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SCIENTIFIC SOLUTIONS FOR TREES AND SHRUBS

David Moore
Historic Oakland Foundation
248 Oakland Avenue SE
Atlanta, GA 30312

Dear Mr. Moore,

Attached please find the Tree Management Plan for Oakland Cemetery based on the evaluation of 150 trees in WPA sections 1-14.

Sincerely,

Chris Hastings
ISA Board Certified Master Arborist SO-2398
August 30, 2010

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Evaluation of 150 Mature Trees in WPA Section 1-14:

Between January and August of 2010, Arbormedics evaluated 150 mature trees in WPA sections 1-14 of Oakland Cemetery. These trees were designated by Historic Oakland Cemetery and included s a representative mix of the mature urban forest at Oakland Cemetery. The purpose of the evaluations were to determine the health, longevity, and structure of individual mature trees in order to provide decision makers with useful information in managing the current urban forest at Oakland Cemetery and planning for improvements to the urban forest in years to come. The evaluation is available as a separate document and is referred to in this document in summary.

Summary of Results:

The tree evaluation identified 30 separate species of native and exotic trees that have been grown in Oakland Cemetery during the past 100 years. Of these 30 species, Water Oaks and Southern Magnolia were the most predominant species with both constituting 21% of the mature forest.

The specific number of each species was as follows:

Common Name (*Botanical Name*):	**Number of Trees Included:**
American Elm (*Ulmus americana)*	4
American Holly (*Ilex opaca)*	3
Arborvitae (*Thuja sp.*)	9
Basswood (*Tilia americana)*	2
Black Cherry (*Prunus serotina)*	1
Black Gum (*Nyssa sylvatica)*	1
Cherrylaurel (*Prunus caroliniana)*	7
Chinese Chestnut (*Castanea mollissima)*	1
Chinese Evergreen Oak (*Quercus myrsinifolia)*	7
Chinese Fir (*Cunninghamia lanceolata)*	1
Crabapple (*Malus sp.)*	2
Crape Myrtle (*Lagerstroemia indica)*	5
Darlington Oak (*Quercus laurifolia)*	1
Eastern Red Cedar (*Juniperus virginiana)*	7
Flowering Cherry (*Prunus serrulata)*	1
Flowering Dogwood (*Cornus florida)*	10
Ginkgo (*Ginkgo biloba)*	1
Hackberry (*Celtis occidentalis)*	1
Hemlock (*Tsuga canadensis)*	2
Kousa Dogwood (*Cornus kousa)*	1
Pecan (*Carya illinoensis)*	1
Pignut Hickory (*Carya glabra)*	3
Post Oak (*Quercus stellata)*	7

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Saucer Magnolia (*Magnolia x soulangiana)*	1
Shumard Oak (*Quercus shumardii)*	3
Southern Magnolia (*Magnolia grandiflora)*	32
Southern Red Oak (*Quercus falcata)*	2
Water Oak (*Quercus nigra)*	32
White Oak (*Quercus alba)*	1
Willow Oak (*Quercus phellos)*	1

The tree evaluation estimated the longevity of each individual tree based on current health and structural integrity. Of the 150 mature trees evaluated, 43% are estimated to live greater than 20 years longer, 32% of the trees are estimated to live 10-20 more years, 15% are estimated to live less than 10 years, 8% are estimated to live less than 5 years, and 1 tree died during the evaluation. The specific counts are as follows:

Dead Trees:	1
Estimate to live less than 5 years:	12
Estimated to live less than 10 years:	23
Estimated to live 10-20 years:	49
Estimated to live greater than 20 years:	65

Of the species of mature trees evaluated, 61% can be considered overstory trees while 39% can be considered understory trees. Of the 65 mature trees that are estimated to live greater than 20 years, 65% are overstory and 35% are understory. By studying the underlying characteristics and longevity of the trees that were evaluated, population trends can be anticipated and accounted for in future plantings.

