APPENDIX A
MOORE SQUARE TREE AND SOIL EVALUATIONS
URBAN TREES + SOILS

Moore Square Tree Evaluation

Raleigh, North Carolina October 29, 2012

Moore Square, Raleigh, North Carolina
Tree Evaluations and Recommendations

Draft 10 25 12
Urban Trees + Soils

Introduction

Moore Square has nearly 70 trees, the majority of which are mature specimens. They are the soul of the park and treasured by the citizens of Raleigh for their green canopy at the perimeter of the park. Maintaining this canopy is critical to the park improvement plans.

The current master plan concepts show places where alterations are proposed in areas that are likely to fall within areas normally considered as part of the trees root zone. This report will set the limits of the Tree Protection Areas, but also indicate what are the most critical things to do and not to do within this area.

Construction of many elements can be compatible with tree rooting areas if undertaken by skilled practitioners and contractors using techniques that are tree sensitive. It is important to note that the Master Plan Report is not a design document. It sets basic frameworks for design that now must be developed and refined to incorporate the many different site conditions and requirements that are typically left to the design development stage. This report is intended to guide the design development process from a tree preservation perspective.

Tree preservation during construction is essentially soil preservation. For this reason, tree preservation guidelines have focused on protecting large areas of ground surface around the tree. This area of protected ground is the **Tree Protection Area**.

At the tree's trunk, there is typically a distinct trunk flair, an enlarged area of wood that supports the tree right at the ground line. Below the ground and trunk flare, large roots form to support the tree and further divide into smaller roots further from the tree that collect the water and nutrients that the tree needs. The most important part of these roots are generally considered the area within the first 4-10 feet from the trunk called the Zone of Rapid Taper roots. The zone of rapid taper roots and the trunk flair together are must receive special consideration to protect them from damage. This area is also the place where most root / paving conflicts begin and paving within this area must take these conflict into consideration. This area is the **Trunk Base Protection Area**.

Often the Tree Protection Area is interpreted as a place where no construction activity should take place. This is an incorrect interpretation. Construction of many types often occurs in this area with no consequences to the tree's long-term health. However, construction must be designed and executed by professionals who are expert in tree preservation and working around trees. It is analogous to having surgery by some one not trained in surgery. Even a trained General practitioner might not be the right person for particular procedures. The more technical the operation the more likely you are to want to find a specialist. It is entirely possible to construct the elements of the Master Plan, with of course appropriate design development refinements in their size, materials, elevations, and locations, and find the mature tree population in better condition that it is today.

Tree evaluations

There have been a number of tree evaluations undertaken for the trees in Moore Square. The City of Raleigh provided the design team with a tree evaluation at the beginning of the project. Jeff Kish of Bartlett Tree Experts, a consultant to the design team made initial evaluations of each tree. These first two evaluations were focused on general tree health.

Urban Trees + Soils, the design team's soil and tree consultant made an additional survey. This survey looked at the trees from the perspective of the trees ability to survive construction, including the trees vigor, structure and the condition of the trees base relative to designing paving and other structures in close proximity to the tree. The goal of this survey was to obtain data to use in calculating the Tree Protection Area and the Trunk Base Protection Area; and to make recommendations on the trees ability to withstand construction impacts.

Note that only the sites large, mature trees were evaluated for construction impact tolerance. There are 37 large mature trees out of a total of approximately 68 existing trees in Moore Square. The remaining smaller trees at the site will be relatively easy to work around where they are determined to be preserved.

The following is the methodology for the Urban Trees + Soils evaluations:

Trunk base evaluation:
This evaluation determines the degree of difficulty in working near the base of the tree. The Trunk Base evaluation is then used to set the **Trunk Base Protection Area**. This area, close to the base of the tree is the area where even minor disturbance may severely injure the tree.

Trunk Base Protection Area: The distance new paving should be kept away from the trunk or where special construction is required to eliminate damage to roots and bark. This area must receive special protection treatment over and above the requirements of the larger Tree Protection Area. The size of the Trunk Base Protection Area is an initial recommendation. The distance may be decreased if special details such as flexible paving surfaces or bridging design are utilized, or may need to be larger due to topography or surface rooting conditions. These stand off dimensions assume that no cut is required to construct the paving in this area. In areas where paving is already inside of the stand off zone, such as along Blount Street, new paving may be installed

provided that the limit of paving is not brought closer to the tree or the paving section deeper than the existing paving.

Trunk base evaluation classifications, criteria, and limits of the Trunk Base Protection Area (**TBPA**) are:

Normal: Reasonably size trunk flair proportion with little damage or other problems. **TBPA** ***radius*** *from center of trunk –* ***1.5 times trunk diameter****.*

Moderate: Larger size trunk flare, minor damage or other problem that may require special attention in the design. **TBPA** ***radius*** *from center of trunk* ***– 2 times trunk diameter.***

Difficult: Extra large trunk flare or significant surface roots, existing trunk flare damage and other issue that may need additional investigation and response during the design process. ***Paving stand off radius*** *from center of trunk –* ***2.5 times trunk diameter****.*

Tree Structure evaluation:
This evaluation notes observed problems with branch structure or tree stability. Tree structure is critical to the long-term success of a tree and may be a significant factor in determining if a tree is a good candidate for tree preservation.

Tree structure evaluation criteria and classifications are:

Good: No observed problems

Fair: Minor branch conflicts such as co-dominant leaders that are easily modified.

Poor: Significant branch conflicts such as co-dominant leaders that are not easily modified, dead portions of trees, asymmetrical canopies or trunk leans.

Tree Vigor evaluation:
This evaluation records tree growth vigor as determined by leaf color, density and distribution in the canopy. A trees vigor is a critical indicator of a trees ability to survive root loss.

Good: Normal leaf color, size and distribution

Fair: Observable variation from normal leaf color, density and distribution in the canopy. Minor twig dieback.

Poor: Significant variation form normal leaf color, density and distribution in the canopy. Significant twig dieback.

Hazard tree investigation recommendation:
Large mature trees in close proximity to people may pose the risk of structural tree failure that can injure people using the park. The City of Raleigh is responsible for the monitoring and mitigation of hazardous conditions in the park and has been doing a good job of removing dead branches and stabilizing trees. However, trees are dynamic organisms who's structural conditions change constantly as the tree grows and adds weight and wind loading in some areas while at the same time decay and added stress from wind and gravity is weakening the tree in other areas. Finding tree conditions that might be dangerous is a constant task in a population of trees of the size and age of the trees in Moore Square.

