

# 9 Plant Wind and Flood Resistant Trees

## I. Summary

### Issue:

People, property, buildings, and utility lines can be at risk from trees damaged by high winds and flooding.

### Recommendation:

In waterfront areas accessible to the public, require wind and salt-tolerant trees and regular tree pruning. Encourage private owners to follow the same practices.

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## II. Proposed Legislation, Rule or Study

*Amendments to the New York City Department of City Planning Zoning Resolution:*

1. Amend Article VI, Chapter 2, Section 62-655 as follows:

(a) (1) Single tree pits

Required trees within Special Flood Hazard Areas shall be planted in well-drained soil with rooting space recommended at 300 cubic feet (“CF”) per small tree (maximum mature height 25 feet), 700 CF per medium tree (maximum mature height of 40 feet), and 1000 CF per large tree (mature height over 70 feet). A single tree pit shall have a minimum dimension of five feet with a minimum exposed area of 30 square feet and a minimum depth of three feet, six inches. The balance of the soil volume may be under pavement by using structural soil. Only tree pits planted with ground cover shall count towards meeting a minimum planting area requirement.

(a) (2) Continuous tree pits

Required trees within Special Flood Hazard Areas shall be planted in well-drained soil with rooting space recommended at 300 CF per small tree (maximum mature height 25 feet), 700CF per medium tree (maximum mature height of 40 feet), and 1000 CF per large tree (mature height over 70 feet). A continuous tree pit is a planting area containing two or more trees. Continuous tree pits shall have a minimum width of five feet and a minimum depth of 3 feet, 6 inches, and a {length as required to meet a minimum of five feet from the trunk of the tree to the end of the tree pit} minimum exposed area of 50 square feet. The balance of the soil volume may be under pavement by using structural soil.

*Amendments to the New York City Department of Parks and Recreation Tree Planting Standards:*

1. Amend Sample Tree Pit Configurations as follows:

Required trees within Special Flood Hazard Areas are recommended to be planted in as large a soil volume as practicable. For reference, the minimum recommend soil volume is at least 300 CF of soil per small tree (maximum mature height 25 feet), 700 CF of soil per medium tree (maximum mature height of 40 feet), and 1000 CF of soil per large tree (maximum mature height more than 70 feet).

2. Amend New York City Approved Street Trees as follows:

To support this proposal, NYC Department of Parks and Recreation should reconcile the March 2013 “Tree Planting Standards” ([www.nycgovparks.org/pagefiles/53/Tree-Planting-Standards.pdf](http://www.nycgovparks.org/pagefiles/53/Tree-Planting-Standards.pdf)), which contains a “New York City Approved Street Trees” list that does not address flood zone tolerance, with the “Street Trees for New York City” and website lists ([http://www.nycgovparks.org/sub\\_your\\_park/trees\\_greenstreets/images/street\\_trees\\_for\\_ny\\_c.pdf](http://www.nycgovparks.org/sub_your_park/trees_greenstreets/images/street_trees_for_ny_c.pdf) and <http://www.nycgovparks.org/trees/street-tree-planting/species-list>) also released by the department that do address flood zone tolerance. These documents should indicate “coastal tolerance” by showing high, medium or low resistance to coastal salt and wind. The NYC Department of Parks and Recreation Greenbelt Native Plant Center Salt-Tolerant Species list and other sources including the Local Law 399 native plant list should be used as references.

Because of the need for pruning to reduce the risk of tree failure, the Department of Parks and Recreation should consider incorporating, as appropriate, additional maintenance requirements into Maintenance and Operations agreements for new waterfront public access areas created pursuant to zoning. For tree planting sites within a Special Flood Hazard Area, trees should be required to be inspected every seven years by a certified arborist or Department of and Recreation forester. Actions recommended by the certified arborist or forester to remove, prune or thin a tree should be required to be implemented by the property owner within the following dormant season.

*Best Practice:*

In flood zones, required trees shall be selected with reference to the list in Department of Parks and Recreation Tree Planting Standards “New York City Approved Street Trees”.

