in the Division) and its tree number (1 through the total number of trees and stumps in the Island).
    b. Individual trees and stumps can be identified by these unique identification numbers via tags affixed to each tree and stump in the field, labels on the tree location maps, and in the provided database.
2. Species
    a. The species of each inventoried tree and stump was identified and recorded as follows:
        i. "Botanical Name" (Genus + Species) is the universally accepted scientific name for each inventoried tree and stump.
        ii. "Common Name" is the regionally accepted species name for each inventoried tree and stump.
        iii. Cultivar names or classifications were determined and recorded only if accurate planting records were available and/or there were readily discernable identification features (e.g. flower color) present at the time the tree was inventoried.
    b. Diligent efforts were made during this Tree Inventory and Assessment to fully and accurately identify each tree's species. These efforts included observing seasonal variation in foliage and flowers (if present), literature searches, and comparing the trees to known specimens elsewhere. Despite these efforts, the identification of some individual trees in the following groups remains in question:
        i. *Tilia* (lindens) are widely considered to be "taxonomically confused" as a result of source-dependent regional variation and hybridization. Some of the trees identified as *Tilia americana* (American linden), *Tilia cordata* (littleleaf linden), *Tilia platyphyllos* (bigleaf linden), and *Tilia x europaea* (European linden) at Green-Wood are in question because they share several of the characteristics normally used to differentiate them. Conversely, *Tilia tomentosa* (silver linden), *Tilia petiolaris* (pendent silver linden), and *Tilia x euchlora* (Crimean linden), and recently planted American and littleleaf lindens identified with a high degree of confidence.
        ii. A small number of the trees identified as *Quercus rubra* (northern red oak), *Quercus velutina* (black oak), or *Quercus coccinea* (scarlet oak) at Green-Wood Cemetery share characteristics normally used to differentiate them and may be inter-specific hybrids.
    c. In some cases, non-specific species values were recorded:
        i. "Undetermined" in the species field indicates that the species was not positively identified (primarily dead trees and stumps).
        ii. In some cases, trees were identified only by genus because the differences between species and hybrids are too subtle to accurately identify them by field observation alone in the absence of detailed planting records. These included:
            - *Malus spp.* (apple and crabapple)
            - *Ilex spp.* (hybrid hollies)
            - *Taxus spp.* (yews)
            - *Cornus spp.* (dogwoods)
3. Stems
    a. "Stems" indicates the number of stems the tree or stump possessed at the point of diameter measurement.
4. Diameter
    a. For trees, the diameter of each stem was measured to the nearest inch at 4.5' above the ground (DBH), or at the point indicated when variation from the standard more accurately reflected the tree's true size.
    b. For new stumps created by the cutting of trees inventoried in 2005, the recorded diameter represents the tree's last recorded stem diameter. In most cases, the actual diameter of the stump measured near ground level will be significantly larger.

c. For stumps that preexisted the 2005 Tree Inventory and were inventoried as stumps at that time, the recorded diameter represents the average diameter measured at the top of the stump. In all cases, stumps remaining from the 2005 Tree Inventory were not remeasured, but may be smaller in many cases due to subsequent decay.

5. Tree Condition

   a. The overall health and structural condition of each tree was rated by systematically assessing its crown, scaffold branch structure, foliage, trunk, and buttress root system, as follows:

      i. Good: The tree had no more than one or two minor defects and was advancing with vigor.

      ii. Fair: The tree had 2-4 minor defects or one major defect and was advancing, but with limitations.

      iii. Poor: The tree had several minor defects and/or two or more major defects and was declining in vigor.

      iv. Dead: 75% or more of the crown was dead and any remaining live portions were deteriorating rapidly.

   b. In addition to overall condition, the health and vigor of each tree was separately rated as Good, Fair, or Poor based on its growth rate over the past several years and the number, type and severity of any health disorders present.

   c. In addition to overall condition, the structure and form of each tree was separately rated as Good, Fair, or Poor based primarily on the number, type and severity of structural defects present, and secondarily on its aesthetic form and appearance.

6. Disorders and Defects

   a. The nature and severity of health disorders, including insect, disease, or other problems induced by site conditions or maintenance practices, were noted if they were determined to be significant enough to affect the overall health, vitality, and longevity of the tree.

   b. The nature and severity of structural defects were noted if they were determined to be significant enough to compromise the current or long-term structural integrity and safety of the tree.

   c. The evaluation of each tree's health and structural condition was limited to simple visual observations of external portions of the tree from the ground and did not include aerial inspections or advanced diagnostic techniques. Therefore, the presence of certain defects may have gone unnoted or the severity of defects may not have been fully realized. While reasonable efforts were made to identify and characterize significant problems, this was not the primary purpose of the Tree Inventory and Assessment and no guarantees that every problem or potentially hazardous condition was identified are made or implied.

7. Tree Notes

   a. "Tree Notes" provides additional miscellaneous information regarding the tree or stump, such as:

      i. Notable physical characteristics (e.g. flower or leaf color when the precise cultivar could not be positively identified).

      ii. Date the tree was planted, if available via planting records provided.

   b. Notes regarding incorrect species information on installed plaques.

CURRENT TREE MAINTENANCE RECOMMENDATIONS

Maintenance recommendations were made and prioritized for individual trees based on the need to mitigate potentially hazardous conditions first, and to improve tree health, structure, and appearance second.

The evaluation of each tree's structural condition was limited to simple visual observations of external portions of the tree from the ground and did not include aerial inspections or advanced diagnostic techniques. Therefore, the presence of certain defects may have gone unnoted or the severity of defects may not have been fully realized.

While reasonable efforts were made to identify and characterize significant problems, this was not the primary purpose of this Tree Inventory and Assessment and no guarantees that every problem or potentially hazardous condition was identified are made or implied.

1. Remove High Priority

   a. High priority removal was recommended for medium to large size trees that are dead or near dead, or which possess severe structural defects that are likely to result in the failure of a large tree part, but cannot be corrected through typical arboricultural techniques.

   b. Trees recommended for high priority removal are imminent safety hazards and high liability risks and should be removed immediately.

2. Remove Medium Priority

   a. Medium priority removal was recommended for medium to large size trees that are near dead or which have significant structural defects that may result in failure of a large tree part, but cannot be corrected through typical arboricultural techniques.

   b. Medium priority trees should be removed as soon as possible, but after the high priority trees are addressed.

3. Remove Low Priority

   a. Low priority removal was recommended for trees that should be removed because they are dead or have serious structural defects, but pose little hazard risk because of their small size or location (e.g. dead transplants, trees in remote areas). Low priority removal may also have been recommended for trees

that should be removed for aesthetic, nuisance, or other non-safety-related reasons.

b. Low priority removals should be completed after all high- and medium-priority work is completed, as time and resources permit.

4. Clean Crown High Priority

   a. High priority crown cleaning was recommended for trees containing one or more dead, dying, diseased, severely decayed, broken, or split limb 4-inches in diameter or larger.

   b. High priority crown cleaning should be completed immediately to eliminate imminent hazards to life and property.

5. Clean Crown Medium Priority

   a. Medium priority crown cleaning was recommended for trees containing three or more dead, dying, diseased, severely decayed, broken, or split limbs two to four-inches in diameter.

   b. Medium priority crown cleaning should be completed as soon as possible to reduce potential hazards, but should be addressed after high priority work is completed.

6. Clean Crown Low Priority

   a. Low priority crown cleaning was recommended for trees containing substantial amounts of relatively small deadwood to help improve their appearance.

   b. Low priority crown cleaning is not essential to improving safety and should be completed after all high- and medium-priority work is completed, to the extent that time and resources permit.

7. Raise Crown / Clear

   a. Crown raising or clearance pruning was recommended for trees that are interfering with roads, paths, sidewalks, signs, traffic controls, headstones, mausolea, buildings, etc.

   b. Clearance of traffic controls and signs at intersections should be completed on a medium- to high-priority basis to ensure traffic safety.

   c. Other crown raising and clearance pruning where safety is not an issue may be completed on a low priority basis.

8. Structural Prune / Corrective Prune

   a. Structural pruning was recommended where specialized pruning is needed for developing a strong, well-spaced branch scaffold. Developmental pruning is generally recommended for young trees, especially those prone to branch failure as they age.

   b. Corrective pruning was recommended for trees that have non-hazardous branch damage, improperly pruned branch stubs, or other specialized pruning needs that did not appear critical to safety.

9. Cable

   a. Cabling was recommended where the installation of steel support cables may help reduce the risk of splitting between weak, codominant stems and branch attachments.

   b. Cabling priorities were set based on the severity of the structural defect, the size of the tree part most likely to fail, and the likelihood of property damage or injury resulting from structural failure.

10. Inspect

    a. Inspection was recommended for trees in which potential problems were noted, but the full extent of the problem could not be readily assessed within the scope of this Tree Inventory and Assessment (e.g. the extent and severity of internal wood decay).

    b. A more detailed examination using more advanced diagnostic techniques is required to fully determine the extent of the problem and an appropriate course of action.

11. Remove Stump

    a. Stump grinding was recommended for all inventoried stumps remaining from the removal of trees in the past.

    b. In all cases, the removal of stumps is a low priority relative to tree pruning and removal.

12. Other Treatments

    a. Various other specialized treatments were recommended where significant problems that will affect the proper development and long-term health and structural condition of the tree exist. These treatments include:

       i. Excavation of buried root collars, primarily on trees planted within the past several years.

       ii. Pruning of girdling roots.

       iii. Treatment of significant insect infestations.

       iv. Propping to support structurally unsound, but valuable, ornamental trees.

       v. Control of competing vine growth.

TYPICAL SEMI-MAINTAINED WOODLOT AREA

TREE STOCKING

STOCKING AND DISTRIBUTION

Green-Wood Cemetery's tree collection currently consists of:

1. 7,135 (6,968 in 2005) individually inventoried shade and ornamental trees.
2. A few hundred additional uninventoried volunteer trees that have invaded low-maintenance areas.

The majority of Green-Wood's trees are individual, free-standing shade and ornamental trees that were planted at variable spacing on large expanses of lawn that are rolling to steeply sloped in topography.

Overall, the per-acre stocking of trees on Green-Wood Cemetery's 478 acres is appropriate. However, the local distribution of trees within the Cemetery is variable, ranging from large areas with no trees, to "savannahs" with individual and small groups of trees sparsely scattered on open lawns, to over-crowded landscapes and dense woodlots.

Interspersed throughout the Cemetery are several relatively small, dense pockets of trees and woody and herbaceous understory vegetation. As a result of limited maintenance in these steeply sloped areas, remnant shade and ornamental tree plantings were invaded by dense volunteer tree and shrub growth creating quasi "woodlots."

The overall distribution of trees which have seeded in or otherwise grown up without being intentionally planted since the 2005 Inventory is almost exclusively limited to these woodlot areas, where steep slopes have prevented maintenance crews from mowing or otherwise clearing seedling tree growth. Distribution of these "volunteer" trees outside of woodlots is so scarce as to suggest that current volunteer trees outside of woodlots are only growing because Cemetery crews have not found and removed them yet.

Even within some of the woodlot areas that remain, Green-Wood appears to have made good progress since the 2005 Inventory in removing substantial numbers of undesirable invasive trees (*Ailanthus altissima*, commonly known and Ailanthus or Tree-of-Heaven and *Acer platanoides*, commonly known as Norway maple, in particular) and thinning, cleaning, and improving the appearance of these areas in general. In some cases, Green-Wood successfully converted entire wooded areas into well-

maintained landscapes of groundcover or other designed plant growth.

Shade and root competition among closely spaced trees has degraded their condition somewhat and prohibits their development into the old, grand specimens found in more open areas. Nevertheless, the wide variation in tree density is aesthetically pleasing and provides a range of seasonal interest, passive recreation opportunities, and wildlife habitats.

PLANTING DESIGN

The distribution of trees planted throughout the Cemetery since 2005 has generally been in clusters, with some areas having received large numbers of new trees while others received few or none. This pattern appears to have been primarily driven by severe losses from Hurricane Sandy and other storms as well as significant losses to advanced age and disease; secondarily, this pattern of new tree distribution has been driven by various design decisions.

In some cases, the planting distribution does not follow the same pattern as previous designs and plantings. For example, few new trees have been planted along roads despite many having been removed, and the arrangement of groups of some newly planted trees often occurred in rows or closely spaced, garden-style groupings when involving species that achieve relatively small size at maturity.

Beyond the obvious shift from an older to a younger population since 2005, one of the more visually apparent changes in Green-Wood's tree collection is a reduction in the number, length, and/or continuity of allées along cemetery roadways. This change is due in part due to significant losses of trees that were previously damaged by vehicles and road repairs and infected with root and lower trunk decay to storms or removed to eliminate safety risks.

In other cases, design decisions were made to reduce the number of trees subject to roadside damage and to improve views into landscaped areas. Roadside allées of *Acer platanoides* (Norway maple) and *Juniperus chinensis* (Chinese juniper) were particularly affected and have not been replaced in-kind.

In most other cases, new plantings have followed previously established patterns of general randomness, though with an apparent focus on framing and avoiding future conflicts with notable structures and other landscape features.

SITE CHARACTERISTICS

The rolling, hill-and-valley topography found throughout much of Green-Wood Cemetery causes wide fluctuations in temperature, solar aspect, and moisture over short distances. These microclimates have a profound effect on the performance and longevity of different species in different areas.

Based on the observed lack of significant, widespread nutrient deficiencies, soils in most areas are sufficiently well-drained, aerated, and fertile to support the growth of a wide range of native and introduced species. Many species have performed extremely well and apparently lived significantly longer than similar trees elsewhere in the New York City region.

Other than competition from adjacent trees, the vast majority of the sites in which trees are growing provide sufficient above and below ground space to permit the normal growth, full development, and long life of most tree species.

