



## Hurricane Ike Tree Mitigation Plan

Developed for:

BROADWAY BOULEVARD  
(State Highway 87)

Galveston, Texas

In support of:

Texas Department of Transportation-Houston District  
City of Galveston Planning & Community Development Department  
City of Galveston Parks & Recreation Department

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## Responding to Hurricane Ike

On September 12-13, 2008, Hurricane Ike slammed into Galveston Island with 110-mile per hour winds and a 15-foot storm surge, inundating most of this barrier island as well as the City of Galveston. In addition to flooded homes and businesses, many of the city's historic trees were also damaged or destroyed. City leaders quickly recognized that wholesale removal of right-of-way (ROW) trees following the storm would forever alter the historic nature of Galveston and pose a barrier to long-term recovery. At the request of the Galveston Planning & Community Development Department's Historic Preservation officer, Texas Forest Service (TFS) urban foresters Mickey Merritt and Pete Smith came to Galveston on September 17, 2008, to begin damage assessments of trees in the Historic Districts and along Broadway Boulevard.

The goal of this assessment phase was to avoid the unintentional and unnecessary removal of public trees during debris clearing activities within four historic districts. The process included a brief, visual inspection of storm-damaged trees that posed an immediate risk to the public space (sidewalks, streets) or adjacent property (homes) due to uprooting, excessive lean (>30 degree angle), crown loss (in excess of 50%), or trunk fractures (standards from the FEMA 325 *Debris Management Guide*). Each tree that met the standard for removal was marked with orange paint and photographed. TFS foresters completed tree assessments in the National Landmark (6<sup>th</sup>-19<sup>th</sup> Streets, north of Broadway), Cedar Lawn, Lost Bayou, and Silk Stocking historic districts on September 18.

Following this initial visit, we returned on September 30 to focus our attention on Broadway Boulevard (State Highway 87), which is the main thoroughfare through Galveston. We completed the assessment on October 2 and documented a total of 35 trees that posed a risk to the public right-of-way and qualified for removal according to the FEMA standards. Of these trees, 28 were on the ground already and seven were marked because of significant root plate shifting or excessive lean. Of the seven, two were on private property but leaning over the sidewalk, two were city-owned trees along the right-of-way, and three were within the medians. The different species documented for removal included live oak, magnolia, palm, and pecan.



Live oak marked for removal due to root plate lifting

While performing these assessments it quickly became apparent that almost all of the trees in Galveston were suffering from excessive salt exposure – either from wind-borne salt spray, the storm surge, or both. Within two weeks, most trees and plants showed brown leaves that were quickly being shed, including the live oaks on Broadway. Very few tree species were spared from this damage, the most notable exceptions being the various species of palm. Our immediate impression was that the salt deposited by the storm surge would not allow the trees to recover quickly without some sort of intervention. Since very little rain has fallen since Ike made landfall and the historic trees along Broadway have very high value to the community, we believe a treatment plan is necessary to mitigate the damage incurred from Hurricane Ike to these remaining trees. The recommendations that follow are specifically directed at the trees on Broadway, but many of them can – and should – be applied to other city trees.

# Broadway Boulevard Tree Mitigation Plan

This treatment plan is prepared for the trees along Broadway Boulevard within the City of Galveston, Texas, which were damaged by Hurricane Ike on September 12–13, 2008. Texas Forest Service foresters conducted storm damage assessments of the above-ground portions of the trees within center medians and along the right-of-way (up to the adjacent property boundary), as well as the soil conditions within the medians, in order to design a simple, cost-effective prescription to restore these historic trees to optimum health.

## Treatment Objectives

### Immediate Objectives:

1. Lower the risk to lives and property from trees that suffered structural damage during Hurricane Ike.
2. Remediate salt damage to the root zones of the remaining median trees caused by the storm surge. Improve the soil environment to stimulate optimum growth for all trees.
3. Replace trees lost in the storm and replant all vacant planting sites.