It is important, however, to understand that Oakland Cemetery has undergone dramatic and violent storm events over the course of its history. The tornado that crossed Oakland Cemetery on March 14, 2008 affected trees violently but also erratically since the tornado path did not affect all trees at Oakland Cemetery consistently. The effect was to distort normal patterns of aging, insect and disease occurrence, and structural integrity. It is important to rely on an in-depth look at individual trees and species rather than relying on percentages in pursuing tree care and replanting goals.

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Managing the Existing Urban Forest at Oakland Cemetery:

The trees at Oakland Cemetery have had a variety of arboricultural maintenance during their history. Some of the work has been beneficial to the health and safety of the trees, while other work has been detrimental. Modern arboriculture strives to promote practices that enhance the safety and well-being of trees while limiting unintended consequences. The International Society of Arboriculture and the Tree Care Industry Association promote the proper care of trees through the American National Standards Institute (ANSI). Arboricultural maintenance at Oakland Cemetery should correspond with ANSI standards for proper tree care.

In the urban forest, there is always the overriding problem of what should be done, and what can be done considering limited budgets and limited personnel. Tree managers should carefully weigh the cost of short-term maintenance program versus long-term removal and replanting costs in understanding the true costs of the urban forest.

Pruning:
Crown cleaning to remove dead, dying, and diseased branches and selective thinning to reduce weight and increase wind penetration are two common pruning goals that directly affect public safety and indirectly affect tree health and well-being. These types of pruning operations are most often specified due to the particular targets under a given tree. Trees growing over or near major points of access may warrant increased attention and maintenance.

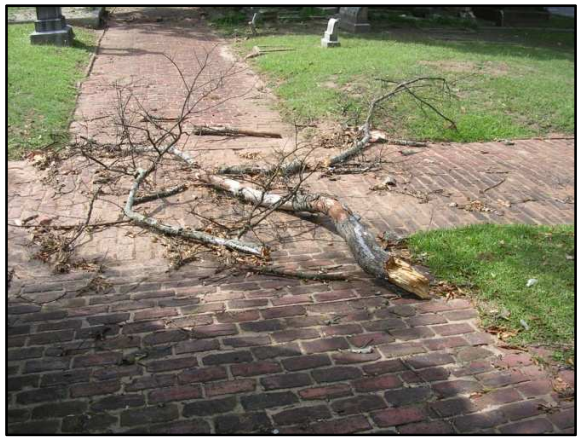

Figure 1- Dead limbs affect public safety

Structural and formative pruning of young and immature trees is a relatively low-cost method of reducing long-term costs while increasing the longevity of the trees in the urban forest at Oakland Cemetery. This type of pruning is often overlooked due to the more pressing safety concerns for larger trees. Structural and formative pruning can often be carried out by trained volunteers since it can often be performed using pole-pruners and ladders and does not require professional tree climbing techniques.

In general, crown cleaning and selective thinning may be required every 3-7 years for mature overstory trees while structural and formative pruning may be necessary every 5-10 years on young and immature trees.

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Fertilizing:
Trees need nutrients to grow and remain healthy. These nutrients are absorbed from the soil and are the products of mineral-bearing rocks and organic matter. Trees store these nutrients in leaves, stems and flowers. When these plant parts fall to the ground below, they decompose and become available for absorption.

It is likely that the soil at Oakland Cemetery has a heterogeneous nutrient content in that either favors or limits optimal tree health and tree growth. The nutrient content of the soil of particular locations can be determined from a soil test analyzed by a soil science laboratory. Once the nutrient content of the soil has been determined for a particular area, deficient nutrients can be added through fertilizing. In order to limit the amount of fertilizing needed for optimal tree healthy, tree leaves should be used as mulch and allowed to cycle their nutrient content into the soil on an annual basis. In areas where this is undesirable or unappealing, periodic soil sampling will be needed to determine the frequency and quantity of fertilizing necessary to maintain optimal soil nutrient levels.