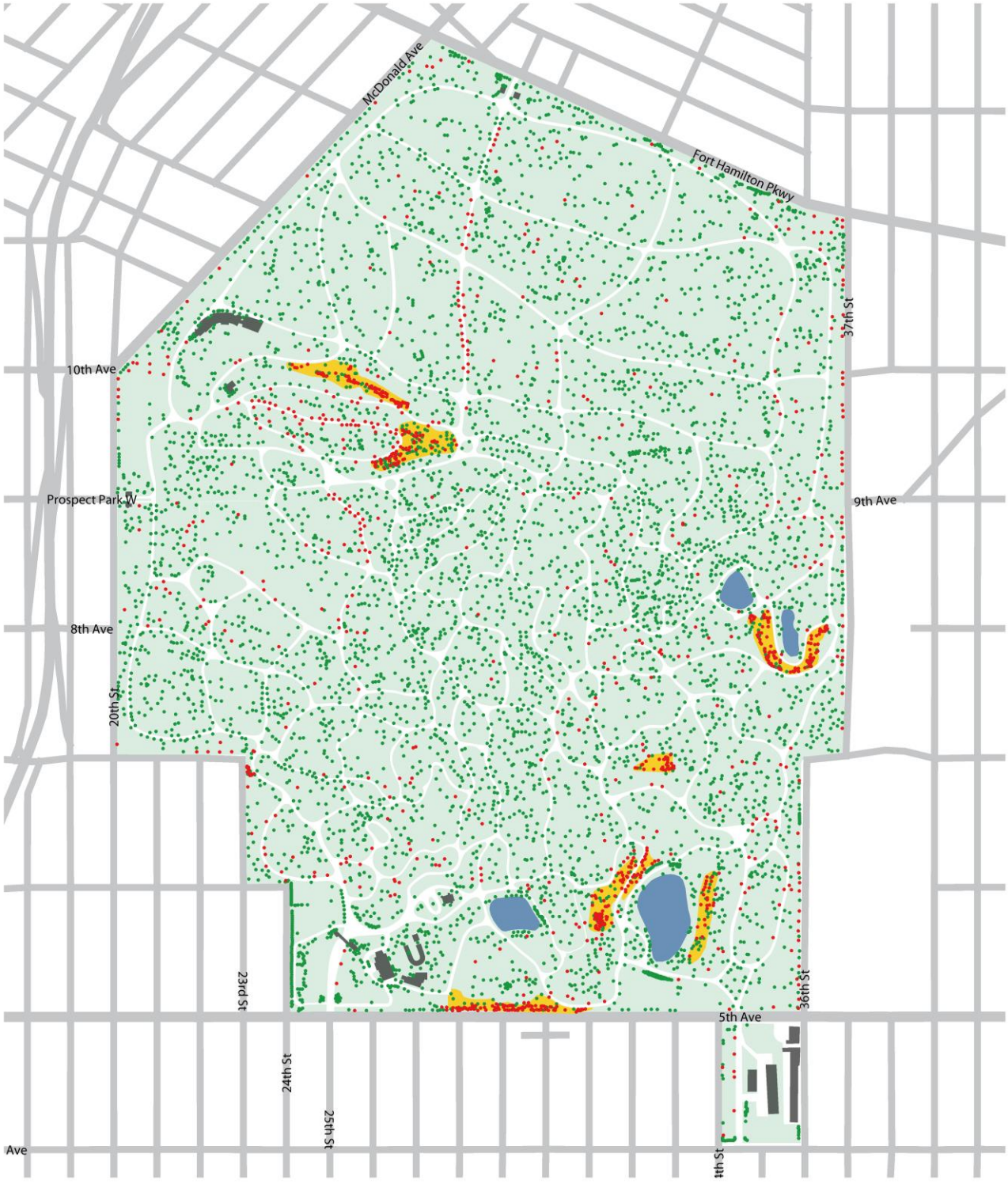
Nearly all areas within the Cemetery are intersected by, or in close proximity to, an extensive network of winding roads and walking paths densely occupied by headstones, monuments, and mausolea and heavily used by Cemetery visitors and maintenance personnel. As such, tree structure and safety is a primary concern in all areas.

A significant number of trees are in spatial conflict with headstones, monuments, mausolea, walking paths, and other hardscape fixtures. In many cases, tree growth has caused significant damage to these fixtures.

2015 AERIAL IMAGE OF GREEN-WOOD CEMETERY

CURRENT TREES, 2016

UNDESIRABLE INVASIVE TREES AND SEMI-MAINTAINED "WOODLOTS"



TREES PLANTED BETWEEN 2005 AND 2016

CURRENT AND REMOVED ALLÉE TREES, 2005–2016

SPECIES COMPOSITION

CURRENT SPECIES COMPOSITION

Green-Wood Cemetery's tree collection is currently comprised of 260 (172 in 2005) different species and hybrids representing 43 (37 in 2005) taxonomic families and 89 (76 in 2005) different genera.

Even before the dramatic increase in species diversity over the past ten years, the wide variety of both native and non-native species, along with the age and condition of many of the trees, made it an exceptional collection of trees with few rivals in the region.

The 2005 Inventory found that the *Acer* (maple) genus comprised a disproportionately large segment of the tree population at 21.3%. While losses and replanting efforts that strived to increase diversity and reduce species-specific vulnerabilities since 2005 have significantly reduced their relative numbers, maples remains the most predominant genus at 15%.

Other prominent genera include *Quercus* (oak) at 9.3% (ranked 2nd at 8.6% in 2005), *Prunus* (cherry and other stone fruit species) at 7.4% (ranked 3rd at 8.1% in 2005), *Taxus* (yew) at 5.8% (ranked 4th at 5.7% in 2005), *Tilia* (linden) at 5.5% (ranked 5th at 5.3% in 2005), and *Cornus* (dogwood) at 4.9% (ranked 6th at 5.1% in 2005).

While the current number of *Acer platanoides* (Norway maple) is significantly reduced from 2005, it still comprises a disproportionately large portion of the tree population at 10.2% (down from 16.3% in 2005). Although a significant number of the Norway maples are self-seeded volunteers growing in low-maintenance woodlots, the species remains a significant species in the designed landscape.

The next most common species include *Quercus palustris* (pin oak) at 4.2% (ranked 2nd at 5.2% in 2005), *Prunus serotina* (black cherry) at 4.0% (ranked 3rd at 4.7% in 2005), *Cornus florida* (flowering dogwood) at 3.3% (ranked 4th at 4.1% in 2005), *Thuja occidentalis* (American arborvitae) at 3.2% (ranked 11th at 2.2% in 2005), *Quercus rubra* (northern red oak) at 2.7% (ranked 9th at 2.4% in 2005), and *Tilia cordata* (littleleaf linden) at 2.6% (ranked 7th at 2.5% in 2005).

Species that are no longer among the most frequent, as they were in 2005, include *Chamaecyparis pisifera* (Japanese falsecypress) at 2.5% (ranked 5th at 2.9% in 2005), *Fagus sylvatica*

(European beech) at 2.5% (ranked 6th at 2.8% in 2005), and the undesirable invasive *Ailanthus altissima* (Ailanthus or Tree-of-Heaven) currently ranked 37th at 0.5% (ranked 8th at 2.5% in 2005).

230 different species each comprise less than 1% of the tree population. Many of these minor types are highly desirable and performing well in Green-Wood Cemetery.

EVERGREEN VS. DECIDUOUS TREES

The spatial distribution of evergreen trees versus their deciduous counterparts has changed since the 2005 Tree Inventory with the most obvious increase being in hedgerows along perimeter fences designed to screen external views and the most obvious reduction being along some cemetery roadways.

The relative proportion of evergreens overall, however, has remained stable since 2005. 25% of the trees individually inventoried in 2005 and 24% inventoried in 2016 were evergreen species. New plantings from 2005 through 2016 mirrored the 2005 level, consisting of 25% evergreen and 75% deciduous species selections.

CLIMATE IMPACTS

The influence of shifting climate patterns appears to be playing a small but notable role in Green-Wood's increased tree species diversity, with the recent plantings of several species that were previously considered to be largely exclusive to areas south of New York City. Some examples of these southern species include *Lagerstroemia spp.* (crape myrtles), *Magnolia grandiflora* (southern magnolia), and *Quercus virginiana* (live oak).

While other factors such as urban heat island, plant breeding for hardiness, and popularity-driven changes in plant availability are likely contributing to this influx of species of southern provenances, it should not be discounted that current climate change models predict increased average annual temperatures for the New York City area into the future. It is reasonable to assume that plant species will be shifting their provenances northward (and to higher elevations) with their respective temperature gradients as the effects of climate change continue to unfold.

EXOTIC INVASIVE SPECIES

Green-Wood's tree collection contains significant numbers of undesirable exotic invasive species including *Acer platanoides* (Norway maple), *Morus alba* (white mulberry), *Ailanthus altissima* (Ailanthus), and *Acer pseudoplatanus* (sycamore maple), though the total quantity and percentage in the overall tree population has been significantly reduced since 2005.

The most notable reduction in these species is among the individually inventoried trees with maintained landscape areas, where only Norway maple still remains in significant numbers.

In total, these species currently comprise 12.9% (919 trees) of the 7,135 individually inventoried trees, down from 21.3% (1,482) in 2005.

The local dominance of exotic invasive species in the "woodlot" areas remains high, a result of aggressive seeding from trees mature tree occupying the areas, as well as those growing elsewhere in the Cemetery and the surrounding neighborhoods. In many cases, the rapid and prolific regeneration and aggressive growth of these invasives is creating maintenance problems and continuing to gradually degrade the condition and character of these areas by displacing remaining native vegetation and desirable landscape plantings, and interfering with or damaging structures.

HEALTH VULNERABILITIES

Though design intent typically drives plant selection in urban landscapes, there are risks associated with over-reliance on a small number of species. Most severe insect and disease problems are species- or genus-specific. As a result, tree populations with limited species diversity are vulnerable to catastrophic losses when unanticipated, species-specific problems emerge.

Rigorous efforts to further diversify Green-Wood's tree collection 2005 have further increased aesthetic variation and its arboretum status. More importantly, additional species diversity will help safeguard the tree collection over the long term.

2005 FAMILY DIVERSITY

- Sapindaceae (23.7%)
- Rosaceae (10.6%)
- Pinaceae (9.2%)
- Malvaceae (5.3%)
- Magnoliaceae (3.7%)
- Leguminosae (1.7%)
- Altingiaceae (1.5%)
- Ginkgoaceae (1.0%)
- Fagaceae (11.4%)
- Cupressaceae (10.0%)
- Taxaceae (5.7%)
- Cornaceae (5.2%)
- Simaroubaceae (2.5%)
- Platanaceae (1.6%)
- Juglandaceae (1.3%)
- 22 other families <1% each (5.6%)

2016 FAMILY DIVERSITY

- Sapindaceae (17.1%)
- Rosaceae (10.4%)
- Pinaceae (7.7%)
- Malvaceae (5.5%)
- Magnoliaceae (4.4%)
- Betulaceae (2.5%)
- Platanaceae (1.6%)
- Juglandaceae (1.1%)
- Ginkgoaceae (1.0%)
- Fagaceae (11.9%)
- Cupressaceae (10.2%)
- Taxaceae (5.8%)
- Cornaceae (5.4%)
- Leguminosae (4.1%)
- Altingiaceae (1.9%)
- Salicaceae (1.6%)
- Ulmaceae (1.1%)
- 25+ other families (<1% each) (6.6%)

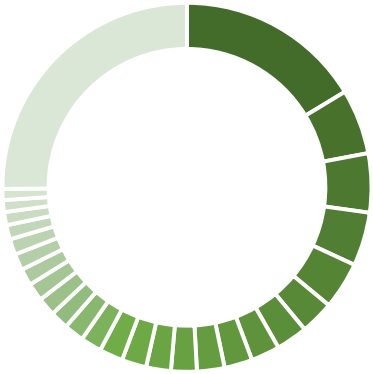
2005 GENUS DIVERSITY

- Acer (21.3%)
- Prunus (8.1%)
- Tilia (5.3%)
- Pinus (4.4%)
- Picea (2.9%)
- Fagus (2.8%)
- Ailanthus (2.5%)
- Liriodendron (2.1%)
- Magnolia (1.6%)
- Liquidambar (1.5%)
- Ginkgo (1.0%)
- Quercus (8.6%)
- Taxus (5.7%)
- Cornus (5.1%)
- Chamaecyparis (3.6%)
- Thuja (2.9%)
- Juniperus (2.6%)
- Aesculus (2.3%)
- Malus (1.9%)
- Platanus (1.6%)
- Carya (1.2%)
- 55 other genera <1% each (11.0%)

2016 GENUS DIVERSITY

- Acer (15.0%)
- Prunus (7.4%)
- Tilia (5.5%)
- Thuja (4.4%)
- Chamaecyparis (3.3%)
- Picea (2.5%)
- Liriodendron (2.2%)
- Malus (1.9%)
- Cercis (1.7%)
- Populus (1.4%)
- Carya (1.1%)
- Ginkgo (1.0%)
- Quercus (9.3%)
- Taxus (5.8%)
- Cornus (4.9%)
- Pinus (3.7%)
- Fagus (2.6%)
- Magnolia (2.2%)
- Aesculus (2.0%)
- Liquidambar (1.9%)
- Platanus (1.6%)
- Carpinus (1.2%)
- Gleditsia (1.0%)
- 65+ other genera (<1% each) (16.6%)

2005 SPECIES DIVERSITY

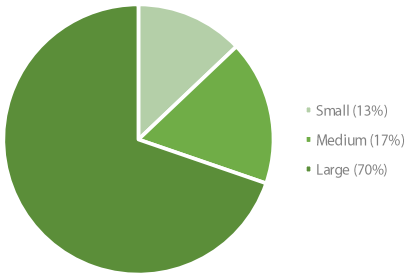


- Acer platanoides (16.3%)
- Quercus palustris (5.2%)
- Cornus florida (4.1%)
- Fagus sylvatica (2.8%)
- Ailanthus altissima (2.5%)
- Prunus serrulata (2.3%)
- Aesculus hippocastanum (2.2%)
- Malus spp. (1.8%)
- Juniperus virginiana (1.6%)
- Pinus strobus (1.6%)
- Acer palmatum (1.4%)
- Picea pungens (1.3%)
- Ginkgo biloba (1.0%)
- 142 species <1% each (25.1%)
- Taxus spp. (5.7%)
- Prunus serotina (4.7%)
- Chamaecyparis pisifera (2.9%)
- Tilia cordata (2.5%)
- Quercus rubra (2.4%)
- Thuja occidentalis (2.2%)
- Liriodendron tulipifera (2.1%)
- Acer pseudoplatanus (1.8%)
- Platanus x acerifolia (1.6%)
- Liquidambar styraciflua (1.5%)
- Picea abies (1.4%)
- Tilia americana (1.1%)
- Juniperus chinensis (1.0%)

2016 SPECIES DIVERSITY

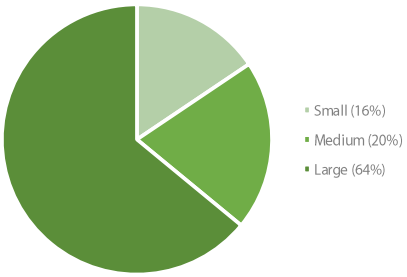
- Acer platanoides (10.2%)
- Quercus palustris (4.2%)
- Cornus florida (3.3%)
- Quercus rubra (2.7%)
- Chamaecyparis pisifera (2.5%)
- Liriodendron tulipifera (2.2%)
- Pinus strobus (1.9%)
- Aesculus hippocastanum (1.8%)
- Acer pseudoplatanus (1.6%)
- Acer palmatum (1.4%)
- Tilia americana (1.3%)
- Picea abies (1.2%)
- Carpinus betulus (1.0%)
- Magnolia x soulangiana (1.0%)
- 219+ species <1% each (33.2%)
- Taxus spp. (5.5%)
- Prunus serotina (4.0%)
- Thuja occidentalis (3.2%)
- Tilia cordata (2.6%)
- Fagus sylvatica (2.5%)
- Prunus serrulata (1.9%)
- Liquidambar styraciflua (1.9%)
- Platanus x acerifolia (1.6%)
- Malus spp. (1.6%)
- Populus tremuloides (1.4%)
- Cercis canadensis (1.2%)
- Cornus kousa (1.1%)
- Gleditsia triacanthos var. inermis (1.0%)
- Ginkgo biloba (1.0%)