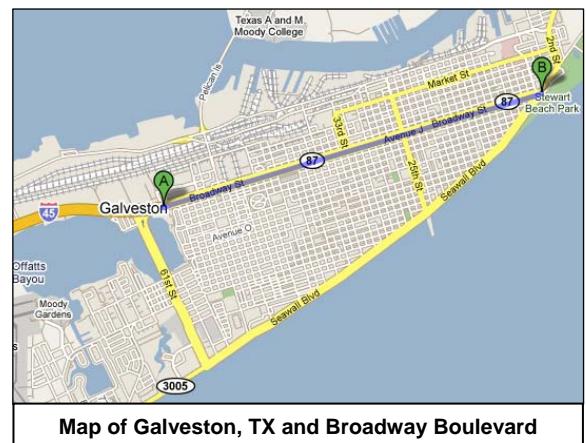
### Long-term Objectives:

4. Establish clear maintenance policies and train city crews in proper tree care practices.
5. Maintain public safety through effective monitoring of trees.
6. Increase the resistance to, and resilience from, future hurricanes.

## Site Description

Broadway Boulevard (SH 87) is the main historic thoroughfare through the City of Galveston. It begins where I-45 ends, at 59<sup>th</sup> street, and continues for 3.8 miles, ending at Seawall Boulevard. Broadway has three lanes for vehicular traffic in both directions, plus a lane for on-street parking for most of its length. The east and westbound traffic lanes are separated by a series of wide medians that are broken at each street intersection, forming a total of 53 separate medians that average 290 feet long by 30 feet wide.

Broadway is a state highway, so official jurisdiction belongs to the Texas Department of Transportation (TxDOT). An old maintenance agreement from the 1960's transfers the day-to-day maintenance of the medians – principally mowing – to the city, but there remains some uncertainty on the topic of tree maintenance. To complicate matters, adjoining property owners sometimes maintain the trees in front of their property between the sidewalk and the curb. TxDOT shares the cost of periodic landscaping improvements to the medians with the city and is in the process of implementing a \$1.2 million landscape plan that will add irrigation and flower beds to the ends of each median.



## Description and Condition of Trees

Forty-six of the medians along Broadway have live oak (*Quercus virginiana*) and palm (*Washingtonia spp.*) trees, planted in two matching rows; the seven medians closest to Seawall Boulevard (and the Gulf of Mexico) are planted exclusively with palms. It is unclear exactly when the trees were planted; some were planted in the early 1900's after Galveston Island was raised and others were planted as memorial trees following one or both World Wars. The oak trees range in size from 10" in diameter (diameter-at-breast-height, or DBH) to over 24" DBH; the palms are approximately 50 feet tall and show few symptoms of damage or decline. Very few young trees exist and there does not appear to be an active re-planting program at this time. Neither TxDOT nor the city of Galveston has a formal tree management or maintenance plan for the trees along Broadway.

As a general observation, the pre-storm condition of the oak trees along Broadway ranged from 'fair' to 'good', but most suffered damage from the hurricane. Twenty-six median and seven ROW trees were either blown down or marked for removal by TFS. Though the vast majority of oaks survived, the wind damage to their crowns ranges from light to severe. As of October 2008, TxDOT crews were in the process of removing the debris and marked trees from the medians and ROWs. Safety pruning work to remove broken branches (>2" diameter) on the remaining trees is pending.

There are some instances where the root flare of a tree – the point where the trunk joins the first major roots – is obscured by the soil, often a factor that predisposes trees to health problems. This condition appears to pre-date Hurricane Ike and may be a result of the gradual raising of Broadway each time a new surface is laid on the roadway. The natural tendency now is for water and other materials to flow *into* the medians, rather than away from them, meaning that trees planted in low spots will see an accumulation of soil and material near their trunks. While the additional water may be beneficial, a buried root flare reduces gas exchange in the roots and can promote conditions that lead to disease, decay, and tree failure.

A more pressing problem, though, is that all of the oak trees are showing signs of salt damage, either from sea spray or the storm surge. High levels of sodium (chemical symbol Na) can interfere with water absorption and result in "burned" leaves, causing them to brown and fall off. In the weeks since the hurricane, some trees have begun to put on new leaves, which is a good sign. However, since salt levels may persist in the soil for some time, these new leaves may also burn and drop. If the trees cycle through just one or two flushes we believe most of the trees will survive; however, trees that cannot maintain a healthy crown of leaves because of high soil salt levels will spiral into decline and, possibly, death.