The action of the proposed major renovation of this park causes the city to take on added liability for these trees. It is assumed, that during a facility wide reconstruction, all systems will be made as safe as possible and that the entire park will meet current codes and safety concerns upon completion. This puts added requirements on the trees to be evaluated for defects and to mitigate these defects even to the point of removing hazardous trees.

For this reason, it is advised that the city conduct a hazard tree evaluation for any tree that may have indications of possible hazardous conditions. During the initial tree evaluation of the park 24 trees were identified as being candidates for further hazard tree evaluation. These trees are noted in the Summary tree Evaluation Data.

Apparently the City does not have a person on staff who is ISA certified in hazard tree evaluation to evaluate the trees using the ISA Hazard Tree Evaluation method. They do have an alternative method to evaluate trees which is apparently has proven effective to reasonably identify most hazardous trees**.** However, the ISA Hazard Tree Evaluation system is the best available methodology to determine safety concerns for trees in public landscapes and the City should consider having the evaluations performed by some one trained in the ISA system. The City, as the owner of the property, will make the decision on this important matter, determining what system to use, and the qualifications of the review person. They will make the final determination of which trees are considered hazardous and approve mitigation requirements to reduce dangerous conditions including tree removal if needed.

Summary Tree Evaluation Data:
The data collected is summarized on the attached tree evaluation and recommendations spreadsheet. This matrix includes the field observations ratings for each of the large, mature trees.

Establishing the Tree Protection Area

The size of the Tree Protection Area for each tree is calculated to guide the design and help assure the survival of the tree. Tree Protection Areas are typically interpreted as being areas of no construction activity. However, if remedial work to improve growing conditions before, during, and after the construction are undertaken and responsible construction methods under tight controls and design guidelines that will protect the tree's vital systems are employed' construction may take place within this area with little to no impact on the tree. Reasonable practices include those that prepare the tree, protect the tree and soil from damage and provide for after care that mitigates any soil or root damage. These reasonable practices will be further elaborated in the section "Tree Protection Plan".

Tree Protection Area Calculations:

The City of Raleigh uses a formula of 1.5 feet of radius for each inch of trunk diameter to establish the Tree Protection Area. This approach is not supported in the literature as being necessary to successfully save every tree. It is an overly large protection area and assumes that nothing is done to modify normal construction or to mitigate damage. It dos not take into account the differences in age of trees nor the differences species tolerance to withstand construction.

This report recommends using the system developed Nelda Metheny and James Clark in their book "Trees and Development: A technical Guide to Preservation of Trees During Land development". This book, published by the International Society of Arboriculture (ISA), is recognized as the best source of tree preservation information. It was peer reviewed by 15 arborist and tree professionals for its accuracy. The ISA is a serious professional and scientific organization with a long history of improving the care and preservation of trees.

The ISA approach starts by determining the trees tolerance to withstand construction. An extensive research questioner, sent to arborist all over the United Stated, ranked hundreds of different tree species. The results of this questioner were tabulated and published in "Trees and Development". The system uses a ranking of good, moderate and poor tolerance to construction. Fortunately most of the large trees on this site are classified as having good tolerance to construction.

The second step is to determine the tree age with three levels proposed. Young trees, considered at less than 20% of their life expectancy; Mature trees between 20 and 80% of their life expectancy; and Over-mature trees, those with less than 80 % of their life expectancy. For the purpose of this report the Bartlett Tree arborist report was used to make the determination of age classification.

The third step is to determine the requirement of the radius of the Tree Protection Area in feet per inch of trunk diameter. In the ISA system, the radius generally ranges from 0.5 feet per inch of caliper to 1.25 feet per inch of trunk diameter.

In only one case, the most restrictive condition, does the ISA method use 1.5 inch per inch of trunk diameter. The ISA system is as follows:

ISA Recommended

Species Tolerance	**Tree Age**	**Radius from the trunk in feet per inch of trunk diameter**
Good	Young < 20% life expectancy	0.5'
	Mature 20-80% life expectancy	0.75'
	Over mature > 80% life expectancy	1.0'
Moderate	Young	0.75'
	Mature	1.0'
	Over mature	1.25'
Poor	Young	1.0'
	Mature	1.25'
	Over mature	1.5'

Using the above system, a radius of Tree Protection Area has been calculated for each large tree. One variation was used to further refine this approach. The above ISA system assumes that the trees health (vigor) is in a normal condition and does not account for other mitigating factors often found at urban sites such as trunk base conditions, soil problems, drainage, or adjacent structures. The ISA system does suggest that these conditions be factored into the final distance. In making the Tree Protection Area calculations for the trees at Moore Square, some of the tree distance requirements were increase 0.25 feet per inch of trunk diameter to factor for observed conditions that would make the tree preservation more difficult. These trees are noted with an asterisk in the Tree Protection Area Ft/Inch column on the tree evaluation chart.

The methodology used to determine that a tree should be given the extra 0.25' / Inch in the rating was as follows.

Any tree that was rated as Vigor – Poor.
Any tree that had two out of three categories (Tree Base, Structure, Vigor) in the lowest rating.
Any tree that had three out of three categories in the medium or low rating.

Using the above methodology, the radius of the Tree Protection Area for the mature trees ranges from 0.5 ft / inch to 1.5 ft / inch with only 3 trees indicated as needing 1.5 ft / inch.

Construction disturbance within the Tree Protection Area:

The Tree Protection Area is not to be considered a place where no construction disturbance is permitted. There are many types of activities including minor grading, paving and small structures that can be successfully implemented provided that proper approaches are taken. Some soil disturbances such as soil invigoration have been shown to improve tree health. These concepts are outlined in the following Tree Protection Plan section. But it should not be assumed that construction disturbances such as paving, grading and the inclusion of structures do not cause any harm to the tree. The construction techniques in the Tree Protection Plan should be limited in their area of impact to the greatest extent possible.

A good rule of thumb is to make the following limitations and requirements on the inclusion of construction impacts in the Tree Protection Area.