2005 SPECIES SIZE CLASSES



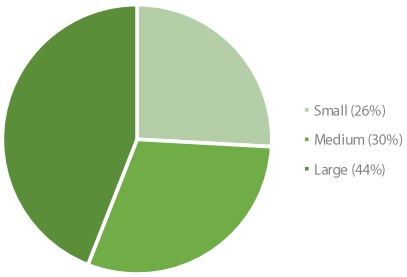
- Small (13%)
- Medium (17%)
- Large (70%)

2016 SPECIES SIZE CLASSES



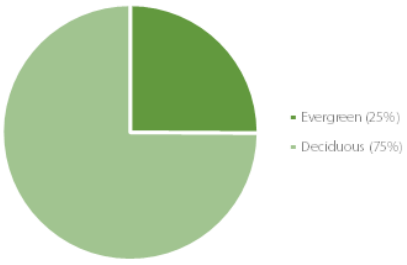
- Small (16%)
- Medium (20%)
- Large (64%)

2005–2016 NEW PLANTINGS



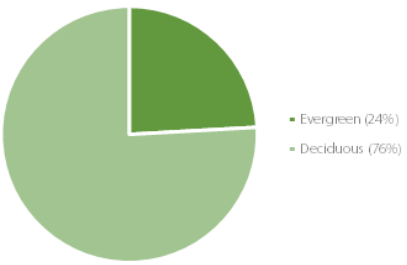
- Small (26%)
- Medium (30%)
- Large (44%)

2005 EVERGREEN VS. DECIDUOUS



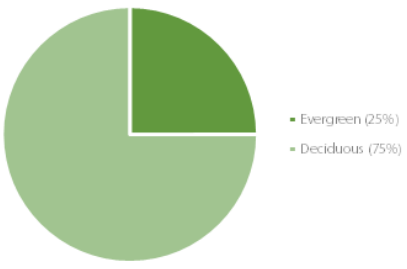
- Evergreen (25%)
- Deciduous (75%)

2016 EVERGREEN VS. DECIDUOUS



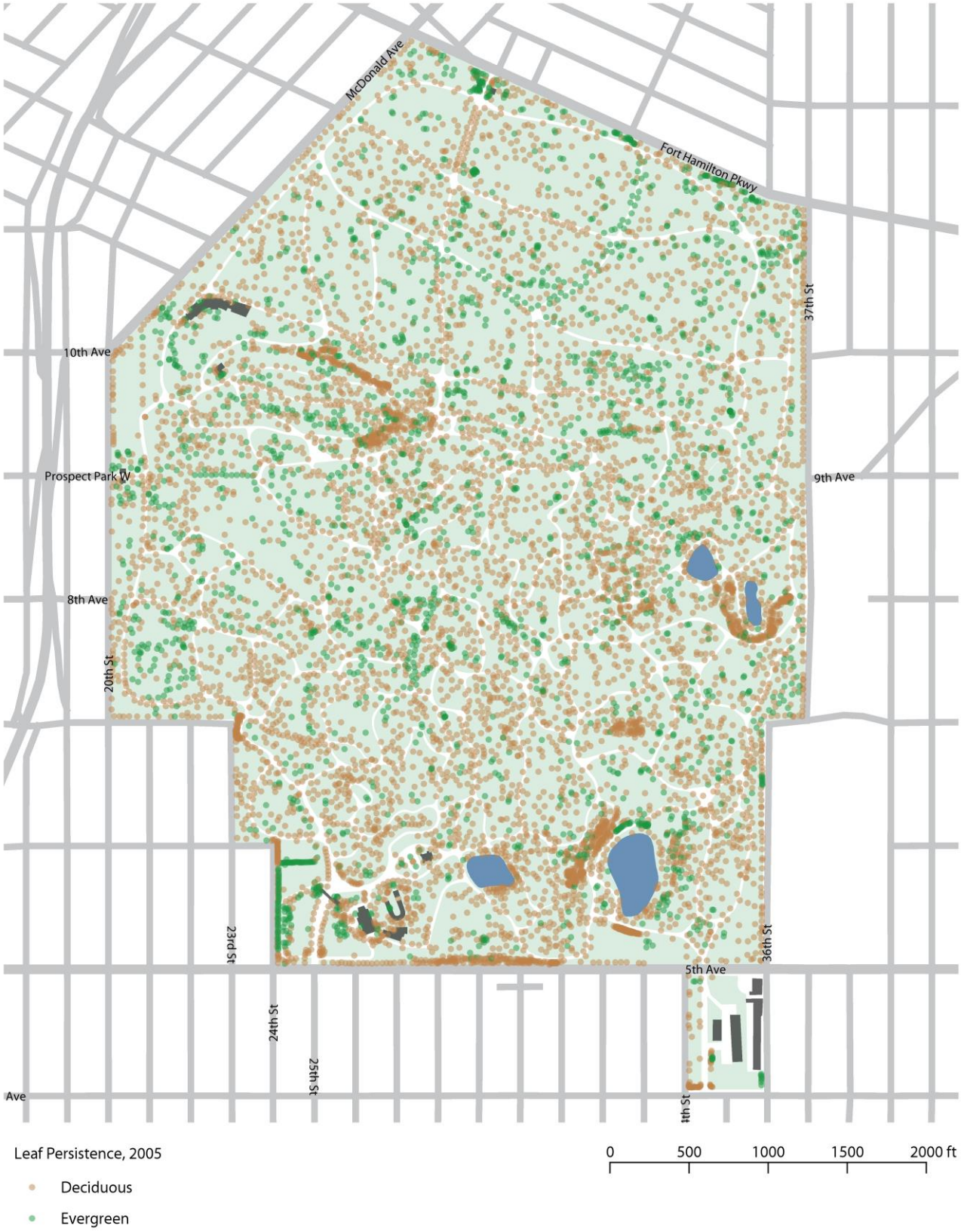
- Evergreen (24%)
- Deciduous (76%)

2005–2016 NEW PLANTINGS

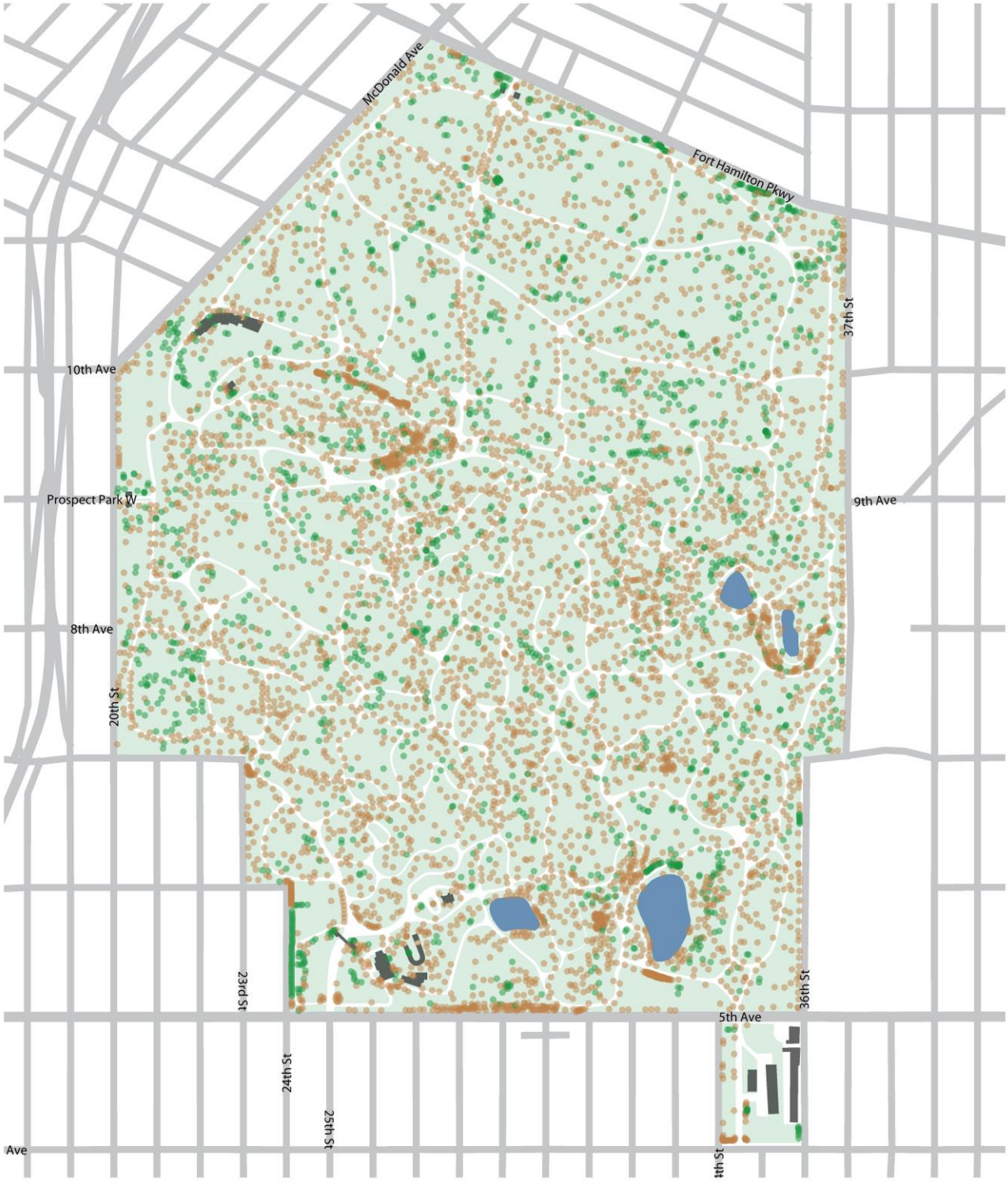


- Evergreen (25%)
- Deciduous (75%)

DECIDUOUS VS. EVERGREEN, 2005



DECIDUOUS VS. EVERGREEN, 2016



DIAMETER AND AGE DISTRIBUTION

CURRENT DIAMETER DISTRIBUTION

In addition to the impressive species diversity, diversity in the size and age of Green-Wood Cemetery's trees range from seedlings planted within the past few months to grand old specimens that have graced and characterized the Cemetery for well over 100-years or more and represent some of the oldest and largest of their kind in the New York City area.

29.2% (16.2% in 2005) of Green-Wood's trees are in the 0"-6" diameter class and 20.3% (22.6% in 2005) are in the 7"-12" class. A significant number of these are relatively small, ornamental species that will not attain substantial age or size. The balance, however, are large species which, with proper maintenance, will become Green-Wood's grand, picturesque trees of the future. Planting efforts should continue to include sufficient large, long-lived species to ensure that this segment of the population is adequately perpetuated.

21.4% (27.5% in 2005) of the trees are in the 13"-18" and 19"-24" diameter classes. Shade trees in these middle diameter classes are generally at their peak – the level of aesthetic and ecosystem benefits they provide relative to the cost of maintaining them is optimal. Proper maintenance is vital at this stage because neglected middle-aged trees can quickly become declining and potentially hazardous mature trees. Ornamental species are typically shorter-lived and smaller at maturity, however. Therefore, many of the trees in these classes are already beyond their prime.

19.1% (27.7% in 2005) of Green-Wood's trees are in the 19"-24" and 25"-30" diameter classes and poised to begin moving into the over-mature classes. Large, over-mature trees can provide the greatest physical and aesthetic benefits, but the cost to maintain them increases disproportionately. Proper maintenance during the young and middle classes can significantly reduce the trees' maintenance requirements and safety as they age.

10.9% (9.9% in 2005) of Green-Wood's trees are 37-inches in diameter and larger. A large number of these trees remain in relatively good condition and include some of the most impressive trees in the region. Many are presumed to have been planted fairly early in the Cemetery's history.

CURRENT AGE STRUCTURE

Because diameter distribution is not well-correlated to age distribution in mixed-species urban forests as it often is in

natural successional forest stands in the Northeast, species-adjusted diameter distribution was used to better analyze the age structure of Green-Wood's tree population. Through this technique, species are first classified as small, medium, large, or very large based on typical terminal size, which is correlated to typical service life expectancy. Then, each tree's current size is expressed as a percentage of service life expectancy expended to date, based on the percentage of terminal size attained.

Balanced, uneven-aged tree populations – those with similar numbers of trees in all age classes – are generally preferred when managing large urban forests. With consistent numbers of young, middle-aged, and old trees, attritional losses to age, disease, and other forces remain relatively consistent from year to year over the long term.

Nevertheless, even-aged groupings of trees are often preferred in designed landscapes because the uniformity in tree size provides desirable, and often dramatic, aesthetic qualities. For example, uniformity in species, age, and size is a key characteristic of allée plantings. Even-aged plantings need not be avoided, provided they are localized and offset by trees of different ages elsewhere to maintain overall population-wide age diversity.

The loss of trees to age is inevitable and must be a primary consideration in planning efforts. Although there is often a tendency to reforest by planting large numbers of trees in a short period of time, a consistent—and even restrained—planting pace should be maintained from year to year to help maintain age diversity and population stability over the long-term. Replanting large numbers of trees with similar life expectancies within a short period of time will result in an even age structure and subject the population to cyclical waves of age-related losses and increased removal and replanting needs.

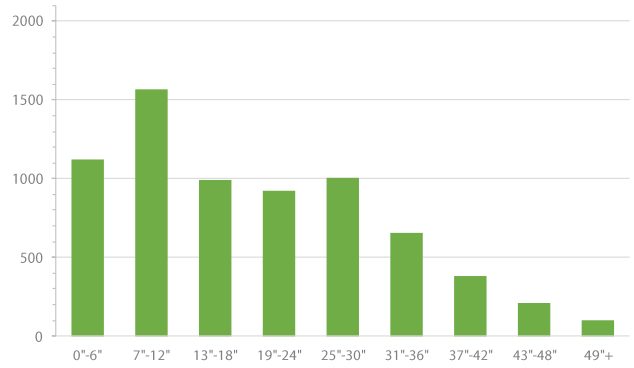
Green-Wood Cemetery's tree population is currently defined as irregular uneven-aged, meaning that there are substantial numbers of trees in the young, middle, and older age classes, but they are not evenly distributed from young to old.

In 2005, there was a similar irregular uneven-aged age structure Cemetery-wide, with a significant quantity spike in the older mature and younger over-mature classes. This was apparently the result of fairly consistent annual removal and replanting efforts over several prior decades. The 2016 Inventory found a dramatic ten-year shift in the age structure with significantly more trees now occupying the young age classes, a direct result of large numbers of mature and over-mature trees being lost to storms, age, and disease and subsequent replanting since 2005.

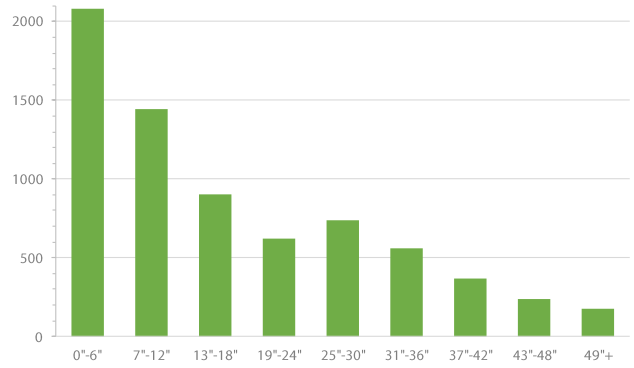
Within several species, there is an even-aged structure, meaning that large numbers of trees of the same species are approximately the same age. This is likely the result of the popularity of different species at different points in time and the periodic planting of monocultural roadside allées and other designed landscape features. In the future, this unbalanced age structure within certain species will result in marked changes in the landscape as relatively large number of trees of the same species, and often in the same area, approach the limit of their service life expectancy together.