Mulching is a practical alternative to provide nutrients to trees through decomposition. Mulch varies in nutrient content and does not represent a natural nutrient cycle. It would still be necessary to monitor soil nutrient levels when using imported mulch instead of leaf mulch.

Hardwood mulch may carry insects and disease that introduce pathogens and pests to trees at Oakland Cemetery from other areas. Conversely, hardwood mulch may promote fungal disease that currently exists on site and gains sustenance from the wood chips. It is important to know the provenance of wood chips and other hardwood mulch brought to the cemetery and to monitor wood chip mulched areas for pathogenic diseases.

Water Management:
According to the Georgia State Climatologist, 13 droughts have occurred in the state over the last 325 years with the most recent droughts occurring in 1998-2002 and 2007-2008. Water stress is a major limiting factor for tree health and development. Water stress can also make trees more susceptible to insect and disease activity. In extreme circumstances, drought can kill trees.

There are a limited number of ways to manage the water resources at Oakland Cemetery to improve tree health and growth. Mulching the soil in tree root zones will help reduce erosion and water run-off while improving water infiltration. This approach has been helpful in certain areas of the cemetery and has the additional benefit of reducing lawn and weed maintenance costs.

There may be limited options for irrigating existing trees during times of drought. Irrigation decisions should be made considering the resources available, the susceptibility of the species to drought, and the value/longevity of the tree. A typical 1 inch rainfall supplies approximately 750 gallons of water to 1000 square foot root zone.

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Insects and Disease:
The mature tree population at Oakland Cemetery is suffering from a collection of insect pests and pathogenic diseases common in the urban forest. The most common insect pests active at this time include scales and mites. The most common pathogenic diseases at Oakland Cemetery are classified as wood destroying fungi and are in the genuses *Ganorderma*, *Inonotus*, and *Armillaria*. Identifying insect pests and disease pathogens properly is an important first step in understanding the damage, and potential damage, which may occur to the trees.

It is always difficult to control insects and diseases in a public area due to the fear of spray drift into non-target areas. Modern insect and disease control chemicals are less toxic that in prior times, but many can be harmful to people and animals nearby. Modern systemic insecticides, fungicides, and miticides offer methods to control insect pest populations with minimal spray drift or movement to non-target areas. All chemical insect and disease control products are labeled with instructions including the method of application, rates of application, and requirements for personal safety. It is important to follow labeled instructions to achieve optimal results in a safe manner.

There are many biological and organic options for insect and disease control that offer better than average control. Biological and organic may be the best option in addressing insect and disease problems, but each situation must be considered separately due to the numerous variables involved.

Conflict with Infrastructure:
A large number of trees at Oakland Cemetery were planted in confined areas that do not offer the tree adequate room for root growth or trunk growth. There are limited options available to deal with current conflicts between trees and sidewalks, walls, and monuments. There may be a limited number of situations where sidewalks and other infrastructure can be re-designed to accommodate tree root and trunk growth. This is especially difficult, however, in trying to reduce conflicts between trees and infrastructure while trying to maintain the historic integrity of the site.