0-30% of the Tree Protection Area

Design impacts to one side of the area avoid circling the tree with different impacts.
No Impacts within the Trunk Base Protection Area
Avoid work in the summer.
Apply water to mitigate impact.
Restore fencing and geogrid/mulch matting after the completing of the work.

30-50% of the Tree Protection Area

Design impacts to one side of the area – No impacts on the opposite side. Increase the size of the Tree Protection Area on the side of the tree that is not being disturbed
No Impacts within the Trunk Base Protection Area
Undertake work during the season most favorable for root development and in periods of low plant stress.
Apply water to mitigate impact and continue to apply water as needed over the following year.
Restore fencing and geogrid/mulch matting after the completing of the work.
Increase frequency of monitoring of tree vigor, disease and insect over the following 5 years

Following these guidelines will significantly reduce the impacts on the trees.

Tree Protection Plan

Protecting a tree during construction requires multiple levels of approaches that go far beyond simply fencing the area of protection. A Tree Protection Plan is required that begins prior to the start of construction and carries on well past the end of construction. The plan will have parts that must be implemented by the City. Parts of the plan will impact the design process and parts that will become a part of the construction documents. Portions of the plan will become part of the park's long-term management plan.

If properly developed and implemented, the result of the Tree Protection Plan over the long term of the life of the tree is that the mature trees in Moore Square will likely be healthier after the construction than before and their life expectancy should increase. Each part of the plan not only protects the trees from damage, but also will improve growing conditions and mitigate existing conditions in ways that would likely not be possible under current park management budgets.

The following is the outline for the Tree Protection Plan, presented as a series of general concepts that will guide the development of specific recommendations for each tree as the details of the design and construction process develops. The plan has four parts. Pre-construction requirements; Design and construction documents requirements; Construction requirements; and Post construction requirements.

Pre-construction requirements:

1. Evaluate the existing tree conditions.
2. Establish Tree Protection Area and Trunk Base Protection Area for each tree.
3. Perform a Hazard Tree Evaluation for each mature tree and develop tree mitigation requirements for all conditions encountered. Implement the mitigation requirements.
4. Establish and fund a preconstruction tree management budget to implement the preconstruction portion of the Tree Protection Plan. This needs to be undertaken as soon as possible and is NOT part of the construction budget.
5. Identify the primary tree care manager within the Parks Department to oversee the Tree Protection Plan.
6. Develop and implement a tree health management contract with an arborist to monitor and treat all disease and insect problems; prune trees to remove deadwood and structural defects.
7. Apply Cambistat tree growth regulator to all mature trees to reduce growth rates and stimulate fine root production. Note that Cambistat requires a minimum of one year to begin to have positive effects on the tree and needs to be applied every three years. Ongoing applications of Cambistat should remain a City responsibility during the construction to assure that consistent application requirements are followed.
8. Apply any nutrients recommended by the soil test to bring soils in the root zone to optimum nutrient levels before, during and after the construction. Ongoing soil testing and applications of nutrient should remain a City

responsibility during the construction to assure that consistent application requirements are followed.

9. During periods of prolonged drought prior to construction, develop and implement a root zone watering program for all mature trees to remain to assure that they are not water stressed.

Design and construction documents requirements:

1. Insert into the design drawings the limits of the Tree Protection Area and Trunk Base Protection Area for each tree. These limits should be included in every site construction plan document of each of design disciplines to assure that all design consultants understand the importance of these areas and when their work is impacting these zones.
2. Develop a Soils Improvement Plan, soil details and soil specifications for all areas of the park that retains good soils; protects root zone soils from damage; and improves soil within and outside the Tree Protection Area for future growth of each tree.
3. Develop Tree Protection Plans, details and specifications that detail specific requirements for tree protection including fencing, mulching/matting, operations allowed within the Tree Protection Area, trenching/ grading techniques, watering requirements, disease and insect controls, pruning, and monitoring and mitigation of inadvertent damage.
4. Establish the cost to the contractor for various levels of tree damage including placing an ISA based value on each tree in the event that it is damaged to the point where the tree's long-term health is compromised by damage caused by the contractor.
5. Protect soil within the Tree Protection Area from compaction by fencing and mulch/geogrid matting.
6. Grading cuts should be minimized or when required made with an air spade and vactor equipment. Roots larger than 1 inch in diameter encountered during grading must be cut only with the approval of the project arborist.
7. Grading fills must be preceded by removal of organic layers or turf. Undertake airspade invigoration of the existing soil that may include mixing existing organic layers with the sub soil below and mixing with the new soil to be installed. Fill soil in the Tree Protection Area must be sandy loams place by low compaction impact procedures. New grades must continue to provide for drainage and aeration of the soil. If fills exceed 12 inched deep aeration layers between the fill and existing grades must be included.
8. Utility line trenches within the Tree Protection Area should be avoided and lines redirected around the Tree Protection Area. Where unavoidable new utility lines shall be installed with directional boring technology; or the use of airspade /vactor equipment.
9. New paving should be placed on geogrid/ aggregate bases. Walls and other structures should employ pier and beam bridging with designs that are flexible to move piers or beams to avoid large roots. All excavation must use airspade / vactor equipment. The arborist must approve any roots to be cut over 1" in diameter.
10. All new planting within the Tree Protection Area must be performed using planting concepts that require the least amount of disturbance. Bare root planting and planting with airspade digging tool is preferred. Spacing of plants should be as wide as practical and allow plants to grow together. Tightly spaced plants to make instant effects of the planting must be avoided.

Construction requirements:

1. Retain an independent arborist to monitor all tree protection provisions during the extent of the work. The arborist must have access to the site frequently enough to make reasonable and timely review of the work. The cost of this provision must be included in the project budget.
2. Implement the requirements in the Tree Protection Plan provisions.
3. Implement the requirements in the Soil Plan provisions
4. The provisions of the Tree Protection Plan must be flexible to accommodate all factors in the construction sequence. The project arborist must approve all modifications to the plan.
5. Provide supplemental water to the root zone during the construction.

Post construction requirements:

1. Assure that there is a well documented and understood transfer point of tree maintenance responsibility from contractor to the City at the end of the construction.
2. Continue supplemental watering of the root zone as required for a minimum of 5 years.
3. Continue Cambistat and nutrient treatments as required for a minimum of 5 years after the end of construction.
4. Continue intensive tree health monitoring for a minimum of 10 years.