This is not necessarily undesirable in all cases, however, since wholesale removal and replacement is the only way to fully recreate the aesthetic impact of even-aged, monocultural plantings like a roadside allée.

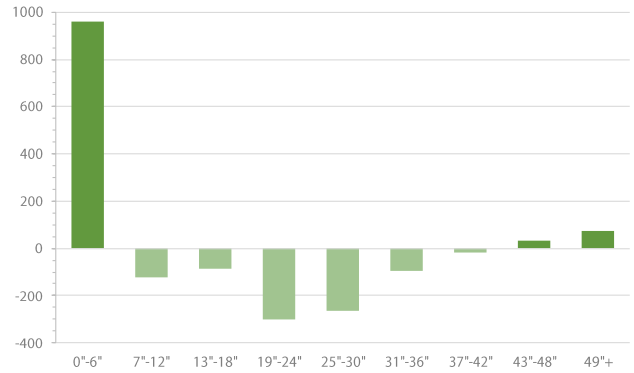
2005 DIAMETER DISTRIBUTION



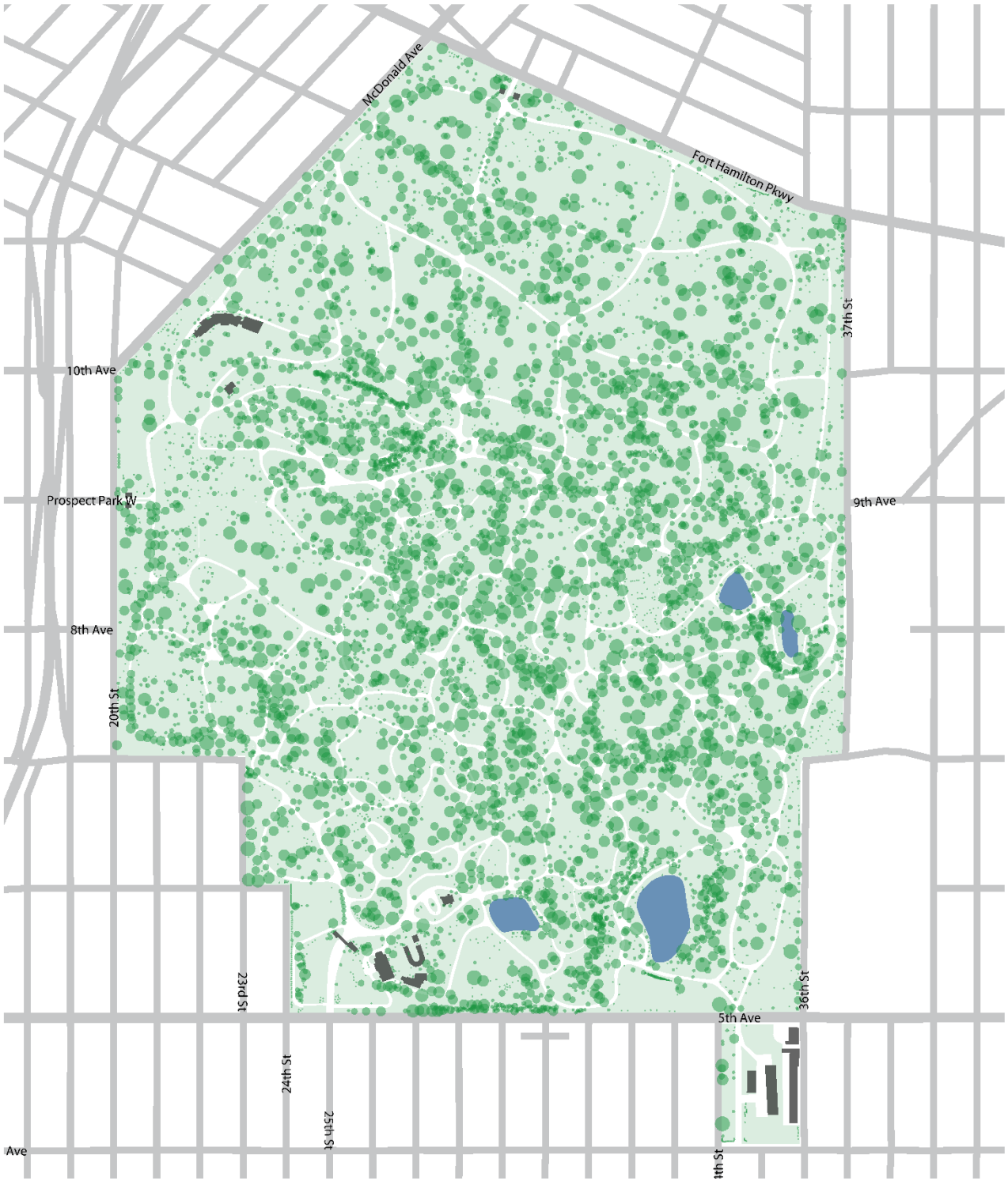
2016 DIAMETER DISTRIBUTION



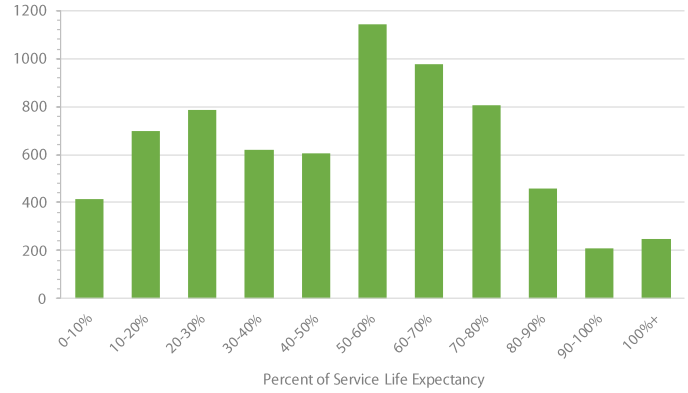
2005–2016 DIAMETER DISTRIBUTION CHANGE



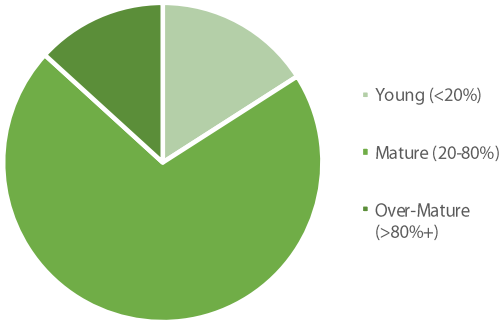
DIAMETER DISTRIBUTION, 2016



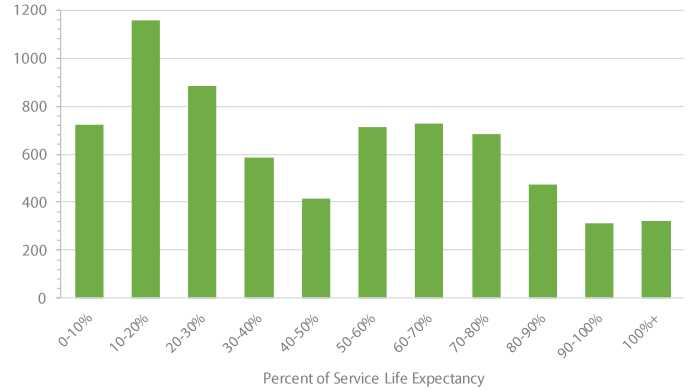
2005 AGE DISTRIBUTION



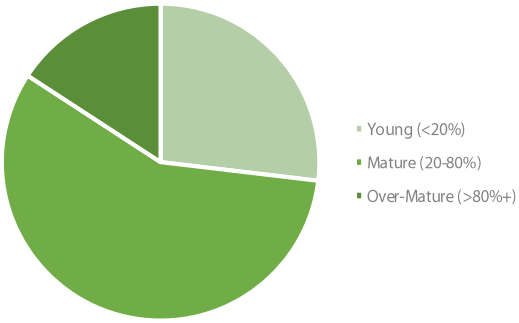
2005 AGE CLASS DISTRIBUTION



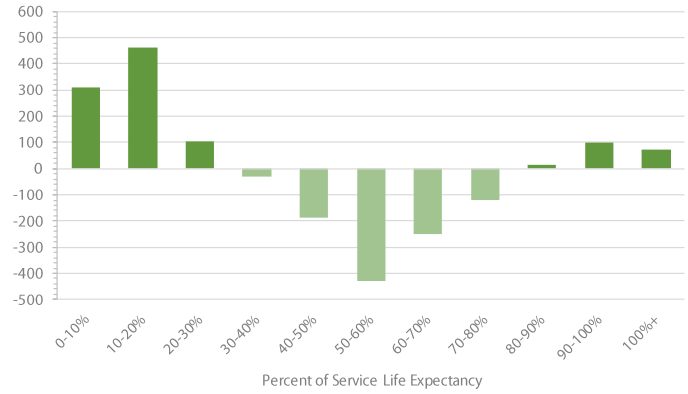
2016 AGE DISTRIBUTION



2016 AGE CLASS DISTRIBUTION



2005-2016 AGE DISTRIBUTION CHANGE



2016 TREE POPULATION OVERVIEW
BY AGE CLASS AS PERCENTAGE OF TYPICAL SERVICE LIFE EXPECTANCY

Excludes trees not identified to species

SPECIES	0-10%	10-20%	20-30%	30-40%	40-50%	50-60%	60-70%	70-80%	80-90%	90-100%	100%+	TOTAL
A												
Abies balsamea		1										1
Abies concolor									1		1	2
Abies nordmanniana	1		1	4	9	9						24
Acer buergerianum			5									5
Acer campestre							1					1
Acer cappadocicum										1	1	2
Acer crataegifolium	1											1
Acer davidii ssp. Grosseri	1											1
Acer griseum		1	1									2
Acer palmatum	5	15	13	12	9	8	20	7	8	1	5	103
Acer platanoides	2	130	124	78	40	109	117	76	30	16	5	727
Acer pseudoplatanus		17	23	12	10	18	20	11			1	112
Acer pseudosieboldianum ssp. Takesimense	1											1
Acer rubrum	8	1	8	8	1	3	5	2	3	2	4	45
Acer rubrum var. trilobum	3											3
Acer saccharinum									1		5	6
Acer saccharum	15					1	3	7	9	13		48
Acer sempervirens	5											5
Acer triflorum	3	2										5
Aesculus hippocastanum		4		1	4	31	34	28	14	10	4	130
Aesculus pavia			1	3								4
Aesculus x carnea										1	3	4
Ailanthus altissima		9	13	9	4	2	1	1				39
Albizia julibrissin	1											1
Amelanchier canadensis		1	11									12
Amelanchier x grandiflora	5	4	2									11
Asimina triloba	8											8
B												
Betula lenta			1	1	1	5	4	1				13
Betula nigra	11	13	1	4								29
Betula papyrifera					1	1						2
Betula pendula			1					1	1			3
Betula szechuanica	5											5
Betula utilis var. jacquemontii	2	5	5			1						13
Buxus sempervirens		2	7	4	3	1						17
C												
Carpinus betulus	17	50	5	1								73

SPECIES	0-10%	10-20%	20-30%	30-40%	40-50%	50-60%	60-70%	70-80%	80-90%	90-100%	100%+	TOTAL
Carpinus caroliniana			6								3	9
Carpinus japonica		1	1									2
Carya cordiformis		1			4	4	8	6	2			25
Carya glabra					1	5	3		2			11
Carya laciniosa				1	1	1	2	1				6
Carya ovata			1	4	9	11	2					27
Carya tomentosa					3	1	2					6
Castanea dentata	1	3										4
Catalpa speciosa		11		1						1		13
Cedrus atlantica	4	2	1	3		1	5	9	2	5	1	33
Cedrus deodora	4											4
Cedrus libani									1			1
Celtis occidentalis	3	5		2			3	1		1	1	16
Celtis tenuifolia	3											3
Cephalotaxus sinensis	2											2
Cercidiphyllum japonicum	13	9	4								1	27
Cercis canadensis	1	26	43	12	1	3	1					87
Cercis canadensis var. alba			1									1
Cercis chinensis	8	1										9
Cercis reniformis	5	3	6									14
Chamaecyparis nootkatensis	3	6										9
Chamaecyparis obtusa	14	3	4	6	11	3	1					42
Chamaecyparis pisifera	6	10	10	25	35	43	22	24	6			181
Chamaecyparis thyoides							1	1				2
Chionanthus retusus		7	1									8
Chionanthus virginicus		1	1	2			1					5
Cladrastis kentukea	2		2			4	1	2	2		3	16
Cornus alternifolia		2	2									4
Cornus controversa			1		1							2
Cornus florida	1	36	17	16	13	31	55	35	28	3	2	237
Cornus florida sub. Urbiniana	1											1
Cornus kousa	3	15	12	11	2	10	5	7	5	2	4	76
Cornus officinalis	3											3
Cornus wilsoniana	6											6
Cornus x 'Rutdan'				1								1
Cornus x 'Rutgan'		1	1									2
Cornus x 'Rutlan'			1									1
Corylus colurna	7	2	5							1	8	23
Cotinus coggygria		2		1	1	2						6
Cotinus obovatus	3											3
Crataegus laevigata				1		4	4	1	2	1	3	16

SPECIES	0-10%	10-20%	20-30%	30-40%	40-50%	50-60%	60-70%	70-80%	80-90%	90-100%	100%+	TOTAL
Crataegus phaenopyrum			1									1
Crataegus viburnifolia	1											1
Crataegus viridis		2	3									5
Cryptomeria japonica	16	8	8	15	5	2						54
D												
Diospyros virginiana	5				3	5						13
E												
Eucommia ulmoides		2	9									11
Euonymus alatus						1						1
Euptelea pleiosperma	3											3
F												
Fagus grandifolia	3									1		4
Fagus sylvatica	19	13	5		5	17	33	35	34	9	8	178
Franklinia alatamata	4	1						1				6
Fraxinus americana			5		1		1	2	1		1	11
Fraxinus baroniana	1											1
Fraxinus excelsior							1	1		1		3
Fraxinus holotricha											1	1
Fraxinus pennsylvanica	1					1		2		1		5
G												
Ginkgo biloba	1	5	3	5	4	11	7	8	7	9	10	70
Gleditsia triacanthos var. inermis	32	13	9	5	3	4	1	3	1			71
Gymnocladus dioicus	3	11	3	1		3	2	4	5	5	1	38
H												
Halesia carolina	1	2	1									4
Halesia diptera	1											1
Halesia diptera var. magniflora	2											2
Halesia tetraptera								1				1
Hibiscus syriacus		1	1									2
Hydrangea paniculata		3	13	12	1	5	1		2			37
I												
Ilex Nellie R. Stevens		1										1
Ilex opaca		1	3	4	1	4		2			2	17
Ilex spp.		2	5	2	1	1	1					12
Ilex x aquipernyi	2											2
J												
Juglans cinerea						1	1					2
Juglans nigra							2					2
Juglans regia							1					1
Juniperus chinensis	5	6	6	6	2							25
Juniperus virginiana	1		2	2	1	5	3	5	2	3		24