City crews watering trees to leach salt from the soil

Even before a recommendation by TFS and TxDOT, city parks department crews began a watering program to leach the salt from the root zones and speed the recovery of these valuable trees. In addition, TFS conducted a survey of the actual soil properties within these medians in order to make specific treatment recommendations beyond this simple watering program.

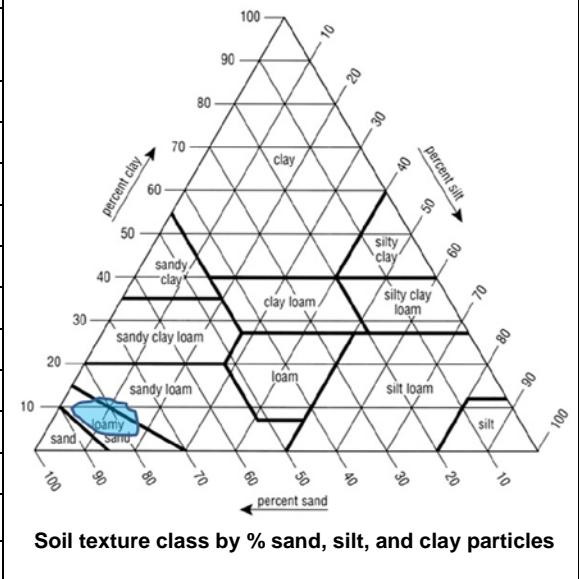
## Soil Sampling & Results

The published soil survey for Galveston County (Soil Conservation Service, 1988; <http://soildatamart.nrcs.usda.gov/Manuscripts/TX167/0/galveston.pdf>) lists the predominant soil type on Broadway and the built areas of Galveston Island as “Galveston-Urban land complex” (**Gd**). “This complex consists of a nearly level, somewhat excessively drained, nonsaline, sandy soil and Urban land.... An average of about 5 feet of sandy material, which was dredged from bay and canals, has been added to the original soil surface in these areas.” (p. 19)

To test soil properties, TFS pulled four to five soil cores (12-16” deep, totaling approximately one cup) from every fifth median, for a total of ten samples over the 53 separate medians. In addition, we took one sample from a right-of-way and another sample (S-11) tested soil from just the upper 3” of median soil. These 11 samples were analyzed by A&L Analytical Laboratories, Inc., of Memphis, TN, for texture, pH, organic matter, nutrients, and the sodium (**Na**) level. Results are summarized in **Table 1** and the complete sample reports are included with this report.



<b>Table 1: Soil Analysis Summary</b>				
<b>Median Samples</b>	<b>Soil Texture Class</b>	<b>pH</b>	<b>Organic Matter</b>	<b>Sodium Rating</b>
S-1	loamy sand	7.8	3.0%	High
S-2	loamy sand	7.8	2.6%	High
S-3	loamy sand	8.0	2.9%	Optimum
S-4	sandy loam	7.7	3.8%	High
S-6	loamy sand	8.1	3.0%	Medium
S-7	loamy sand	8.1	2.3%	High
S-8	loamy sand	7.7	2.3%	Optimum
S-9	loamy sand	7.9	2.2%	Medium
S-10	loamy sand	8.0	2.3%	High
S-11	sandy loam	7.6	4.4%	High
<b>Right-of-way Sample</b>				
S-5	clay	7.9	3.0%	High



Several key findings inform our recommendations. As we suspected, most of the samples showed high sodium levels, meaning a treatment plan is warranted. Sample S-11 showed the highest sodium value (4,886 lbs./acre), meaning that the highest levels of salt are still near the surface.

Second, all the medians have very sandy soil texture, as shown in the shaded area of the soil texture triangle. This makes leaching of the salts feasible with watering alone. On clay soils, gypsum is sometimes added to chemically release the sodium ions into solution so that watering will wash them away.

Third, the soil pH ranges from 7.6 to 8.1, which is considered mildly alkaline and not optimum for tree growth. Trees prefer slightly acid soils below 7.0 (neutral) for best nutrient uptake and growth. Finally, all the samples showed low levels of organic matter – well below the optimum value of 5% – which is critical for root growth, nutrient and water uptake, and buffering from the extremes of this highly-urbanized environment.