Introduction
The following is the report of findings of the soil conditions at Moore Square in Raleigh, North Carolina. This report examines the soil from the perspective of existing and future plant growth. The findings are based on review of the site conditions on September 17 and 18, 2012, and the review of the planning documents for the proposed improvements to the park. All references to historical site conditions are taken from the master plan reports.

Historical overview of soil disturbance:
Moore Square was part of the original 1772 Town Plan for the city. It likely evolved from either forest or farm land directly into a public park. This would have resulted in minimum soil disturbance.

Only two structures of any significance were ever built in the park, those being before 1896. These structures fall in the central area of disturbance and were likely out of the current root zones of large existing trees. The small kiosk built on the south side of the park appears to have caused minimum soil disturbance compared to disturbances from walks, later grading and utility work.

The earliest representations of trees show the trees clustered on the east side of the park, possibly a remnant forest or second growth after logging. This edge is characterized by steeper slopes and may have been more irregular than currently sloped. The more formal designs of 1896 and 1914 would have likely smoothed grading on the east side of the park as well as removing the previously mentioned trees. The grading of the current plan appears to have pushed a layer of fill to the east of the center of the park.

The many alignments of walks over the parks history have caused soil disturbance along the edges of the alignments. The center of the park and the four widen arms of the crossing diagonals have also introduced their share of soil disturbance.

The many different uses and events at the square from pasture, civil war troop camp to contemporary music festivals, all extracted a toll on soil quality. Hard layers of soil were encountered in many locations. Multiple rounds of park utility electric and water lines also have disturbed the soil.

Throughout the park, large areas of mulch beds cover the ground. These are areas where park maintenance has not been able to keep turf growing. Much of this turf problem is related to intense use during the many concerts and festivals staged in the park. These areas are also almost always within the canopy of the large trees. It is likely that people gather more in the shade during events contributing to turf damage. Trees and turf are also difficult partners, and problems are increase with the added compaction of people. Serious consideration on solving the shade, event, and turf conflicts must accompany any park redesign. Recent study of the national Mall turf in Washington DC indicates that event structures, turf abrasion, and events on saturated soil contribute the majority of turf damage rather than compaction from park users.

While all these disturbances result in almost all areas of the park being disturbed to some degree, the soil disturbance in the large center space, its northern extension to Hargett Street and portions of the east side of the park are significant to the point of impacting existing and future tree growth.

Current topography and soil disturbance:
Current topography can be read for soil disturbance. Cut and fill slopes appear associated with paving throughout the park. This is particularly true at the perimeter where the walks and grades meet the street sidewalk edges. It appears that the streets were generally cut into the existing predevelopment grades as part of a larger scale grading scheme to create smooth street grade transitions from the ridge line parallel to Fayetteville Street and the lower lands east of the downtown area. In the middle portion of the site the contours are highly irregular with minimum organizing features, characteristic of continuous changes from different construction efforts. Only the slopes in the parks east side seem to reflect a pre development contour pattern. But even here fill soils were discovered.

Soil profile pit descriptions:
20 multi layer profile pits were dug and recorded. Soil profile descriptions are in the following section. A general review and interrelationship of the soil profiles follows later in a later section "**Interpretation of the soils information."**

The approximate locations of all profile pits are shown on the attached "Soil Profile Pits Location Plan. The following are the description of the soil profiles observed.

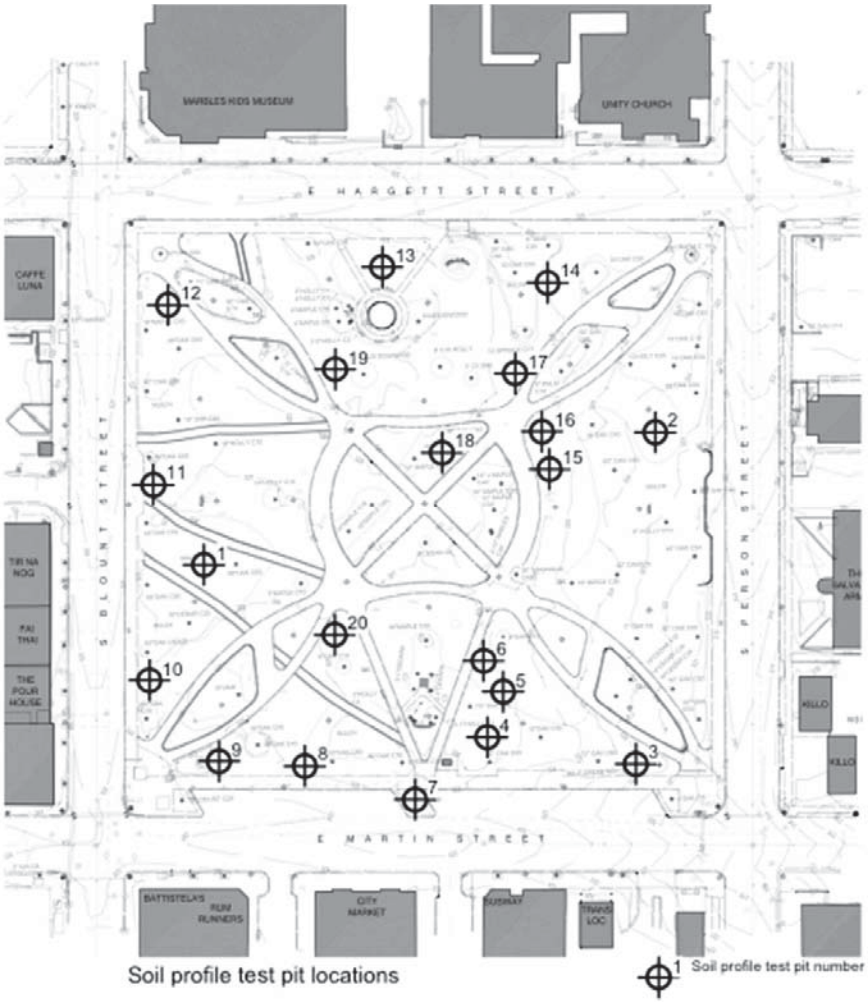
Note the following gradations of terms for moisture and compaction are used in this report to describe soil conditions. Soil textures are USDA terminology as estimated during the digging process.