SPECIES	0-10%	10-20%	20-30%	30-40%	40-50%	50-60%	60-70%	70-80%	80-90%	90-100%	100%+	TOTAL
K												
Koelreuteria paniculata		2	3	2					1		1	9
L												
Lagerstroemia indica		9	9									18
Larix decidua						1	1					2
Larix kaempferi						2	1	1				4
Liquidambar styraciflua	13	24	2	2	2	7	24	30	16	7	6	133
Liriodendron tulipifera	6	13	3	2	4	7	9	29	30	25	26	154
M												
Maackia amurensis		2	3	1			3					9
Magnolia acuminata		1	1	1			1	2	1	5	6	18
Magnolia denudata						3	5	2	2	3	3	18
Magnolia grandiflora		5	7	1								13
Magnolia stellata	1	4	3	1		1					1	11
Magnolia virginiana	6	2					1					9
Magnolia x brooklynensis	3											3
Magnolia x soulangiana		7	6	6	1	5	7	8	11	9	11	71
Malus 'Cortland'							1					1
Malus 'Donald Wyman'		4	3									7
Malus 'Granny Smith'				1		1						2
Malus hupehensis			1									1
Malus 'Indian Magic'		2										2
Malus 'Robinson'		2	1									3
Malus 'Royal Raindrops'		1	2									3
Malus 'Snowcloud'								1				1
Malus spp.		29	14	8	6	13	6	6	12	4	13	111
Malus 'Strawberry Parfait'					1		1					2
Malus 'Yellow Delicious'				1					1			2
Metasequoia glyptostroboides	4	11	8	2	1	1	1				1	29
Morus alba		1	2	3	3	6	8	5	2		11	41
Morus australis										1		1
N												
Nyssa sylvatica	21	2	1			3	2			1		30
O												
Ostrya virginiana		5									1	6
Oxydendrum arboreum			1	1	1		1	1			1	6
P												
Parrotia persica	1	18	1	1								21
Parrotia subaequalis	3											3
Phellodendron amurense				1	4	1					1	7
Picea abies	4	2	5	8	16	23	18	6	1	2		85

SPECIES	0-10%	10-20%	20-30%	30-40%	40-50%	50-60%	60-70%	70-80%	80-90%	90-100%	100%+	TOTAL
Picea glauca	1	1	4	2	3		1					12
Picea omorika	5	1	3									9
Picea orientalis	13	1			2	1						17
Picea pungens	2	1	2	6	8	9	11	11	4	2		56
Pinus bungeana	1											1
Pinus cembra		1		1	1	2	4		1	1		11
Pinus flexilis				1	4	5		1			4	15
Pinus koriensis	1	1						2				4
Pinus mugo			1	1								2
Pinus nigra	2		1	5	10	8	1					27
Pinus parviflora	4	2										6
Pinus peuce		1										1
Pinus rigida	1											1
Pinus strobus	33	11	3		7	20	22	17	13	5	5	136
Pinus sylvestris			1	1			1					3
Pinus thunbergii	3		1	3	3							10
Pinus wallichiana	3		2		3	6	7	9	9	6		45
Platanus occidentalis										1		1
Platanus x acerifolia	3	3	4	3	1	5	18	32	29	9	8	115
Poliothrysis sinensis	4											4
Populus deltoides							1					1
Populus tremuloides	27	69	1									97
Prunus avium										1		1
Prunus cerasifera		1	2	1		5	2					11
Prunus incisa		1										1
Prunus padus	3											3
Prunus sargentii		2	4									6
Prunus serotina	3	73	92	57	20	22	4	5	2	2	4	284
Prunus serrulata	1	1	9	11	20	25	21	17	6	7	19	137
Prunus subhirtilla		3	3	15	11	5	1		1		1	40
Prunus virginiana		3	5									8
Prunus x Okame		3										3
Prunus x snozofam							1					1
Prunus x yedoensis			5	3	1	3	2	1	1	3	13	32
Pseudotsuga menziesii				4	5	3	4					16
Pyrus calleryana		4	2	5		1		3	1			16
Q												
Quercus acutissima	1		2	1								4
Quercus alba	4	5	2				1	2	6	4	6	30
Quercus bicolor	4	8	4									16
Quercus cerris											1	1

SPECIES	0-10%	10-20%	20-30%	30-40%	40-50%	50-60%	60-70%	70-80%	80-90%	90-100%	100%+	TOTAL
Quercus coccinea		5	2					1	2	1		11
Quercus imbricaria	1	14										15
Quercus macrocarpa	5	13		1								19
Quercus michauxii	2											2
Quercus nutalli	1		1									2
Quercus palustris	4	10	11	32	8	17	28	53	60	51	27	301
Quercus phellos		4	3	4							4	15
Quercus prinus										1		1
Quercus robur		15						1		1		17
Quercus rubra	17	24	9	11	4	7	10	31	34	33	15	195
Quercus shumardii	1	2										3
Quercus velutina		1						1		1	12	15
Quercus virginiana	6											6
Quercus x warei	4	1										5
R												
Rhododendron catawabiense					1							1
Rhus copallinum		1										1
Robinia pseudoacacia	3	10	4	4	2	1	1	1				26
S												
Salix alba	1											1
Salix babylonica											2	2
Salix matsudana	3	4	1									8
Salix nigra											1	1
Sassafras albidum	1	2	5	6	5	1	1	2	1		4	28
Sciadopitys verticillata				1								1
Stewartia monodelpha	2											2
Stewartia pseudocamellia		1										1
Styphnolobium japonicum				1	3	3	1	3	2			13
Styrax americanus	5											5
Styrax japonicus			5	2		1						8
Styrax obassia				1								1
Syringa reticulata		9	1		1	3						14
T												
Taxodium ascendens	3		1									4
Taxodium distichum	5	1	1			7	4	3	1			22
Taxus baccata	1	4	3	3	1	3						15
Taxus spp.	9	58	109	51	46	47	23	20	7	9	15	394
Taxus wallichiana var chinensis	3											3
Tetradium daniellii	2			1								3
Thuja occidentalis	107	49	32	9	6	9	8	5		2	2	229
Thuja orientalis		1	2	1		2	1	9	2	4	1	23

SPECIES	0-10%	10-20%	20-30%	30-40%	40-50%	50-60%	60-70%	70-80%	80-90%	90-100%	100%+	TOTAL
Thuja plicata	37	20	1	1		1						60
Tilia americana	1	28	4			8	12	24	10	6	2	95
Tilia cordata	5	27	27	13	1	10	27	36	25	9	4	184
Tilia petiolaris							4	2	2	2	2	12
Tilia platyphyllos						4	4	3	3			14
Tilia tomentosa		1					1	4	2	3		11
Tilia x euchlora	1	2				12	21		2			38
Tilia x europaea				1	4	6	10	6	1	1	1	30
Trochodendron aralioides	1											1
Tsuga canadensis		4	3	3	3		1					14
U												
Ulmus americana	12	8	1	1				1		1		24
Ulmus glabra			2			1	2	1		2	7	15
Ulmus macrocarpa	1											1
Ulmus parvifolia			1									1
V												
Viburnum prunifolium						1	1	1				3
X												
X Cupressocyparis leylandii	2	3	6	2								13
X Gordlinia grandiflora	3											3
Z												
Zelkova serrata	4	22	3		2	1		1	1			34
TOTALS*	**722**	**1159**	**886**	**586**	**416**	**711**	**727**	**685**	**474**	**312**	**320**	**6998**

** Excludes trees not identified to species.*

CHANGES SINCE 2005

Two overarching population distribution transitions are occurring within Green-Wood Cemetery's urban forest that affect overall canopy cover. These can be described as a transition from a forest composed primarily of mature trees of species that achieve large stature at maturity (e.g. oaks, elms, planetrees) to a forest with both a higher concentration of young trees and a higher concentration of trees that achieve small to medium stature at maturity. Generally, these smaller trees are also shorter-lived.

In 2005, 70% of the tree population was comprised of species classified as large or very large in mature size potential, 17% classified as medium, and 13% classified as small. Among the approximately 1,800 new trees planted over the past ten years, just 44% are classified as large of very large, 30% are classified as medium, and 26% are classified as small. This has resulted in a current tree population comprised of 64%, 20%, and 16% in each of the species size classes respectively.

This two-fold change means that not only has the overall canopy cover decreased over the past ten years as large trees were lost to Hurricane Sandy and other storms, age, and disease and replaced with small, young trees, but the overall long-term potential for mature canopy cover has also decreased as a result of large species being removed and replaced with species that will only achieve small or medium size.

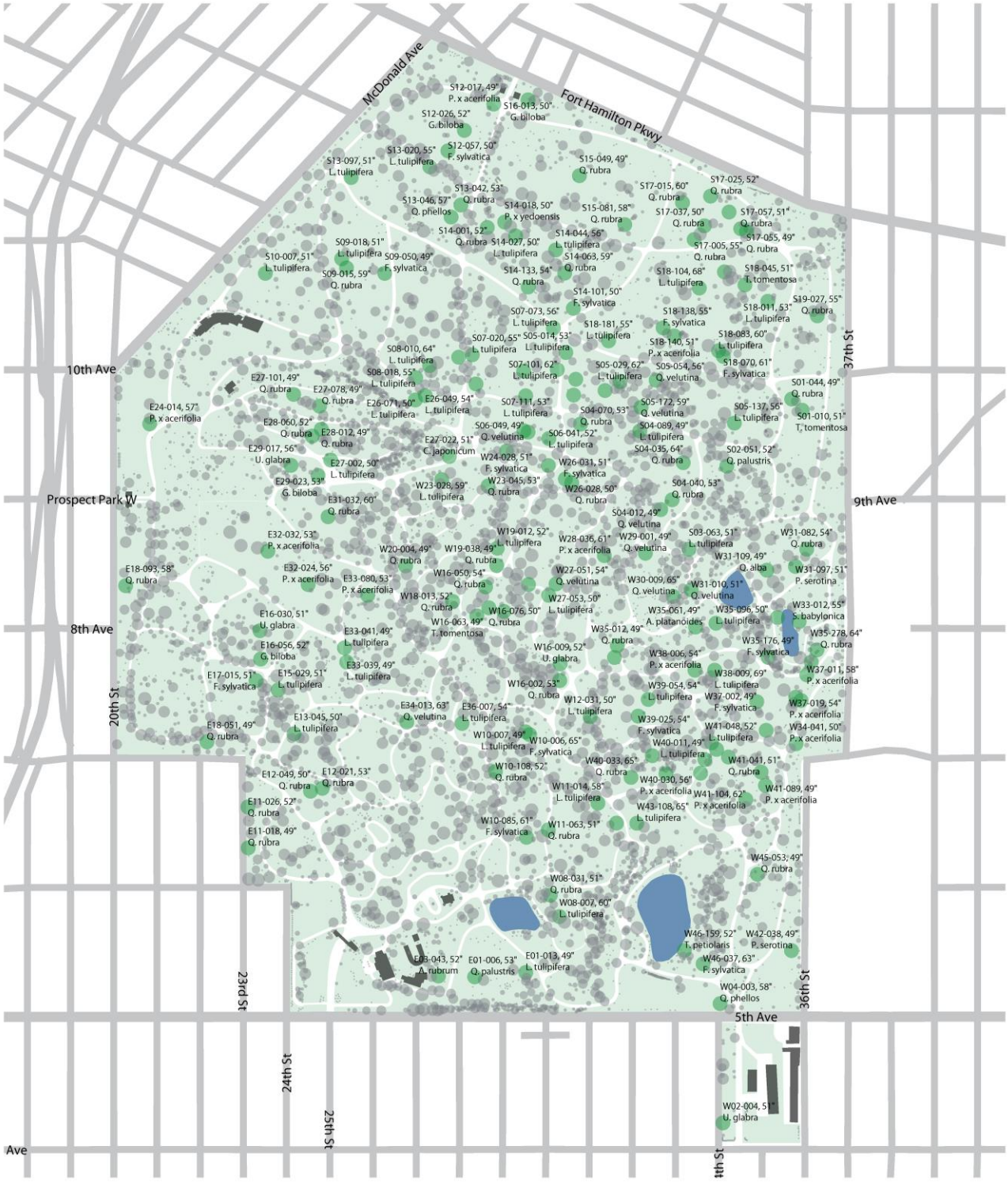
TREE POPULATION CHANGES, 2005–2016

GREEN-WOOD CEMETERY'S LARGEST TREES

December, 2016

ISLAND	TAG NO.	SPECIES	DIAMETER	CONDITION
W38	9	*Liriodendron tulipifera* (tulip)	69″	Good
S18	104	*Liriodendron tulipifera* (tulip)	68″	Fair
S07	8	*Fagus sylvatica* (European beech)	66″	Good
W10	6	*Fagus sylvatica* (European beech)	65″	Fair
W40	33	*Quercus rubra* (northern red oak)	65″	Fair
W43	108	*Liriodendron tulipifera* (tulip)	65″	Fair
W30	9	*Quercus velutina* (black oak)	65″	Poor
W35	278	*Quercus rubra* (northern red oak)	64″	Fair
S08	10	*Liriodendron tulipifera* (tulip)	64″	Poor
S05	22	*Liriodendron tulipifera* (tulip)	64″	Poor
S04	35	*Quercus rubra* (northern red oak)	64″	Fair
E34	13	*Quercus velutina* (black oak)	63″	Fair
W46	37	*Fagus sylvatica* (European beech)	63″	Fair
S05	29	*Liriodendron tulipifera* (tulip)	62″	Fair
S07	101	*Liriodendron tulipifera* (tulip)	62″	Fair
W41	104	*Platanus x acerifolia* (London planetree)	62″	Good
W10	85	*Fagus sylvatica* (European beech)	61″	Good
W28	36	*Platanus x acerifolia* (London planetree)	61″	Fair
S18	70	*Fagus sylvatica* (European beech)	61″	Good
W41	46	*Liriodendron tulipifera* (tulip)	60″	Poor
E31	32	*Quercus rubra* (northern red oak)	60″	Good
S17	15	*Quercus rubra* (northern red oak)	60″	Fair
W11	22	*Liriodendron tulipifera* (tulip)	60″	Good
W08	7	*Liriodendron tulipifera* (tulip)	60″	Fair
S08	64	*Magnolia acuminata* (cucumber magnolia)	60″	Good
S18	83	*Liriodendron tulipifera* (tulip)	60″	Fair

GREEN-WOOD'S LARGEST TREES



TREE CONDITION

CURRENT TREE CONDITION

Green-Wood Cemetery's tree population is currently in fair condition overall, based on the number of trees in each of the Good, Fair, Poor, and Dead condition classes. While substantial segments of the population are in good to very good condition, others are deteriorating due to advancing age, environmental stresses, insect and disease pressures, and/or certain maintenance practices.