## **Short-term Recommendations (immediate-3 years)**

### **1. Public Safety:**

- Complete the removal of debris, stumps, and standing trees marked for removal.
- Broken limbs greater than 2" in diameter that pose risk to pedestrian or vehicular traffic should be located and removed as soon as possible.

### **2. Soil Remediation:**

- Watering will help leach salt levels out of the soil. All trees should receive 8 to 10 gallons per diameter-inch at least once a week as long as rainfall is less than 1-inch per week. This program should continue into mid-winter 2009.
- Lower the soil pH by applying elemental sulfur at a rate of 5 lbs./1000 ft.<sup>2</sup>. Since the effects of elemental sulfur are localized and temporary, this treatment should be repeated every three months (4 applications/year) for at least the next three years. Test soil pH and Na levels annually, before treatment.
- Apply a one-inch layer of non-manure compost to all medians, once annually, for the next few years. Compost will improve soil structure, increase nutrient-holding capacity, reduce soil compaction and crusting, reduce fertilizer requirements, and improve root growth.
- Apply a 2-3" layer of mulch – such as shredded hardwood material – after spreading the compost. Mulch will help the soil retain moisture, reduce soil compaction, suppress weeds, and protect tree roots, trunk, and bark from mechanical damage. Mulch also decomposes and becomes organic matter for the soil, and reduces or eliminates the need for mowing. Reapply each year for the next three years.

### **3. Tree Replacement:**

- Begin a program to replace all trees lost during Hurricane Ike. Since additional trees may not survive the saltwater inundation, new trees should be planted during the dormant season for each of the next three years. Purchase high-quality plant material with a minimum 3-inch caliper trunk; larger trees may be brought in as "boxed" trees or by using a tree spade. Avoid material that would require extensive staking.
- Establish a community fund for tree planting. A partnership between the city, local businesses, foundations, the local historical society, and citizens can galvanize support for restoring this important community asset. Beyond the Broadway medians, many other public trees in Galveston have been lost and having a fund to share the cost of replacement will speed the re-greening process along.

## **Long-term Recommendations (2-10 years)**

### **4. Tree Maintenance:**

- Conduct a crown “cleaning” of all remaining Broadway oak trees, within the medians and along the ROW. Crown *cleaning* is a selective pruning method used by arborists to remove only dead, diseased, or broken limbs. No live limbs should be removed during this operation to keep as much live foliage on the trees as possible to speed their recovery.
- Establish a set of formal pruning standards for work to be performed on all city trees. A commonly used set of standards is the latest ANSI A-300 *Standards for Tree Care Operations*. Additional policies may apply to the historic trees on Broadway. City workers that perform any tasks (including mowing) near trees should attend appropriate training classes; those with responsibility for tree work should become Certified Arborists through the International Society of Arboriculture (ISA).
- Develop a long-term management plan for these historic trees. This plan should incorporate a GPS-based inventory of size, condition, and species for existing trees as well as potential planting sites. Inventory work can often be accomplished using trained volunteers such as Master Gardeners or Master Naturalists. The plan should include a monitoring standard for reviewing safety of the trees along this busy thoroughfare, as well as practices that are likely to reduce damage from future storms. A written plan for replacing and restoring the Broadway trees is important to guide the annual treatments over the next decade.
- Use a professional arborist or urban forester to write the plan and guide the work. This can be accomplished through a professional services contract, but the city should consider adding a staff member with these credentials to guide the management of all city owned trees.

### **5. Advocacy:**

- Establish an advocacy group or “trees committee” to support the care and restoration of historic trees on the Island. Such a support group can help educate the community on the benefits of trees, provide valuable input during plan development, and seek sources of funding to implement the recommendations of the plan. Big and historic trees capture the imagination of citizens, so the Broadway trees provide a ready-made platform for advocacy and fundraising in Galveston.

## **Acknowledgements & References**

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- Brian Scott, TFS Urban Forester, Amarillo, TX

Web references that discuss how to influence soil pH:

<http://edis.ifas.ufl.edu/pdffiles/SS/SS48000.pdf>

<http://ag.arizona.edu/yavapai/anr/hort/byg/archive/gypsum.html>.