Moisture: terminology for soil moisture from dry to wet as determined by visual analysis and feel.
Dry – soil will not hold together after being crushed
Damp – soil will marginally hold together when crushed
Moist – soil can be formed into a ball
Wet – soil sticks together and will stick to the hand
Saturated – free water observed on the soil

Density: terminology for soil density from loose to solid as felt during the angering process. *Note that dry soils can "feel' compacted, while compacted soil can "feel" soft when moist. The presence of roots is a better indication of compaction below root limiting levels.*

Loose – auger easily penetrates the soil
Soft – auger penetrates the soil with moderate effort

Firm – auger requires strong push to penetrate the soil
Hard – auger requires maximum pressure to penetrate the soil
Refusal – auger refuses to penetrate the soil



Location 1:

Soil profile	Depth	Description Surface cover: Wood chip mulch
	0-0.2’	Decomposing wood chip mulch; dark brown/black; moist; soft; roots observed
	0.2’–0.5’	High organic fine sandy loam; dark brown; damp/dry; firm; roots observed
	0.5’-1.0’	Fine sandy loam; light brown, dry; firm; roots observed
	1.0’-1.4’	Fine sandy clay loam; light brown/orange; dry; hard; roots observed
	1.4’-1.8’	Fine sandy clay loam; orange/brown; dry; very hard; roots observed
	1.8’-2.1’	Fine sandy clay loam; orange; dry; very hard; roots observed
	2.1’	Auger refusal

Remarks: The soils below 0.5’ are likely to be an undisturbed soil profile. Soil profile taken near one of the older and healthier trees in the park.

Location 2:

Soil profile	Depth	Description Surface cover: Wood chip mulch
	0-0.2’	Wood chip mulch
	0.2’-0.3’	Very organic loam, dark brown/black; moist; loose; roots observed
	0.3’-0.4’	Interface; sandy loam fill; brown; dry; firm; roots observed
	0.4’-0.6’	Interface; loam fill; dark brown; dry; firm; roots observed
	0.6’-1.2’	Interface; fine sandy/gravel loam; grey/brow; dry; hard to V hard; roots observed
		Coal ash fragments
	1.2’	Trace of sandy clay, orange; dry; auger refusal

Remarks: Fill soils over subgrade soils. Disturbed soil profile.

Location 3:

Soil profile	Depth	Description Surface cover: Wood chip mulch
	0-0.3’	Wood chips; dark brown/black; moist; soft; roots observed
	0.3’-0.5’	Decomposed organic material; dark brown/black; moist; soft; roots observed
	0.5’-0.8’	Fine sandy loam/ sandy clay loam; brown; moist; soft; roots observed
	0.8’-1.4’	Fine sandy clay loam/gravel; orange brown; moist; soft; roots observed;
		Cloth strip fond at approximately 1.0’, roots observed and large root struck
	1.4’-1.7’	Fine sandy clay loam, orange/ brown; moist; soft; minor roots
	1.7’-2.6’	Gritty, gravel sandy clay loam; orange; dry; firm to very hard w/depth
	2.6’	Same as above; very dry; auger refusal

Remarks: Profile below 1.4 feet likely an undisturbed sub soil. Profile adjacent to largest (DBH) tree on site

Location 4:

Remarks: Profile similar to Location #3

Location 5:

Remarks: Profile similar to Location #3 except Orange soil starts at about 1.5'.

Location 6:

Soil profile	Depth	Description Surface cover: Wood chip mulch
	0-0.3'	Decomposing wood chips, dark brown/black; moist; soft; roots observed
	0.3-0.7'	Interface; sandy loam; dark brown; moist; soft; roots observed
	0.7-1.4'	Interface; fine sandy loam; light brown; damp, firm; roots observed
	1.4'-2.4'	Interface; gravel and fine sandy clay; orange; moist, firm
	2.4'	Stopped digging

Remarks: Highly disturbed soil near walk

Location 7:

Soil profile	Depth	Description Surface cover: Mulch
	0-0.1	Scant wood chip mulch
	0.1'-0.7'	Sandy loam; brown; damp; soft
	0.7'-1.0'	Coarse sand; grey; dry; soft
	1.0'	Refusal at gravel layer

Remarks: Tree planting island built into parking space. Tree recently planted. Another tree in similar island is dead.

Location 8:

Soil profile	Depth	Description
		Surface cover:
	0-0.2’	Decomposing wood chips; dark brown/black; moist; soft; roots observed
	0.2’-0.7’	Fine sandy loam; brown; dry; firm; roots observed
	0.7’-1.2’	Interface; fine sandy silt loam; light brown; dry; firm; roots observed
	1.2’-1.3’	Interface; silty sandy loam; dark brown; moist; firm; roots observed, glass fragment, likely buried fill soil
	1.3’-1.9’	Interface; fine sandy silt loam; light brown; dry; hard; roots observed
	1.9’	Auger refusal; bits of hard orange subsoil observed

Remarks: Disturbed fill soils

Location 9:

Soil profile	Depth	Description
Profile not photographed		Surface cover: Wood chip mulch Highly disturbed soil; multi layers; moist, one layer slightly anaerobic

Remarks: in bed next to electric vault

Location 10:

Soil profile	Depth	Description
Same as profile #1		Surface cover: Wood chip mulch

Remarks:

Location 11:

Soil profile	Depth	Description
Same as profile #1		Surface cover: Wood chip mulch

Remarks:

Location 12:

Soil profile	Depth	Description
Same as profile #1		Surface cover: Wood chip mulch Soil slightly wetter than other #1 profiles

Remarks:

Location 13:

Soil profile	Depth	Description Surface cover: Turf grass
	0-0.3’	Loam; dark brown/black; moist; soft; roots observed
	0.3’-0.5’	Sandy loam; dark brown; moist; soft; roots observed
	0.5’-0.8’	Sandy loam; brown; moist; soft; roots observed
	0.8’-1.2’	Sandy clay loam; light brown/orange; moist; firm; roots observed
	1.2’-1.6’	Clay loam; orange; damp to moist; hard
	1.6’	Very hard; Stopped digging

Remarks: Disturbed profile

Location 14:

Soil profile	Depth	Description Surface cover: Wood chip mulch
Same as profile #1		

Remarks:

Location 15:

Soil profile	Depth	Description Surface cover: Turf grass
Profile not photographed	0-0.7’	Loamy soil, dark brown; moist; soft
	0.7’	Fine sandy clay loam; orange, damp; firm

Remarks:

Location 16:

Soil profile	Depth	Description Surface cover:
Same as # 15		

Remarks:

Location 17:

Soil profile	Depth	Description Surface cover: Turf grass
Same as # 1		

Remarks:

Test pits at locations 15 -17 was an attempt to confirm the edge of the disturbed soil in this area of the site.