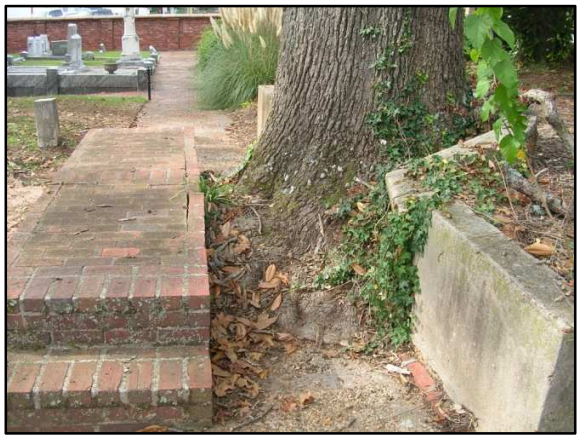

Figure 2-Modification of sidewalk

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Lightning Protection:
During the course of this evaluation, three trees in the study area were struck by lightning. Of these, one tree died immediately and two trees are in the process of dying due to the related damage. Lightning is a random event that favors tall objects. While lightning is random, it is apparent when viewing lightning strike data that topography and climate patterns tend to favor one area over another. Considering the location of Oakland Cemetery and its surrounding topography, it is possible that the trees at Oakland are at a greater than average risk for lightning strikes.

Lightning strikes are common in the mature urban forest and often lead to tree death or decline. Lightning protection systems have been developed that safely carry the lightning strike to ground with little or no impact to the tree. These lightning protection systems should be designed and installed by a trained arborist following the ANSI standards for tree lightning protection. Tree lightning protection may be a viable and cost effective method of preserving the mature forest while avoiding tree removal costs.

Cabling:
Cabling is an arboricultural technique that addresses underlying weaknesses in a tree's structural integrity. When specified and installed properly, cabling systems can help trees remain healthy and safe. They can also reduce (but not eliminate) the risk of a particular tree to visitors and property nearby.

When specified incorrectly or installed improperly, cabling systems can restrict tree movement and cause shifts in the natural hormonal messages within tree trunks and branches. This restriction may eventually lead to a weaker tree with a greater susceptibility to failure than otherwise. It is also important to remember that cabling systems need to be monitored and maintained by a trained arborist over the life of the system.

Tree Removal:
As the mature trees at Oakland Cemetery age, it is inevitable that trees will die or need to be removed for safety purposes. The evaluation of 150 mature trees estimates that 8.5% (13 trees) are in need of removal now or within the next 5 years. The decision to remove a tree can be easy if a tree has already died. The decision to remove a tree for safety reasons can be complex and require the assessment of a trained arborist. The City of Atlanta employs professional arborists to manage the City's urban forest. It is important for cemetery managers to monitor the trees regularly for signs of change and/or problems, but also to enlist the regular help of these trained professionals to assess and make decisions about the removal of individual trees.

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Planning the Future Urban Forest at Oakland Cemetery:

The evaluation of 150 mature trees in WPA sections 1-14 has provided insight into the health and longevity of the current urban forest at Oakland Cemetery. It also provides important information that can be used to estimate the future needs of the urban forest at the cemetery.

Need for a Complete Tree Inventory:
While the mature tree evaluation provides valuable understanding of the existing mature trees and allows for improvements in planning, a complete tree inventory of the entire site including GPS locations of existing trees and future planting sites is paramount in planning and managing the urban forest at Oakland Cemetery. A complete tree inventory and locate will allow decision makers to select tree species, coordinate locations, improve timing of planting, and optimize the benefits of the urban forest.

Benefits of the Urban Forest at Oakland Cemetery:
The urban forest is a critical component of the experience of visiting Oakland Cemetery. It also has community benefits to those living in and around the area. Each tree, or group of trees, may contribute to provide one or more benefits of the overall urban forest. It is important to understand that the urban forest should not represent uniformity or monotony. In fact, overall goals can be achieved while meeting different and variable expectations for specific areas of the cemetery.

Solar Radiation:
Solar energy is captured by leaves in the process of photosynthesis before it reaches people and objects below. Trees make cemeteries more comfortable during summer months by intercepting sunlight that would otherwise affect people directly by heating skin and clothes, and affect people indirectly by heating roads, buildings, sidewalks, and monuments. During winter months, deciduous trees allow sunlight to warm people and objects below.

Air movement:
Trees have a distinct impact on wind movement and air circulation. The primary variables that affect air flow are type of species, density of plantings, height of the trees, and distance from the target. Air movement can be both a benefit and detriment depending on the season. Deciduous species block less wind during the cold winter months when wind might cause the cemetery to be less hospitable.