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## Section III: Supporting Information

The proposal recommends the following:

1. For tree planting in public access areas in flood zones, trees should have characteristics demonstrated to withstand high winds and salt tolerance and set standards for minimum soil volumes and drainage rates

2. Encourage private property owners to follow New York City Department of Parks and Recreation (NYCDPR) tree species selection criteria when planting near overhead power lines, including planting only small or medium trees (those under 40 feet mature height)
3. Increase frequency of tree inspections and tree pruning to reduce risk of tree failure

### **Expanded Issue and Benefits:**

#### **Wind Resistance**

Three key factors influence a tree's wind resistance: biological characteristics, site and cultural factors:

1. **Biological:** Tree characteristics which enhance wind resistance include slow-growing hardwood species with an open branching habit, strong branch attachments, good ability to compartmentalize decay, small or fine-textured leaves, straight leader, symmetrical branching habit, and no co-dominant limbs. Each of these characteristics results in a tree that has better than typical structural stability and a smaller mass-to-wind ratio.
2. **Site:** Site characteristics that encourage wind resistance include well-drained soil allowing percolation rates greater than 0.5" per hour and generous soil volume to allow for radial root spread. This volume should be at least 300 cubic feet per small tree, 700 cubic feet per medium tree, and 1000 cubic feet per large tree based on a soil depth of three feet. Soil may be in-situ or manufactured/imported soil. The roots that stabilize a tree typically grow within 18" of the surface so depth is not as important as total volume to create stability.
3. **Cultural:** Trees planted in groups are less effected by wind than single trees planted in individual pits or isolated, exposed sites. The suggested minimum group size is five trees planted 10-12 feet apart in adequate soil volume. The 2013 DPR Street Tree Guidelines specifically reference grouped plantings as a good strategy for green streets and similar conditions. This is not recommended as a street tree planting strategy, but is recommended for sites with flexibility to plant trees in groupings.

#### **Flood Resistance**

Trees may overturn in high winds due to the rapid saturation of soil. This saturation alters the soil structure by allowing soil aggregates to fall apart from reduced cohesion, thereby reducing the friction between the soil and tree roots. Prolonged inundation or soil saturation will result in root rot, spread of fungal disease, loss of oxygen to roots and eventual death (see "Sources"). Additionally, structural damage from construction or excavation work can lead to root loss or damage which reduces tree stability and increases susceptibility to wind.

It is suggested that the recommendations of Local Law Intro 79-A (plants for stormwater tolerance) be incorporated herein. Further, plants that have tolerance to salt are recommended in storm surge locations.

Mitigation of salt (sodium chloride) from storm surge requires dilution of toxic salt build up, typically accomplished by natural rainfall, hand watering, or irrigation. These methods push (or leach) the salt below the root zone and can be used to alleviate damage to leaves that have been inundated with salt water as well. Typically, deciduous species will recover by the following growing season if the above procedures are followed. Likelihood of success is improved by conducting soil tests of salinity content after the storm surge event and again before the

following growing season. There is limited direct data on storm surge salt mitigation since it is rarely encountered. Our proposals are largely based on documentation of water to dilute toxic levels of road salt.

### **Tree Selection and Planting**

Proper tree selection and planting methods greatly improve tree vitality and are essential to maximizing wind and flood resistance and limiting damage to overhead utility lines. While private property owners are encouraged to use NYCDPR Street Tree Guidelines as a basis for proper tree selection, it would unduly restrict choices on private property to mandate these guidelines. To ensure protection of property and infrastructure, the following guidelines are recommended:

1. Select the right tree for a given location based on wind tolerance, soil characteristics and volume, salinity tolerance, proximity to structures, subsurface infrastructure constraints, overhead utility wires, etc.
2. Specify and provide trees that have strong central leaders, good branching structure, are disease-free, and have been grown within the climatic zone of the installation site.
3. Plant trees with care by careful handling of tree and root ball to avoid damage, digging pits to correct width and depth, using pre-tested soil backfill, ensuring root flare is visible after backfilling, staking properly (only in high wind areas), and watering regularly (especially important in the first year).
4. Provide supplementary water for two years after installation during times of low rainfall (Level 1 drought conditions), remove tree stakes after two years, prune as required to correct crossed limbs and ensure open, symmetrical branching pattern.