Location 18:

Soil profile	Depth	Description
		Surface cover: Wood chip mulch
	0-0.6’	Decomposing mulch; dark brown/black; moist; soft; roots observed
	0.6’-1.1’	Fine sandy loam; dark brown; moist; soft; roots observed
	1.1’-1.5’	Fine sandy loam; brown; moist; soft; roots observed
	1.5’-2.1’	Fine sandy clay loam; brown/ orange; moist; soft; roots observed
	2.1’	Auger refusal on large root

Remarks:

Location 19:

Soil profile	Depth	Description
Same as #13		Surface cover: Turf grass

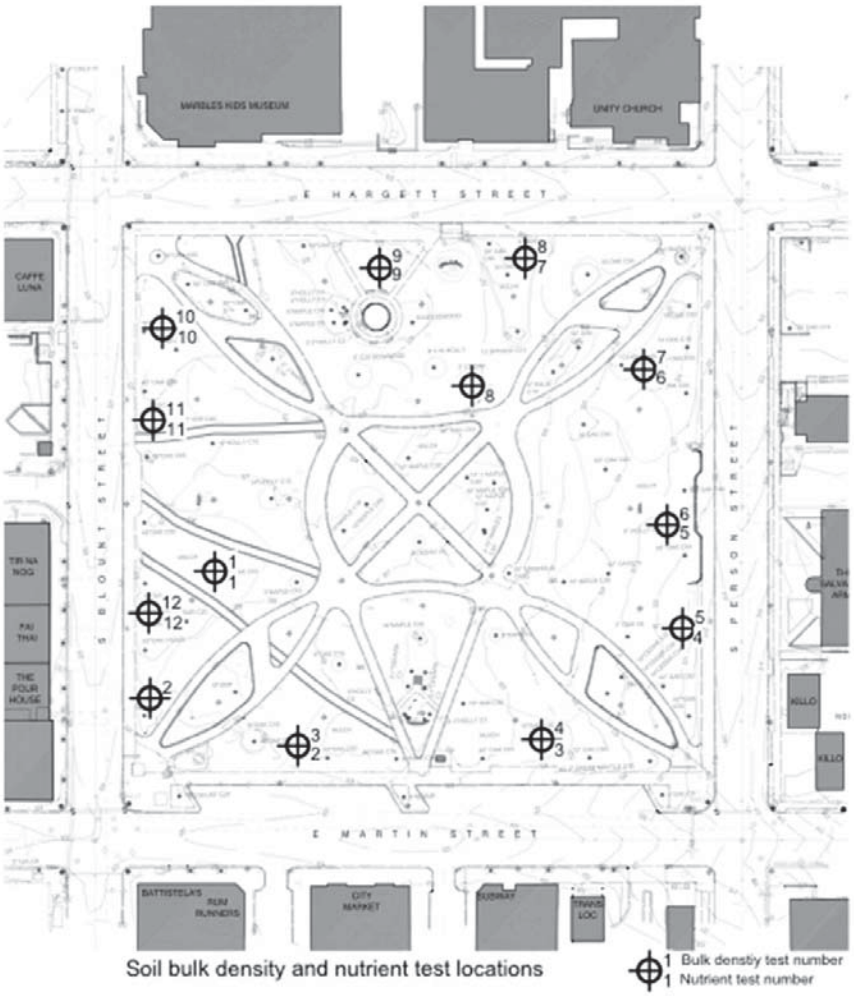
Remarks:

Location 20:

Soil profile	Depth	Description
		Surface cover:
Profile not photographed	0-1.5’	Sandy loam; brown; damp; firm
	1.5’	Interface; coarse sandy clay loam; red/orange; damp hard

Remarks: Fill soil over graded subsoil

Soil nutrient testing:
At 12 locations, marked 1 thru 2, on the Soil Bulk Density and Nutrient Test Location plan, soil was collected by the Bartlett Tree Experts from the top layer of the soil for nutrient testing. Samples were processed by Bartlett Tree Expert soil labs. The purpose of the testing was to gain a background chemical profile of the upper layer of the soil. The following are the test results and lab recommendations for modifications to soil nutrients. A general review of the soil testing results and recommendations follows later in section **Interpretation of the soils information.**



Soil bulk density and nutrient test locations

Nutrient Test Location 1:

Soil Analysis Report - Technician Copy
Bartlett Tree Research Laboratories
Chris Counts Studio

Bartlett Arborist: Jeffery Kish
Plant Species: Other
Location/ELM ID: #1 under tree 65
Fertilization Goal: Maintain Vitality

Moore Square in downtown Raleigh
Raleigh, North Carolina 27604

Sample ID: 131905
Date: 18-Aug-10
A&L: 10-229-0511

Results

Soil pH	6.3	Acceptable	Ideal pH range for Other: 5.5 to 6.5
Nitrogen (ENR)	113.0		
Phosphorous (P)	110.0	High	
Potassium (K)	514.0	Very High	
Magnesium (Mg)	618.0	Very High	
Calcium (Ca)	4646.0	* Medium	
Soil Organic Matter (OM)	4.4	Medium	Nutrient Retention Capacity 17.6 Very High

Recommendations

Fertilization Area: 1000 sq.ft or 93 sq. m. - Mix in 30 gallons or 113 liters of water Soil inject 1 Quart per site

Prescription Fertilization		cc/ml	cups	quarts	gallons	grams	pounds
Nitrogen	Nitro 30	2.5 L	10.6	2.6			
	Nitroform	3.7 L	15.5	3.9	1.0	2.4 Kg	5.0
Phosphorus	Liquid Phosphorus						
Potassium	Potassium Sulfate						
Gypsum	pelletized	36.9 L			9.8	48.0 Kg	100.0
Lime	pelletized						
	powdered						
Sulfur	pelletized						
	powdered						
Magnesium Sulfate	Epsom salt						
Iron chelate	gallons						
	pounds						
Manganese chelate	gallons						
	pounds						
Conventional Fertilization							
Boost Natural		121.2 L			32.0		
Boost		60.6 L			16.0		
Boost Granular		2.5 L	10.5	2.6		2.4 Kg	5.0
Organic Milorganite		7.1 L	30.0	7.5	1.9	4.8 Kg	10.0
Mulch or incorporate organic matter:		Yes					

Comments:

* indicates a deficiency ** indicates a potential toxicity
***Limestone Maximum Rate for a single application to soil surface is 100 lbs for powdered or 150 lbs for pelletized lime, with Root Invigoration apply up to 200 lbs.