Ambient Air Temperature:
The air temperature in a forest is moderated due to the presence of the trees as a result of shade and evaporative cooling. The direct effects of individual trees and small tree groups in the urban forest are harder to measure. Despite this, several studies have indicated that trees do reduce the air temperature in the urban forest. For instance, Souch and Souch found that the air temperature was .7 to 1.3 degrees Celsius cooler beneath urban tree canopies (*J. Arbor*. 19(5):303-312).

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Sound Control:
Tree leaves, twigs, branches, and trunks absorb sound vibrations and can improve the comfort and quality of visits to the cemetery. This may be particularly important in certain areas of the cemetery like the northern side adjacent to MARTA and rail lines where noise pollution can be excessive. Cook found that bands of trees can reduce noise pollution by 5-10 decibels ("Trees, Solid Barriers, and Combinations: Alternatives for Noise Control." Proceedings of the National Urban Forest Conference 1978 pp330-334).

Erosion Control and Stormwater Runoff:
Trees have a positive benefit on underlying soils by buffering the effect of heavy rainfall on exposed soils, and by increasing infiltration of water during and after rainfall events. Tree root zone that have a natural leaf litter and/or are mulched improve water infiltration compared with bare soil.

Wildlife Habitat:
Trees are the source of food, and the homes, for a variety of wildlife including birds, squirrels, raccoons, and bats. In general, wildlife is thought to have a favorable effect on the experience of those visiting an urban forest. A diverse tree population tends to provide habitat for a greater and more diverse wildlife population.

Heat Island Effect:
The infrastructure of cities absorbs solar radiation and emits heat that affects the atmosphere. Urban tree canopies reduce this affect by absorbing solar radiation before it strikes buildings, parking lots, roads, and other infrastructure. In addition, trees shade buildings and require less air conditioning during summer months. This effect may not have a direct bearing on the experience on Oakland Cemetery, but would have a positive effect on the surrounding community.

Air Pollution:
Trees have been documented to provide direct benefits in reducing air pollution. This reduction is a complicated mix of primary and secondary effects on atmospheric particulates and gases. Conversely, air pollution has been shown to negatively affect the health and vigor of tree certain tree species that have been labeled as "sensitive." Trees known to be tolerant of urban conditions should be used in order to positively affect air pollution without being negatively affected themselves. A reduction of air pollution may not have a direct bearing on the experience on Oakland Cemetery, but would have a positive effect on the surrounding community.

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Planting Trees:
Deciding on a particular location to plant a particular species of tree is a juggling act that requires a comprehensive and holistic approach to meet specific and general goals. It is impossible to achieve a perfect mix of aesthetic goals, historic site development goals, urban forestry goals, budgetary goals, and arboricultural goals. It is important, though, to consider all these aspects of the urban forest in each decision in order to achieve as many goals as possible while minimizing unintended consequences.

The current urban forest at Oakland Cemetery is less diverse than it could be, and filled with similar aged specimens due to the planting tendencies of tree managers in the past. One of the hardest decisions that might face current decision makers is when and where not to plant a tree instead of when and where to plant a tree. It would be helpful to develop policies and guidelines that promote a careful and steadfast approach to developing the urban forest at Oakland Cemetery rather than one that capitalizes on the enthusiasm of one generation versus the next.

Tree Locations:
Considering the difficulty of finding appropriate planting locations amongst the infrastructure of the cemetery and dealing with the mix of private and public lots, it would be helpful to locate and designate individual planting locations as appropriate for understory, mid-story, or overstory trees. This designation should take into account the future girth of the tree's trunk, the relative size of the tree's root zone, the aesthetic goal for the area, the historic nature of the area, the potential benefits to the immediate surrounding (shading, erosion control, etc), and the potential benefits to the cemetery as a whole (sound reduction, air movement, etc). During these deliberations, it would be helpful to strive for an optimal coverage of 80-100% overstory canopy coverage while accepting the reality that efforts will fall short of these numbers. Similarly, it may be useful to strive for 30-40% canopy coverage of mid-story trees, and 30-40% understory trees.