Additionally, the spatial distribution of tree conditions within the Cemetery is generally balanced, with roughly the same proportions of good to fair to poor trees throughout. Trees in under-maintained woodlot areas tend to have the poorest average distribution of condition ratings, while areas of maintained lawn with partially closed, uncrowded canopies tend to have the best.

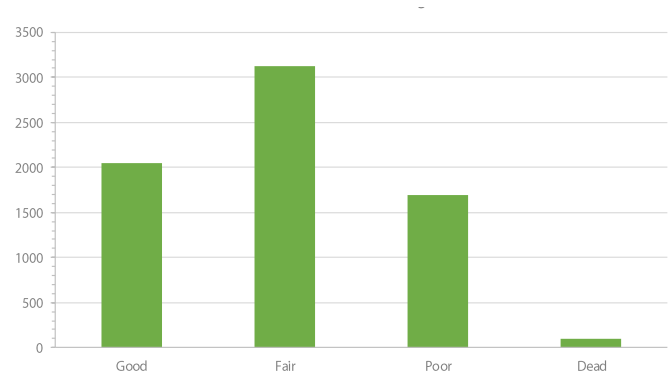
36.7% (29.5% in 2005) of Green-Wood's individually inventoried trees were rated in 'Good' condition, 45.3% (44.9% in 2005) were rated in 'Fair' condition, 17% (24.3% in 2005) were rated in 'Poor' condition, and 1.0% (1.4% in 2005) were Dead at the time they were inventoried.

Trees that are currently in 'Good' condition require no immediate attention (other than priority pruning or other maintenance treatments, where recommended) and should survive well into the future with minimal care. It is important to realize, however, that even trees in good condition are not maintenance free. Many of the trees rated in good condition require high priority pruning.

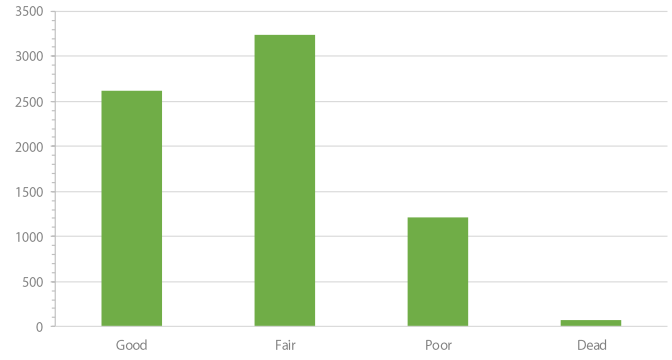
Although trees in 'Fair' condition can be expected to survive for at least several years, they may deteriorate without treatment and routine maintenance. With corrective treatments and proper maintenance, trees currently in fair condition can often be improved to good condition at a lower cost than neglecting and eventually removing and replacing them.

It is important to note that a Fair rating, as defined for this Tree Inventory and Assessment, does not mean that a tree is in a significantly degraded condition. Rather, for mature trees, it should be considered "average" condition in the urban context. Trees tend to accumulate health issues and structural defects over time, making it increasingly unlikely that most trees will maintain a Good rating through maturity. Conversely, young

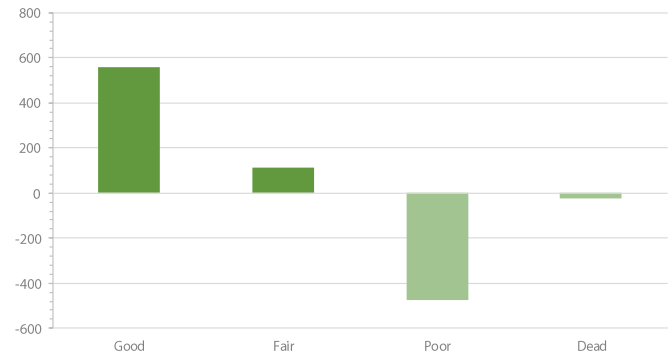
2005 CONDITION RATINGS



2016 CONDITION RATINGS



2005-2016 CONDITION RATINGS CHANGE



trees that have fully recovered from transplanting tend to be in Good condition.

Trees in 'Poor' condition have significant health disorders and/or structural defects and are likely to continue to deteriorate and require removal within the short term. Treatments may improve their condition temporarily, but the need for ongoing treatments to maintain them will be costly and of little benefit over the long term.

Many of the trees rated in 'Poor' condition because of structural defects, rather than health, have been recommended for removal. The priority level at which their removal is recommended is dependent upon the nature and severity of the defects.

All 'Dead' trees of significant size must be removed on a priority basis due to the potential for hazard and liability.

Since 2005, there has been a significant increase in the number of trees rated in Good condition and a corresponding reduction in the number of trees rated in Poor condition. This is largely due to Green-Wood Cemetery's diligence in addressing and often removing dead, dying, structurally defective, and irreparably storm-damaged trees.

A substantial number of trees are fully foliated and growing well, but possess potentially hazardous structural defects such as cracks, wood decay, and weakly attached co-dominant stems and limbs. Many of the 'Poor' ratings were the sole result of the number and severity of structural defects in trees that are in an otherwise healthy and vigorous condition.

Structural problems frequently noted throughout the Cemetery and which often resulted in reduced condition ratings and/or recommendations for removal in otherwise healthy trees include structurally defective branching, such as codominant stems, and advanced wood decay, one or both of which is likely to result in the failure of a large portion of the tree.

1. Structurally defective branching. In many cases, these defects may have been corrected through developmental pruning when the tree was young.
2. Advanced wood decay resulting from the splitting of structurally defective branches, insufficient or improper pruning, bark wounds, or root injury related to soil excavation. In all cases, the resulting wounds served as an entry point for wood decay organisms and the advancement of decay over time.

In many cases, trees installed under the NYRP program were planted too deeply, with the root collar set two inches or more below the surrounding soil grade.

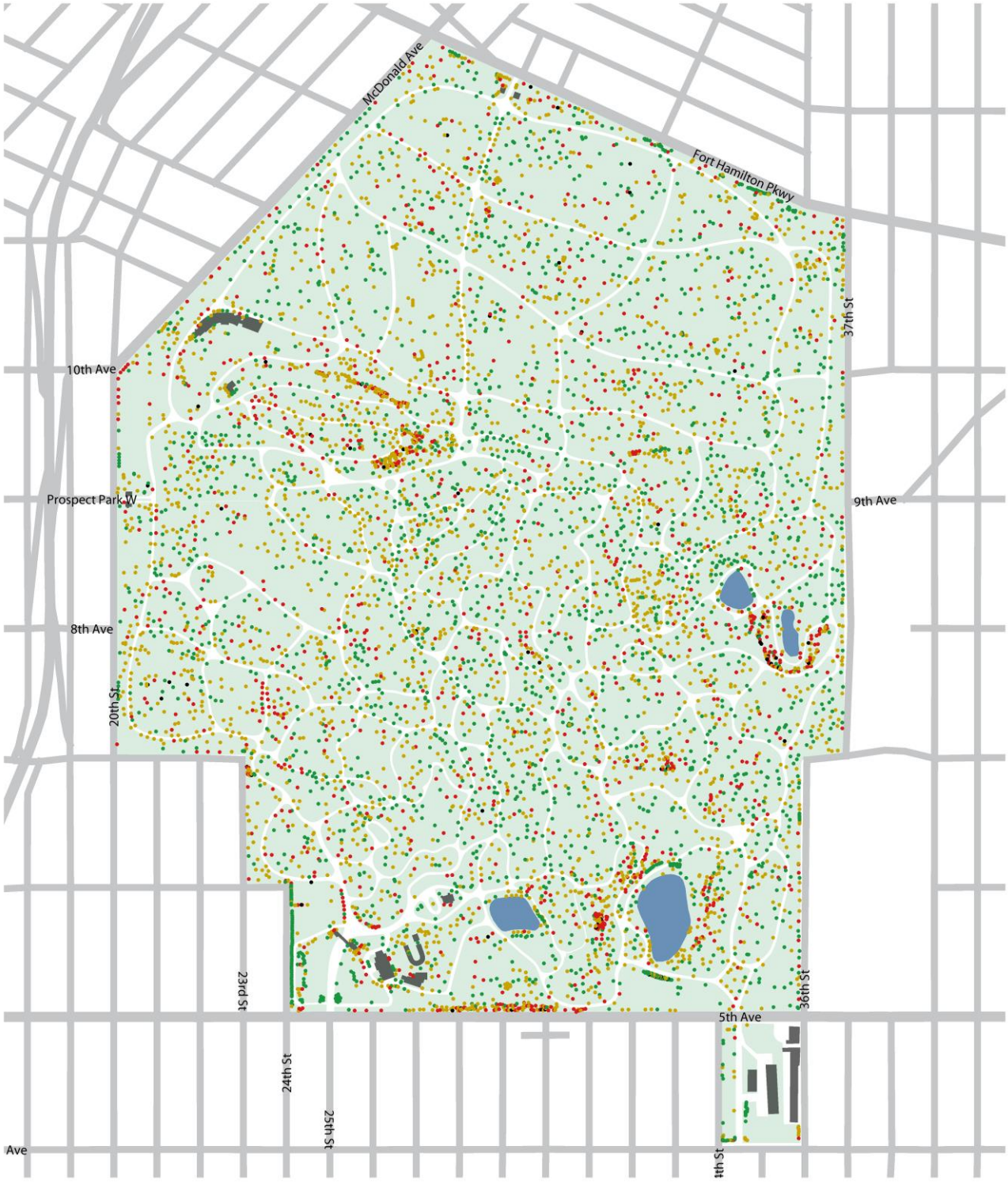
Deep planting can have a profound negative effect on tree development and longevity by encouraging the development of circling and stem-girdling roots and susceptibility to a variety of diseases of the roots and lower stem. Root collar excavation and correction of misdirected roots within a few years of planting can eliminate such issues and allow normal, long-term development.

SPECIES PERFORMANCE

Significant differences exist in the performance and current condition of certain tree species within Green-Wood Cemetery.

Of the species comprising at least 1% of the trees rated in Poor condition, the following are performing poorly more often than other species at Green-Wood Cemetery (based on the species comprising a significantly greater percentage of the trees in Poor condition than its percentage among all trees):

TREE CONDITION, 2016



1. *Acer platanoides* (Norway maple): 16.7% of the trees in poor condition, versus 10.2% of the tree population.
2. *Prunus serotina* (black cherry): 13.1% versus 4.0%
3. *Cornus florida* (flowering dogwood): 7.7% versus 3.3%
4. *Acer pseudoplatanus* (Sycamore maple): 4.4% versus 1.6%
5. *Aesculus hipposcastanum* (horsechestnut): 3.2% versus 1.8%
6. *Prunus serrulata* (Japanese flowering cherry): 2.9% versus 1.9%
7. *Morus alba* (white mulberry): 2.5% versus 0.6%
8. *Ailanthus altissima* (Ailanthus): 1.6% versus 0.5%
9. *Acer saccharum* (sugar maple): 1.4% versus 0.7%
10. *Pinus nigra* (Austrian pine): 1.3% versus 0.4%

In two cases (i.e. horsechestnut, sugar maple), the relatively high percentage of trees in poor condition is more closely related to the number of aged versus young trees than a significant inherent problem with the species that should limit its replanting.

Norway maple, black cherry, Ailanthus, and sycamore maple are inherently troublesome species with strong invasive tendencies that are generally considered to be undesirable in high-use landscapes. The use of these and other species with similar site requirements and growth characteristics should be limited, or completely eliminated, in the future.

Although flowering dogwood is also a troublesome species in terms of maintaining long-term health, it is highly desired. To maintain the condition of future dogwood plantings, extra care should be given to selecting appropriate sites and ensuring that the trees receive sufficient follow-up maintenance.

Of the species comprising at least 1% of the tree population, the following are performing well, or have performed well for extended periods of time at Green-Wood Cemetery (based on the species comprising a significantly lesser percentage of the trees in poor condition than its percentage among all trees):

1. *Acer palmatum* (Japanese maple)
2. *Ginkgo biloba* (Ginkgo)
3. *Gleditsia triacanthos* (honeylocust)
4. *Liquidambar styraciflua* (sweetgum)
5. *Liriodendron tulipifera* (tulip)
6. *Platanus x acerifolia* (London planetree)
7. *Picea abies* (Norway spruce)
8. *Pinus strobus* (White pine)
9. *Quercus palustris* (pin oak)
10. *Quercus rubra* (northern red oak)
11. *Thuja occidentalis* (American arborvitae)
12. *Tilia cordata* (littleleaf linden)

These species—and many other minor species that have more trees in good and fair condition than poor—should be perpetuated.

Additionally, other species and cultivars with similar site requirements and growth characteristics should continue to be introduced in future plantings. No single species, however, should be favored to the extent that Cemetery-wide species diversity is reduced.

KEY FOREST HEALTH ISSUES

Key forest health issues that currently threaten Green-Wood's tree population and the surrounding urban forest include:

- **Emerald ash borer (EAB) *(Agrilus planipennis):*** Emerald ash borer is an invasive wood-boring beetle native to eastern Asia which has been shown to cause nearly complete mortality of native ash trees *(Fraxinus spp.)* in the areas it infests within the United States. After an infestation in Michigan in the early 2000's which decimated the ash tree population by killing millions of trees, EAB has spread to numerous states, including New York, causing extreme and catastrophic losses of native ash trees wherever it spreads. While EAB has not yet been detected in New York City, it has been detected throughout New York State and, in the past two years, in several locations in New Jersey. Green-Wood Cemetery is currently at low risk due to the relatively low percentage of ash trees within the cemetery (0.3%; 21 trees).

- **Asian longhorned beetle (ALB) *(Anoplophora glabripennis):*** Asian longhorned beetle is an invasive wood-boring beetle native to Asia which has been shown to be particularly virulent and generally fatal in many tree species native to America, including maples *(Acer spp.)*, elms *(Ulmus spp.)*, buckeyes *(Aesculus spp.)*, willows *(Salix spp.)*, planetrees *(Platanus spp.)*, and birches *(Betula spp.)*. The first American infestations of ALB occurred in the 1980s, as increased trade with China led to the import of goods shipped on pallets constructed of infested poplar *(Populus)* wood. Numerous outbreaks occurred throughout the United States in subsequent decades, but programs combining the restriction of wood transport and the requirement for China to fumigate pallets prior to international shipping have greatly reduced or eliminated ALB infestations throughout North America, including within New York State. Although Green-Wood Cemetery possesses a large number of susceptible trees, current risk is relatively low due to the beetle's current scarcity and effective control policies in place.

- **Oak wilt *(Ceratocystis fagacearum):*** Oak wilt is a fungal disease of unclear origin which has been shown to be fatal to nearly all native oak species *(Quercus spp.)* in the United States, but which is particularly virulent within the red oak subgenus *(Erythrobalanus)*. Oak wilt was first detected in the US in 1942 and has existed in the central and Midwestern United States since then, causing widespread losses of native oak trees within both forests and urban areas. The disease is

spread through both insect vectors and root grafts. Until recently, the fungus did not exist in the northeastern Atlantic states or New England, but oak wilt was recently identified within Green-Wood Cemetery. Green-Wood is at a high risk of significant losses to oak wilt due to the high percentage of oak trees (9.3%; 664 trees) and the confirmed presence of the fungus within the Cemetery.