Nutrient Test Location 2:

Soil Analysis Report - Technician Copy

Bartlett Tree Research Laboratories

Chris Counts Studio

Bartlett Arborist: Jeffery Kish
Plant Species: Other
Location/ELM ID: #2 common area between trees 31 and 32
Fertilization Goal: Maintain Vitality

Moore Square in downtown Raleigh
Raleigh, North Carolina 27604

Sample ID: 131915
Date: 18-Aug-10
A&L: 10-229-0511

Results

Soil pH	5.6	Acceptable	Ideal pH range for Other: 5.5 to 6.5
Nitrogen (ENR)	86.0		
Phosphorous (P)	334.0	Very High	
Potassium (K)	182.0	* Low	
Magnesium (Mg)	270.0	* Medium	
Calcium (Ca)	1954.0	* Medium	
			Molybdenum (Mo) 0.0
Soil Organic Matter (OM)	3.1	* Low	Nutrient Retention Capacity 8.4 High

Recommendations

Fertilization Area: 1000 sq.ft or 93 sq. m. - Mix in 30 gallons or 113 liters of water Soil inject 1 Quart per site

Prescription Fertilization		cc/ml	cups	quarts	gallons	grams	pounds
Nitrogen	Nitro 30	2.5 L	10.6	2.6			
	Nitroform	3.7 L	15.5	3.9	1.0	2.4 Kg	5.0
Phosphorus	Liquid Phosphorus						
Potassium	Potassium Sulfate	1.1 L	4.6	1.2		1.9 Kg	4.0
Gypsum	pelletized	22.2 L			5.9	28.8 Kg	60.0
Lime	pelletized						
	powdered						
Sulfur	pelletized						
	powdered						
Magnesium Sulfate	Epsom salt	2.8 L	11.7	2.9		3.4 Kg	7.0
Iron chelate	gallons						
	pounds						
Manganese chelate	gallons						
	pounds						
Conventional Fertilization							
Boost Natural		189.5 L			50.0		
Boost		94.7 L			25.0		
Boost Granular		5.0 L	21.0	5.3	1.3	4.8 Kg	10.0
Organic Milorganite		14.2 L			3.8	9.6 Kg	20.0
Mulch or incorporate organic matter:		Yes					

* indicates a deficiency ** indicates a potential toxicity

***Limestone Maximum Rate for a single application to soil surface is 100 lbs for powdered or 150 lbs for pelletized lime, with Root Invigoration apply up to 200 lbs.

Nutrient Test Location 3:

Soil Analysis Report - Technician Copy

Bartlett Tree Research Laboratories

Chris Counts Studio

Bartlett Arborist: Jeffery Kish
Plant Species: Other
Location/ELM ID: #3 under tree 36
Fertilization Goal: Maintain Vitality

Moore Square in downtown Raleigh
Raleigh, North Carolina 27604

Sample ID: 131904
Date: 18-Aug-10
A&L: 10-229-0511

Results

Soil pH	6.4	Acceptable	Ideal pH range for Other: 5.5 to 6.5
Nitrogen (ENR)	113.0		
Phosphorous (P)	168.0	Very High	
Potassium (K)	704.0	Very High	
Magnesium (Mg)	856.0	Very High	
Calcium (Ca)	5756.0	* Medium	
Soil Organic Matter (OM)	4.4	Medium	Nutrient Retention Capacity 22.5 Very High

Recommendations

Fertilization Area: 1000 sq.ft or 93 sq. m. - Mix in 30 gallons or 113 liters of water Soil inject 1 Quart per site

Prescription Fertilization		cc/ml	cups	quarts	gallons	grams	pounds
Nitrogen	Nitro 30	2.5 L	10.6	2.6			
	Nitroform	3.7 L	15.5	3.9	1.0	2.4 Kg	5.0
Phosphorus	Liquid Phosphorus						
Potassium	Potassium Sulfate						
Gypsum	pelletized	36.9 L			9.8	48.0 Kg	100.0
Lime	pelletized						
	powdered						
Sulfur	pelletized						
	powdered						
Magnesium Sulfate	Epsom salt						
Iron chelate	gallons						
	pounds						
Manganese chelate	gallons						
	pounds						
Conventional Fertilization							
Boost Natural		121.2 L			32.0		
Boost		60.6 L			16.0		
Boost Granular		2.5 L	10.5	2.6		2.4 Kg	5.0
Organic Milorganite		7.1 L	30.0	7.5	1.9	4.8 Kg	10.0
Mulch or incorporate organic matter:		Yes					

Comments:

* indicates a deficiency ** indicates a potential toxicity

***Limestone Maximum Rate for a single application to soil surface is 100 lbs for powdered or 150 lbs for pelletized lime, with Root Invigoration apply up to 200 lbs.