### **Tree Care**

Trees that are diseased, weak-wooded or have poorly-formed branching structure are at risk of injuring people, falling on power lines, and damaging property. Preventative, regular tree inspection and pruning can greatly reduce the likelihood of these problems occurring. Studies show that regularly pruned trees survived Gulf Coast hurricanes at a rate of 73% compared to 46% of unpruned trees. Currently NYCDPR manages 50% of the City's 5.2 million trees, of which nearly 600,000 are street trees. Street trees are on a cyclical rotation of pruning. There is no pruning requirement for trees on private property. Trees in public parks are pruned based on need, availability of arborists and/or foresters and funding.

To increase the likelihood of tree survival and limit damage following storm events, the city should consider requiring that:

1. Street trees be inspected and pruned on a 7-year cycle.
2. Public park and Green Street trees be inspected and pruned on a 5-year cycle.
3. Trees on private property be inspected and pruned upon transfer of property, substantial alterations (alterations where the value exceeds 50% of the value of the building) or repairs ensuing from storm damage.
4. Additional funding be provided to NYCDPR to increase city-wide Forestry staff and to carry out a more frequent regimen of tree inspections and pruning.
5. Enforcement of existing Local Laws designed to protect public trees against construction impacts (sidewalk sheds, road and infrastructure work) be strengthened.
6. NYCDPR is encouraged to complete a comprehensive tree management plan and compile statistical data of storm and flood resiliency to inform future decisions on tree selection.

### **Trees and Climate Change**

The impacts of climate change on trees include earlier bloom and leaf-out time in the spring due to changes in average temperature (studies indicate that for every 1 degree Celsius increase, bloom and leaf-out is 5-6 days earlier), greater variability and frequency in rainfall, increased storm and drought occurrence, greater spread of pathogens, and greater migration of invasive species.

It is recommended that:

1. NYCDPR, other agencies, as well as educational and not-for-profit institutions, participate in on-going data collection and studies related to tracking and recording climate change impacts to tree and plant species.
2. Planting of trees and other species comply with Local Law Intro 399 to increase biodiversity on City-owned property.

### **Post Sandy Tree Replacement**

A significant portion of trees lost during Sandy will have had under-sized planting areas. It is recommended that tree pit size be increased where possible. In many cases adjacent paved areas will have been damaged and rebuilding with less paved areas and larger tree pits, or the introduction of structural soils, will be relatively simple.

### **Cost:**

Turner Construction Company prepared cost estimates based upon several standardized building typologies. Due to the innate variances in construction costs between projects, the complexity of the Task Force proposals, and the wide range of buildings to which the proposals may apply, these cost estimations should only be used as rough order-of-magnitude guides. The cost analysis is presented at the end of this proposal; more information about the cost methodology is given at the end of the full report.

The following analysis was performed by the authors of this proposal:

There is no cost impact associated with tree selection and purchase, since there are no proposed changes to tree caliper; and price differences among species of the same caliper are generally de minimis.

There is a cost impact to create greater soil volume in sites that are largely paved.

There is a cost impact for private property owners to retain arborists and follow regular tree pruning schedules. For public property, there is a cost impact to allocate more public funding for NYCDPR to hire more arborists/foresters.

Pruning costs NYC \$1.87 million annually, or \$56.58/tree, per the City of New York Municipal Forest Resource Analysis prepared for NYCDPR by the Center for Urban Forest Research in 2007 ([www.milliontreesnyc.org/downloads/pdf/nyc\\_mfra.pdf](http://www.milliontreesnyc.org/downloads/pdf/nyc_mfra.pdf)).

**Implementation:**

Market availability: There are potential limitations regarding market availability of trees identified in this proposal. There are potential limitations in the number of certified arborists within the NYC area.