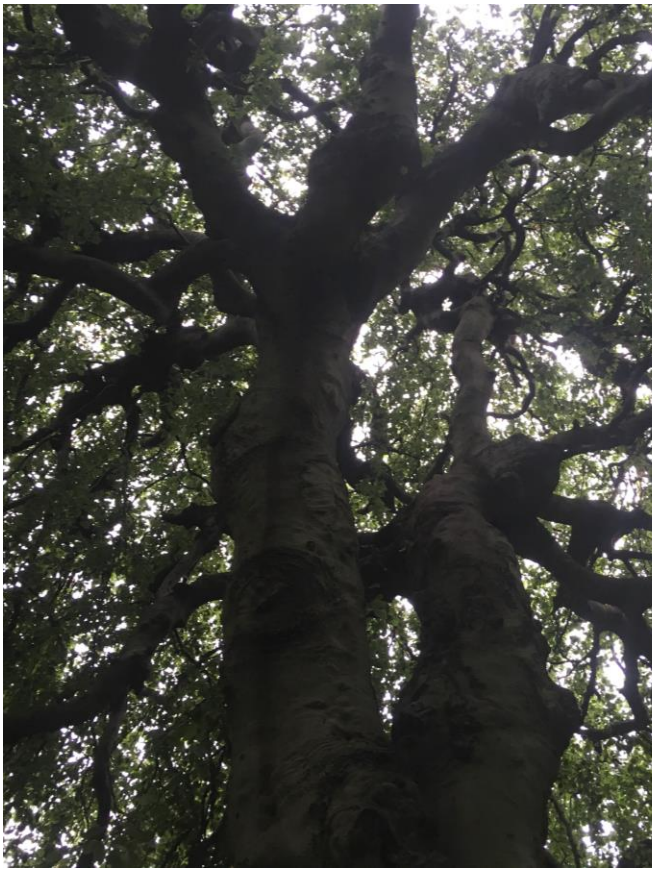
- **Southern pine beetle *(Dendroctonus frontalis):*** Southern pine beetle is a native bark beetle that is fatal to pine trees *(Pinus spp.)* in the United States, especially during seemingly random periods when the beetle's population reaches epidemic levels. Southern pine beetle has been a major forest pest in the United States for as long as forestry has been in practice here. When the beetle's populations are at low levels, the beetle does not cause significant damage to pine tree populations, but when populations swell to epidemic levels, even healthy trees and stands can succumb en-masse. Green-Wood Cemetery is at moderate risk for significant health issues to its urban forest from southern pine beetle due to its moderate percentage of pine trees (3.7%; 266 trees) and the confirmed presence of the beetle in regions close to the Cemetery, including Long Island and Rockland County.

- **Bacterial leaf scorch (BLS) *(Xylella fastidiosa):*** Bacterial leaf scorch is a bacterial disease of water-conducting vascular tissue that is fatal to several species of trees in the New York – New Jersey region—primarily oak *(Quercus spp.)* as well as elm *(Ulmus spp.),* planetrees *(Platanus spp.),* sweetgum *(Liquidambar styraciflua), and* maple *(Acer spp.).* No effective treatments are currently known beyond antibiotics that slow, but do not halt, symptom progression. The bacterium's existence has been documented as early as the late 1800's in the grape industry, but has been a known pathogen of American trees since the 1930's. BLS's range appears to span the ranges of its host species, and it has been detected throughout New York State, including within Green-Wood Cemetery via a positive test in 2005. The Cemetery is at a moderate risk for significant health issues to its urban forest from BLS due to its relatively high percentage of potential host trees, particularly those within the red oak subgenus *(Erythrobalanus), and* the confirmed presence of the bacterium in the past.

- **Canker stain *(Ceratocystis fimbriata f. sp. platani):*** Canker stain is a fungal disease which is highly damaging and potentially fatal to trees in the planetree genus *(Platanus spp.)* and which can cause widespread mortality in areas of high planetree density. Canker stain is widespread throughout New York City and has presented a significant threat to the City's urban planetree population, moving through populations throughout the five Boroughs and causing significant losses. Green-Wood Cemetery is at moderate risk for significant health issues to its urban forest from canker stain due to its moderate planetree population (1.6%; 116 trees) and the current presence of the fungus in several areas within the Cemetery.

- **Bleeding canker *(Phytophthora spp.):*** Bleeding canker is a fungal disease caused by an ubiquitous, soil-borne pathogen that has proven fatal to European beech trees *(Fagus sylvatica),* as well as oaks and several other species. This fungus damages the cambium of infected trees, causing significant aesthetic and functional damage before eventually killing the entire tree. Bleeding canker has been identified on, and led to the recent loss of, numerous European beech trees throughout the Cemetery as well as some oaks. Green-Wood Cemetery is at high risk for significant health issues to its urban forest from bleeding canker due to its significant European beech (2.5%; 178 trees) and oak populations and the current presence of the fungus throughout the Cemetery.

- **Butt rot** is a general wood decay condition that invades via the root plate and progresses up into the lower trunk. This disease affects a wide variety of tree species, partially because it is caused by a multitude of fungal pathogens that can infest many different tree species, and partially due to abiotic factors such as tree planting depth, root collar depth, presence of girdling roots, and improper mulch practices. At Green-Wood Cemetery, butt rot appears to be primarily occurring in oaks that have had damage to their root systems, such as pin oaks *(Quercus palustris)* along recently repaved or recurbed roads and oaks near active gravesites. Green-Wood Cemetery is at moderate risk for significant health issues to its urban forest from butt rot because of the presence of many susceptible large, mature trees as well as the frequent soil excavation performed for interments, which can cause significant root wounding leading to butt rot.



TREE MAINTENANCE

Green-Wood Cemetery's tree maintenance program has been very active since the 2005 Tree Inventory and Assessment was completed. Large numbers of trees that were found to be dead or structurally defective were removed or otherwise corrected. Nevertheless, some maintenance recommendations from the 2005 Inventory remain incomplete and a substantial list of new needs has emerged.

Prioritized maintenance recommendations were made, where necessary, for each inventoried tree.

All recommendations conform to ANSI A300 Standards for Tree Care Operations and were prioritized as High, Medium, or Low based primarily on the need to reduce hazard risks and secondarily to improve tree condition.

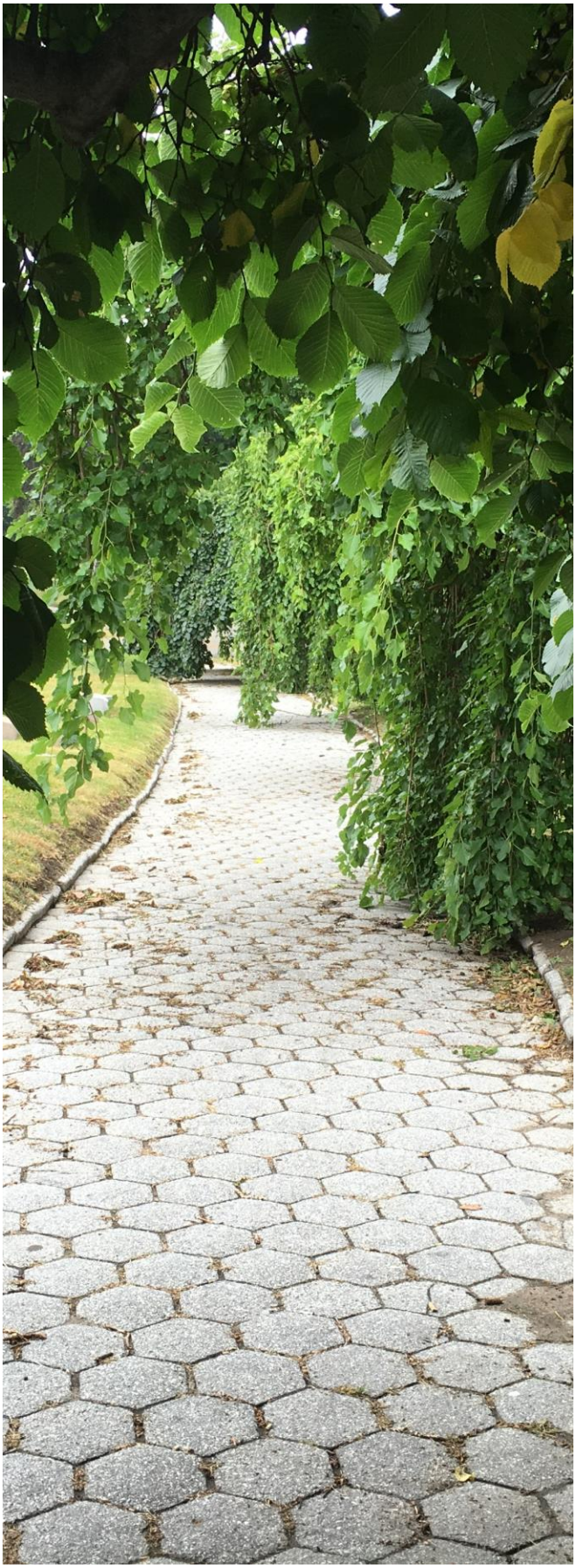
Of the 7,135 current trees individually inventoried in 2016, 1,413 (19.8%) were identified as requiring high priority pruning, removal, detailed inspection and assessment of significant structural defects, or other treatments to mitigate potentially hazardous conditions.
An additional 1,641 (23.0%) of the trees were identified as requiring medium priority pruning, removal, or other treatments to mitigate less potentially hazardous conditions.

2,656 low priority recommendations were made for pruning, small tree removal, root collar excavation, and insect and disease control, and various other treatments were made to address non-hazardous conditions, primarily to improve tree condition.

As of December, 2016:

1. 606 (8.5%) trees were recommended for removal. At the time the 2005 Tree Inventory and Evaluation was completed, 637 (9.2%) trees were recommended for removal.
    a. 316 (4.4%) were recommended for removal on a high priority basis because they are dead or so structurally unsound that they represent imminent hazard risks.
    b. 211 (3.0%) were recommended for removal on a medium priority basis because they are dead or structurally unsound to the extent that they represent moderate hazard risks.
    c. 79 (1.1%) were recommended for removal on a low priority basis. These are generally small trees that pose little risk to life and property should they fail.

2. 2,541 (35.6%) trees were recommended for crown cleaning to remove dead, dying, diseased, and damaged branches. At the time the 2005 Tree Inventory and Evaluation was completed, 2,830 (40.7%) trees were recommended for similar cleaning.
    a. 1,030 (14.4%) were recommended for cleaning on a high priority basis because they contain potentially hazardous dead, structurally unsound, or interfering limbs.
    b. 1,221 (17.1%) were recommended for cleaning on a medium priority basis because they contain moderately hazardous dead, structurally unsound, or interfering limbs.
    c. 290 (4.1%) were recommended for cleaning on a low priority basis.
3. 1,448 (20.3%) trees, versus 551 (7.9%) in 2005, were recommended for various specialized pruning, including crown raising, clearance pruning, and structural pruning. The large increase since 2005 is due, in large part, to the large number of newly planted trees for which developmental structural pruning would be highly beneficial.
    a. The majority (90.5%) of current recommendations are for structural pruning to help minimize the formation of, or mitigate the severity of, branch defects that may lead to structural failure.
    b. Of the 1,358 recommendations for structural pruning, 97% are made on a low priority basis for small and young trees that would benefit from pruning to help ensure their proper structural development as they mature.
    c. The remainder are high- and medium-priority recommendations for reducing the severity of existing structural issues in mature trees.
4. Cabling was recommended for 163 (2.3%) trees to help reduce the risk of structural failure at weakly attached codominant stems and large limbs.
5. More detailed aerial or internal inspections were recommended for 80 (1.1%) trees to more fully determine the extent of structural defects noted and an appropriate course of corrective action. The equipment and procedures necessary for completing detailed inspections and assessments were beyond the scope of this Tree Inventory and Assessment.
6. 980 existing stumps from trees previously removed were inventoried. Of these, 956 were recommended for stump removal, typically on a low priority basis. Stump removal was not recommended for a small number of existing stumps due to their location.
7. Root collar excavation to correct problems with planting depth was recommended for 787 (11.0%) recently planted trees. In 2005, similar treatment was recommended for 362 (5.1%) trees. The large increase is attributed to the large number of new trees planted over the past ten years. Based on field observations, trees planted prior to 2014, particularly many planted under the NYRP program, had significantly more issues with deep planting than those planted since 2014.



SUMMARY OF 2016 TREE MAINTENANCE RECOMMENDATIONS BY STEM DIAMETER CLASS

WORK TYPE (PRIORITY)	0"-6"	7"-12"	13"-18"	19"-24"	25"-30"	31"-36"	37"-42"	43"-48"	49"+	TOTAL
Remove (High)	1	32	38	38	65	57	36	28	21	316
Remove (Medium)	6	57	45	35	35	18	9	3	3	211
Remove (Low)	29	39	10						1	79
REMOVE SUBTOTALS	36	128	93	73	100	75	45	31	25	606
Clean Crown (High)		30	53	89	202	240	181	132	103	1030
Clean Crown (Medium)	7	111	188	235	295	190	104	58	33	1221
Clean Crown (Low)	13	81	95	46	28	11	10	5	1	290
CLEAN CROWN SUBTOTALS	20	222	336	370	525	441	295	195	137	2541
Clear (Medium)					1	1				2
Clear (Low)	7	3	5	1		3				19
Corrective Prune (High)		1								1
Corrective Prune (Medium)								1		1
Corrective Prune (Low)	2	7	4	4	1	1	1			20
Raise Crown (Low)	16	13	9	3	2	1	1	1		46
Reduce (Low)			1							1
Structural Prune (High)				1	4	1	1			7
Structural Prune (Medium)		6	14	13	5		2			40
Structural Prune (Low)	675	440	147	27	17	3	2			1311
SPECIALTY PRUNE SUBTOTALS	700	470	180	49	30	10	7	2	0	1448
Cable (High)			1	2	6	2	3	6	4	24
Cable (Medium)			7	14	23	33	21	8	16	122
Cable (Low)		1	4	2	2	1	3	4		17
CABLE SUBTOTALS	0	1	12	18	31	36	27	18	20	163
Inspect (High)				1	3	13	5	6	7	35
Inspect (Medium)				2	7	10	13	4	8	44
Inspect (Low)									1	1
INSPECT SUBTOTALS	0	0	0	3	10	23	18	10	16	80
Clear Vines and Weeds (Low)	4	13	8	5	4	1	1			36
Excavate Root Collar (Low)	483	211	83	6	2		2			787
Other (Low)	4				1					5
Prune Girdling Root (Low)	4	1	4	1	4	1				15
Treat Disease (Medium)	1			1	2					4
Treat Disease (Low)	1			1		1	1	2	2	8
Treat Insect (Low)	4	11	4	1	1					21
PLANT HEALTH CARE SUBTOTALS	501	236	99	15	14	3	4	2	2	876
Remove Stump (Low)	90	276	174	135	112	84	52	19	14	956
REMOVE STUMP SUBTOTALS	90	276	174	135	112	84	52	19	14	956
TOTAL	**1347**	**1333**	**894**	**663**	**822**	**672**	**448**	**277**	**214**	**6670**

MANAGEMENT RECOMMENDATIONS

OVERVIEW

The 2005 Tree Inventory and Assessment Report prepared by Paul Cowie and Associates presented goals, objectives, and general recommendations for guiding long-term management of Green-Wood Cemetery's urban forest resource. Many of those goals, objectives, and recommendations remain valid and appropriate and are reaffirmed below. Some modifications and additions have been made to address shifting needs and priorities since 2005.