Tree Spacing:
Tree spacing has a direct effect on short-term and long-term canopy coverage, but also has a direct effect on tree growth, well-being, and maintenance costs. Again, due to the difficulty in finding appropriate planting locations amongst the infrastructure of the cemetery it would be helpful to strive for optimal spacing while understanding that these figures may be impossible to attain in certain areas of the cemetery. When dealing with specific planting situation, decision makers will need to assess the relative importance of spacing in relation to achieving other goals. In general, overstory trees can be planted as closely as 25-35 feet apart.

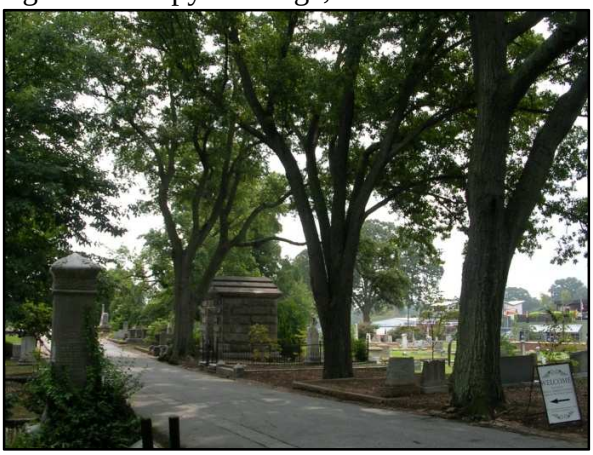

Figure 3-Overstory spacing at 25-35 feet.

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Mid-story trees can be planted as closely as 20-30 feet apart. Understory trees can be planted as closely as 10-20 feet apart.

Tree Selection:
One of the most important and difficult decisions in planning an urban forest is that of tree species selection. The urban forest at Oakland Cemetery has historically featured a collection of native and exotic species. In planning the future urban forest, a decision-making model needs to be developed to navigate the relative merits and detriments of native vs. exotic species. In addition to this criterion, it is important to strive for diversity and to avoid monoculture. In general, no more that 20% of any given genus should be used in future plantings. In addition, no more that 20-25% of any given species should be used.

Timing of Planting:
Of the 150 mature trees evaluated, 56% are estimated to die, or need to be removed, in the next twenty years. Of these, 8.5% are estimated to die within the next 5 years. Tree death and removal provides locations for new tree plantings, but it also encourages us to mimic the tree decisions that were made in the past. For instance, 20% of the 150 mature trees that were evaluated are Water Oaks that were planted during approximately the same era. Of these trees, 28% are estimated to die or need to be removed within 5 years and only 1 tree is estimated to have a useful life of greater than 20 years. If these 31 locations are replanted in the coming 20 years using overstory trees with similar longevity, the pattern of forestation and deforestation will not be broken. This pattern can be broken to achieve a multi-aged, diverse urban forest by careful decision making using overstory trees species with varying longevities and/or pacing the use of available overstory tree planting locations. A complete cemetery-wide tree inventory will be most helpful in determining the exact number over overstory, midstory, and understory trees that should be planted in any given era.

Figure 4-Multi-ages overstory plantings

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Summary:
The evaluation of 150 mature trees in WPA sections 1-14 of Oakland Cemetery has provided specific and general information about the current health of the urban forest and identified trends and needs of the future urban forest.

Through careful planning and implementation, the urban forest at Oakland Cemetery can become a diverse and multi-aged while achieving the comprehensive benefits of the urban forest.

In order to move forward with specific tree selection, location, and forest management, a comprehensive tree inventory along with GPS locates of existing trees and tree planting locations needs to be performed.

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