Speed of implementation: There are no foreseen constraints to rapidly implementing this proposal. Immediate implementation is recommended because projects undergoing rebuilding should be considering new and replacement tree planting in the next planting season. In addition, the sooner the tree inspection and pruning recommendations are implemented, the less likely it is that trees will cause damage in future storms.

Anticipated difficulties: Allocating dedicated funding in the NYC expense budget for arborists/foresters to inspect and prune trees on public property.

**Sources:**

1. New York City, NY Municipal Forest Resource Analysis, March 2007
2. Urban Forest Recovery Program, University of Florida
3. City of New York Forest Resource Analysis  
[www.milliontreesnyc.org/downloads/pdf/nyc\\_mfra.pdf](http://www.milliontreesnyc.org/downloads/pdf/nyc_mfra.pdf)
4. US Department of Agriculture Plant Database (provides Fact Sheets about salt and wind tolerance of over 40,000 species of plants in the United States)  
<http://plants.usda.gov/characteristics.html>
5. NYC Department of Parks and Recreation Tree Planting Standards 2013  
[www.nycgovparks.org/pagefiles/53/Tree-Planting-Standards.pdf](http://www.nycgovparks.org/pagefiles/53/Tree-Planting-Standards.pdf)
6. “Recommended Urban Trees – Site Assessment for Tree Selection and Stress Tolerance” by the Urban Horticulture Institute, Cornell University, 2009. [urbanhort@cornell.edu](mailto:urbanhort@cornell.edu)
7. NYC Department of Parks and Recreation “Street Trees for New York City”  
[http://www.nycgovparks.org/sub\\_your\\_park/trees\\_greenstreets/images/street\\_trees\\_for\\_nyc.pdf](http://www.nycgovparks.org/sub_your_park/trees_greenstreets/images/street_trees_for_nyc.pdf)
8. NYC Department of Parks and Recreation Greenbelt Native Plant Center Salt-Tolerant Species list  
[http://www.nycgovparks.org/sub\\_about/parks\\_divisions/gnpc/pdf/salt\\_tolerant\\_species\\_list.pdf](http://www.nycgovparks.org/sub_about/parks_divisions/gnpc/pdf/salt_tolerant_species_list.pdf)
9. Section D-Species Selection in 2012 NYCDPR Tree Planting Standards

9 PLANT WIND & FLOOD RESISTANT TREES

NEW CONSTRUCTION												
	Commercial High Rise			Commercial Low Rise			Residential High Rise			Residential Low Rise		
	Quantity	Unit	Unit Cost	Total	Quantity	Unit	Unit Cost	Total	Quantity	Unit	Unit Cost	Total
<b>9 Plant Wind &amp; Flood Resistant Trees</b>												
Select trees per NYC approved street tree standards (assume 1 medium tree every 20' on 2 sides of the building)	15	EA	\$0.00	\$0	10	EA	\$0.00	\$0	11	EA	\$0.00	\$0
Increase soil volume for tree pits (increase from 300 cubic feet to 700 cubic feet for each)	222	CY	\$80.00	\$17,800	152	CY	\$80.00	\$12,200	156	CY	\$80.00	\$12,500
				\$0				\$0				\$0
				\$0				\$0				\$0
<b>SUBTOTAL DIRECT WORK</b>				\$17,800				\$12,200				\$12,500
Contingency				10%				\$1,220				\$1,250
<b>SUBTOTAL</b>				<b>\$19,580</b>				<b>\$13,420</b>				<b>\$13,750</b>
GC Mark-ups				20%				\$2,684				\$2,750
<b>TOTAL</b>	620,000	GSF	\$0.04	<b>\$23,496</b>	4,000	GSF	\$4.03	<b>\$16,104</b>	231,000	GSF	\$0.07	<b>\$16,500</b>
												15,000
												\$0.84
												<b>\$12,540</b>

EXISTING BUILDINGS												
	Commercial High Rise			Commercial Low Rise			Residential High Rise			Residential Low Rise		
	Quantity	Unit	Unit Cost	Total	Quantity	Unit	Unit Cost	Total	Quantity	Unit	Unit Cost	Total
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