TREE INVENTORY GOALS AND OBJECTIVES

It is strongly recommended that this Tree Inventory and Assessment and the associated database and mapping be utilized and updated on an ongoing basis to:

1. Provide accurate and updateable baseline data from which comprehensive, long-term tree management strategies and proactive management programs can be established, implemented, and evaluated.
2. Monitor and evaluate trends in the tree resource.
3. Improve the efficiency of day-to-day tree management activities by identifying, prioritizing, and scheduling planting, replanting, maintenance, and hazard abatement needs.
4. Track management activities and evaluate their long-term impact on the tree collection.
5. Monitor and evaluate progress toward the overall goals and objectives of Green-Wood Cemetery.
6. Maintain planting and maintenance records for individual shade and ornamental trees.

Specific efforts that will help achieve these goals include:

1. Producing and reviewing summary reports once per year to document the current status of the tree population, to review existing maintenance needs, and to evaluate the impact that past maintenance efforts have had.
2. Reviewing the inventory prior to planning any planting and area renovation projects.
3. Continually recording tree removals and new tree plantings by utilizing the tree tagging system established and updating the inventory database accordingly.

4. Continually utilizing the tree inventory database to schedule and record tree monitoring and maintenance activities.

TREE PLANTING GOALS AND OBJECTIVES

It is recommended that all tree planting efforts in Green-Wood Cemetery be directed toward the following long-term goals:

1. Achieve and perpetuate a desired level of tree cover Cemetery-wide, and maintain desired variations in tree cover type and density in different areas.
2. Maximize long-term stability in the tree population by optimizing and maintaining tree species and age diversity.
3. Minimize future maintenance needs and costs.
4. Minimize conflicts between trees and sidewalks, buildings, utilities, and other fixtures.
5. Protect steep slopes and minimize erosion in vulnerable areas.
6. Minimize the occurrence of undesirable invasive species within the Cemetery.
7. Improve aesthetic appeal, seasonal variation, and physical benefits to the Cemetery and the surrounding community.

The following recommendations are made to assist Green-Wood Cemetery in achieving the above goals:

1. Planting Frequency
    a. Continue to replant trees on a carefully planned, consistent, and continuous basis.
    b. Pace the rate of planting by scheduling planting projects so that the number of trees planted during each five-year period is consistent. Doing so will help maintain a balanced, uneven-aged population overall and help reduce future cycles of high demand for removal and replacement due to age attrition.
    c. Schedule plantings so that age diversity is maintained throughout the three Divisions, to the extent that design objectives permit.
2. Species Selection
    a. Carefully select species with the knowledge of how each planting project will change the composition of the tree population over the short and long terms. Generally:
        i. No single genus should comprise more than 10% of the tree population.
        ii. No single species should comprise more than 5% of the tree population.
        iii. No single cultivar should comprise more than 2% of the tree population.
        iv. Local monocultures may be planted if appropriate for the design. Cemetery-wide species diversity should be the primary goal.
    b. Vary the species planted from year to year to maintain species diversity over all of the age classes, and age diversity within each species.
    c. Favor species that are currently growing well in Green-Wood and the surrounding region, as well as species with similar cultural requirements.
    d. Use a variety of different seed sources and insect- and disease-resistant cultivars of each species, rather than continually using the same genetic clones.
    e. Increase the use of minor species (less than 1% of the tree population) that are currently performing well in the Cemetery and introduce others that should be expected to perform well.
    f. Minimize (not necessarily eliminate) the use of species vulnerable to known major forest health concerns such as oak wilt, Asian longhorned beetle, bacterial leaf scorch, Asian ambrosia beetle, and emerald ash borer.
    g. Minimize or eliminate the planting of exotic invasive species.
3. Tree Placement
    a. Conduct pre-planting site inspections to determine each planting site's soil structure and chemistry, soil drainage and aeration rates, exposure, physical limitations, etc., and plant only those species whose site requirements and growth characteristics match the site.
    b. Place new trees in a manner that will minimize future conflicts with overhead and underground utilities, sidewalks and paths, headstones, structures, and other hardscape fixtures based on the mature size of the species planted.
    c. Review and consider historic design intent in planning new plantings and modifying placement in replacement plantings.
4. Tree Installation
    a. Develop detailed planting specifications for all tree plantings based on current arboricultural standards and best management practices and ensure that all work is completed accordingly.
    b. Locate the true root collar within the root ball prior to planting and set the tree so that the root collar is slightly above and the first primary roots are within one-inch of the surrounding grade.
    c. Provide sufficient irrigation and post-planting protection and maintenance until the tree is fully established.
5. Woodlot Renovation
    a. Where appropriate, plant desirable trees and understory vegetation in the woodlots in voids created by efforts to clear undesirable invasives. Immediate replanting supplemented with chemical and mechanical control measures is necessary to help minimize reinvasion until the plantings are established.
6. Inventory Database Use and Maintenance

a. Develop and continually implement procedures to tag and map trees and to update the inventory database to reflect trees removed and planted.

b. Continually utilize the Tree Inventory and Assessment to make sound decisions regarding species selection and tree placement and to monitor progress toward overall program goals.

TREE MAINTENANCE GOALS AND OBJECTIVES

It is recommended that tree maintenance efforts in Green-Wood Cemetery be rigorous, ongoing, and directed toward the following long-term goals:

1. Minimize the risk of trees to public safety.
2. Improve and maintain the long-term health and structural condition of the tree population at a level that is appropriate and reasonable for the design and level of use in each area.
3. Optimize the benefits that the trees provide relative to the cost of maintaining them.
4. Maximize the service life of existing trees.
5. Implement maintenance programs to reduce the development of structural defects in young trees as well as providing ongoing proactive, versus reactionary, care for mature trees.
6. Maximize the cost-efficiency of tree maintenance activities.
7. Minimize the time required to identify, respond to, and resolve tree maintenance needs.

The following recommendations are made to assist Green-Wood Cemetery in achieving the above goals:

1. Staffing
    a. Provide sufficient in-house and/or contractor-based personnel and equipment dedicated to tree maintenance to a level that is capable of meeting the current and ongoing future needs.
    b. Supplement the work of the existing tree maintenance crew with outside contractors when needs dictate.
    c. Provide the necessary technical and safety training for Cemetery employees on a continuous basis.
2. Existing Priority Maintenance Needs
    a. Complete all tree pruning, removal, stump removal, and other treatment recommendations identified during this Tree Inventory and Assessment in order of priority.
        i. High Priority recommendations were assigned to trees that pose the greatest safety and liability risks and should be completed immediately.
        ii. Medium Priority recommendations were assigned to trees that pose moderate safety and liability risks and should be completed as soon as possible, but not at the expense of the High Priority recommendations.
        iii. Low Priority recommendations were assigned to trees that appear to pose little or safety risk and should be completed as time and resources permit.
    b. Nearly all of the woodlot areas contain trees that were not individually inventoried along their perimeters and paths that require high or medium priority pruning and removal. These should be continually identified via ongoing monitoring and addressed on an area-by-area basis.
    c. Complete more detailed inspections to more precisely determine the extent of defects and the need to remove certain trees where "Inspect" recommendations were made. Aerial inspections and specialized testing, such as Resistograph probing, will be necessary in many cases.
    d. Given the extent of the High Priority work recommendations and current staffing levels, it is unlikely that this work can be completed in-house in a reasonable amount of time. Therefore, it is strongly recommended that Green-Wood consider contracting with a private tree maintenance firm to assist in initial efforts to catch-up with existing needs.
3. Tree Monitoring
    a. Develop and implement procedures and schedules for monitoring the condition of all shade, ornamental, and woodlot trees on a set schedule to ensure prompt detection of changes in their condition and the emergence of potentially hazardous conditions.
        i. The frequency of monitoring and the extent of subsequent maintenance is dependent upon the origin of the trees (planted trees carry a higher level of responsibility than indigenous trees) and the level and type of use (areas that encourage visitors to congregate for lengths of time demand a higher level of attention than areas where use is transitory and/or infrequent).
    b. Develop and implement concise, standard procedures for reporting and mitigating the problems identified in a timely fashion.
    c. Develop and implement procedures for updating the shade and ornamental tree inventory database.
4. Post-Planting Maintenance
    a. Ensure that newly planted trees are adequately watered, mulched, and protected during the post-planting establishment period.
    b. Remove all planting stakes and stake ties one year after planting or after the root system has become sufficiently established.
    c. Invest in developmental structural pruning approximately 3 to 5 years after planting and again after approximately 10 years to correct existing branch defects and to help encourage the development of a strong, structurally sound branch scaffold. Many of the existing hazardous defects noted in mature trees could have been prevented with proper pruning early in the trees' lives.

5. General, Ongoing Maintenance

    a. Continually identify and address priority pruning and removal needs as they emerge, in order of priority.

    b. Strive to routinely prune all trees on a fixed, 5-7 year rotation.

    c. Develop detailed specifications for all tree pruning, removal, and other treatments based on current arboricultural standards and best management practices and ensure that all work is completed accordingly. All tree maintenance treatments should be completed in accordance with current ANSI A300 standards for tree care operations.

    d. Maintain woodlot trees (primarily pruning and removal to minimize potential hazards) at a level that is appropriate for the level and type of use in each area.

    e. Each time a tree is pruned, its permanent tag should be reset to help prevent it from being enveloped in the wood as the tree grows.

    f. Include stump grinding as a standard part of tree removal operations to help avoid their accumulation in the future.

    g. Continue to use turf herbicides conservatively and cautiously to avoid impacting tree health. Extreme care should be used to avoid placing weed controls over the root ball of young trees and contacting the foliage of all trees. Turf weed controls should not be used to control basal suckers on trees.

    h. Continually update the Tree Inventory and Assessment survey maps and inventory database and mappings to reflect trees removed and to record tree maintenance activities.

6. Treatment-Specific Recommendations (see inventory database for individual tree recommendations)

    a. Continue to maintain continuous control over aggressive climbing vine growth, where necessary, via the ongoing use of both mechanical and chemical control techniques.

    b. Continue to gain and maintain continuous control over invasive species, primarily in the semi-maintained woodlots and landscape areas, via the ongoing use of both mechanical and chemical control techniques.

    c. Continue to train lawn maintenance personnel and Cemetery visitors to understand the impact that mechanical wounding has on the health and long-term safety of trees and how to avoid it.

    d. Excavate the root collars or reset the depth of trees planted too deeply. The basal flare should be exposed above the surrounding soil and mulch surface and the first primary roots should be within one-inch of grade level. Circling roots encountered during root collar excavations should be pruned.

    e. Properly mulch trees, particularly smaller trees, wherever possible to help maintain root health and to help minimize the risk of damage from lawn maintenance equipment.

        i. Mulch should never accumulate to more than 3-inches in depth, should extend as close to the drip line as possible, and should not contact the base of the trunk.

        ii. Mulch should be cultivated periodically to keep it loose and maintain water and air infiltration.

    f. Complete all crown cleaning, structural pruning, crown raising, cabling and bracing, and other treatments in strict accordance with current ANSI A300 standards for tree care operations.

        i. Where low-hanging branches are interfering with lawn maintenance operators, roads, and paths, avoid "tipping back" branch ends. Properly raise the crowns by removing whole branches at the trunk or parent limb.

    g. Provide fertilizer and other supplements to high-value trees in accordance with ANSI A300 standards, if necessary and justified. Fertilizer formulations and dosages should be based on soil test results.

    h. Improve soil drainage and/or alleviate soil compaction to improve subsurface aeration, where necessary and feasible.

    i. Treat insect and disease problems on high-value trees, if justified.

    j. Continually monitor for oak wilt, bacterial leaf scorch, Asian longhorned beetle, and other serious forest health concerns, and immediately implement appropriate control measures when issues are noted.

ARBORETUM STATUS GOALS AND OBJECTIVES

Green-Wood Cemetery recently achieved Level 2 arboretum status from ArbNet, The Interactive Community of Arboreta. As an arboretum, the Cemetery has the freedom to decide whether its tree collection will be maintained to any specific goals, purposes, or themes.

Tree collection themes can range from the most broad (e.g., trees that will grow in Brooklyn, maintaining the most diverse collection of trees possible, etc.) down to the most specific (e.g., maintaining themed areas within the Cemetery such as trees from specific regions or plants of various leaf colors or sizes; generating an overall theme of "natural woodland" in all or a portion of the Cemetery; creating indoor greenhouses to maintain trees that are not hardy to Brooklyn; etc.).

The choice of a goal or theme is an important one, as it will help guide the Cemetery's future planting practices through both species choices and plant placement.

The Cultural Landscape Report produced alongside this Tree Inventory and Assessment report will give insight into how the historical intent and character of the Cemetery can shape the future direction of its urban forest to reflect both historic design and modern design strategies.

Recommended goals to improve and expand upon the Cemetery's current arboretum status include:

1. Choosing one or several theme(s) or plant collections goal(s) to guide future planting efforts throughout the Cemetery, establish an "arboretum character," and maximize educational value.
2. Improving and expanding upon the Cemetery's record keeping policies to streamline new tree, tree maintenance, and tree removal data entry into the tree inventory and GIS, as well as ensuring persistence of associated data including plant species, cultivar, source, genetic information (if applicable), planting date, etc.
3. Updating and improving the map of current trees within the Cemetery's new Geographic Information System.
4. Adding new trees to the Cemetery's tree inventory and GIS systems immediately upon planting.

WOODLOT AREA GOALS AND OBJECTIVES

The semi-maintained "woodlot" and landscape areas scattered throughout Green-Wood Cemetery provide aesthetic variation, wildlife benefits, and erosion control on steep slopes. However, many of the areas are comprised, to a great extent, of undesirable invasive plants. Substantial progress was made since 2005 in improving the condition and appearance of some of these areas and eliminating some portions. Similar efforts should continue.

Whether design objectives call for the clearing and re-landscaping of these areas or simply maintaining and enhancing their quasi-natural character, the design process should address:

1. Soil erosion on steep slopes.
2. Conflicts and the potential for damage to hillside mausoleums caused by tree growth.
3. Sufficient access for future tree maintenance.
4. Habitat for birds and other wildlife.
5. Ongoing control over undesirable invasive species and competing vines that may negatively affect the development of desirable species.

The following maintenance recommendations apply to all woodlot areas:

1. Complete all high- and medium-priority tree pruning and removal work recommended through this Tree Inventory and Assessment.
2. Remove trees growing in close proximity to mausoleums and other structures to help prevent damage from tree growth.
3. Periodically inspect all inventoried and uninventoried trees and complete any additional tree pruning and removal work necessary on a prioritized basis.
4. Maintain understory and ground-level vegetation as well as leaf litter on slopes to help minimize soil erosion.
5. Maintain control over competing vines and other undesirable vegetation while encouraging the natural regeneration of native and other desirable species where they exist.