Nutrient Test Location 4:

Soil Analysis Report - Technician Copy

Bartlett Tree Research Laboratories

Chris Counts Studio

Bartlett Arborist: Jeffery Kish
Plant Species: Other
Location/ELM ID: #4 Adjacent to tree #44
Fertilization Goal: Maintain Vitality

Moore Square in downtown Raleigh
Raleigh, North Carolina 27604

Sample ID: 131907
Date: 18-Aug-10
A&L: 10-229-0511

Results

Soil pH	5.9	Acceptable	Ideal pH range for Other: 5.5 to 6.5
Nitrogen (ENR)	110.0		
Phosphorous (P)	138.0	Very High	
Potassium (K)	438.0	High	
Magnesium (Mg)	500.0	High	
Calcium (Ca)	4006.0	* Medium	

Soil Organic Matter (OM) 4.3 Medium — Nutrient Retention Capacity 15.2 Very High

Recommendations

Fertilization Area: 1000 sq.ft or 93 sq. m. - Mix in 30 gallons or 113 liters of water Soil inject 1 Quart per site

Prescription Fertilization		cc/ml	cups	quarts	gallons	grams	pounds
Nitrogen	Nitro 30	2.5 L	10.6	2.6			
	Nitroform	3.7 L	15.5	3.9	1.0	2.4 Kg	5.0
Phosphorus	Liquid Phosphorus						
Potassium	Potassium Sulfate						
Gypsum	pelletized	36.9 L			9.8	48.0 Kg	100.0
Lime	pelletized						
	powdered						
Sulfur	pelletized						
	powdered						
Magnesium Sulfate	Epsom salt						
Iron chelate	gallons						
	pounds						
Manganese chelate	gallons						
	pounds						
Conventional Fertilization							
Boost Natural		121.2 L			32.0		
Boost		60.6 L			16.0		
Boost Granular		2.5 L	10.5	2.6		2.4 Kg	5.0
Organic Milorganite		7.1 L	30.0	7.5	1.9	4.8 Kg	10.0
Mulch or incorporate organic matter:		Yes					

Comments:

* indicates a deficiency ** indicates a potential toxicity

***Limestone Maximum Rate for a single application to soil surface is 100 lbs for powdered or 150 lbs for pelletized lime, with Root Invigoration apply up to 200 lbs.

Nutrient Test Location 5:

Soil Analysis Report - Technician Copy

Bartlett Tree Research Laboratories

Chris Counts Studio

Bartlett Arborist: Jeffery Kish
Plant Species: Other
Location/ELM ID: Adjacent to tree #47
Fertilization Goal: Maintain Vitality

Moore Square in downtown Raleigh
Raleigh, North Carolina 27604

Sample ID: 131919
Date: 18-Aug-10
A&L: 10-229-0511

Results

Soil pH	5.9	Acceptable	Ideal pH range for Other: 5.5 to 6.5
Nitrogen (ENR)	98.0		
Phosphorous (P)	348.0	Very High	
Potassium (K)	374.0	Very High	
Magnesium (Mg)	256.0	* Medium	
Calcium (Ca)	1924.0	* Medium	

Soil Organic Matter (OM) 3.7 Medium — Nutrient Retention Capacity 8.4 High

Recommendations

Fertilization Area: 1000 sq.ft or 93 sq. m. - Mix in 30 gallons or 113 liters of water Soil inject 1 Quart per site

Prescription Fertilization		cc/ml	cups	quarts	gallons	grams	pounds
Nitrogen	Nitro 30	2.5 L	10.6	2.6			
	Nitroform	3.7 L	15.5	3.9	1.0	2.4 Kg	5.0
Phosphorus	Liquid Phosphorus						
Potassium	Potassium Sulfate						
Gypsum	pelletized	22.2 L			5.9	28.8 Kg	60.0
Lime	pelletized						
	powdered						
Sulfur	pelletized						
	powdered						
Magnesium Sulfate	Epsom salt	2.8 L	11.7	2.9		3.4 Kg	7.0
Iron chelate	gallons						
	pounds						
Manganese chelate	gallons						
	pounds						
Conventional Fertilization							
Boost Natural		121.2 L			32.0		
Boost		60.6 L			16.0		
Boost Granular		3.5 L	14.7	3.7		3.4 Kg	7.0
Organic Milorganite		14.2 L			3.8	9.6 Kg	20.0
Mulch or incorporate organic matter:		Yes					

Comments:

* indicates a deficiency ** indicates a potential toxicity

***Limestone Maximum Rate for a single application to soil surface is 100 lbs for powdered or 150 lbs for pelletized lime, with Root Invigoration apply up to 200 lbs.

Nutrient Test Location 6:

Soil Analysis Report - Technician Copy

Bartlett Tree Research Laboratories

Chris Counts Studio

Bartlett Arborist: Jeffery Kish
Plant Species: Other
Location/ELM ID: #6 between trees 24 and 25
Fertilization Goal: Maintain Vitality

Moore Square in downtown Raleigh
Raleigh, North Carolina 27604

Sample ID: 131916
Date: 18-Aug-10
A&L: 10-229-0511

Results

Soil pH	5.7	Acceptable	Ideal pH range for Other: 5.5 to 6.5
Nitrogen (ENR)	106.0		
Phosphorous (P)	192.0	Very High	
Potassium (K)	262.0	High	
Magnesium (Mg)	254.0	* Medium	
Calcium (Ca)	2004.0	* Medium	
Soil Organic Matter (OM)	4.1	Medium	Nutrient Retention Capacity 8.7 High

Recommendations

Fertilization Area: 1000 sq.ft or 93 sq. m. - Mix in 30 gallons or 113 liters of water Soil inject 1 Quart per site

Prescription Fertilization		cc/ml	cups	quarts	gallons	grams	pounds
Nitrogen	Nitro 30	2.5 L	10.6	2.6			
	Nitroform	3.7 L	15.5	3.9	1.0	2.4 Kg	5.0
Phosphorus	Liquid Phosphorus						
Potassium	Potassium Sulfate						
Gypsum	pelletized	22.2 L			5.9	28.8 Kg	60.0
Lime	pelletized						
	powdered						
Sulfur	pelletized						
	powdered						
Magnesium Sulfate	Epsom salt	2.8 L	11.7	2.9		3.4 Kg	7.0
Iron chelate	gallons						
	pounds						
Manganese chelate	gallons						
	pounds						
Conventional Fertilization							
Boost Natural		121.2 L			32.0		
Boost		60.6 L			16.0		
Boost Granular		2.5 L	10.5	2.6		2.4 Kg	5.0
Organic Milorganite		7.1 L	30.0	7.5	1.9	4.8 Kg	10.0
Mulch or incorporate organic matter:		Yes					

* indicates a deficiency ** indicates a potential toxicity

***Limestone Maximum Rate for a single application to soil surface is 100 lbs for powdered or 150 lbs for pelletized lime, with Root Invigoration apply up to 200 lbs.

Soil Analysis Report - Technician Copy

Bartlett Tree Research Laboratories

Chris Counts Studio

Bartlett Arborist: Jeffery Kish
Plant Species: Other
Location/ELM ID: #7 under tree #3
Fertilization Goal: Maintain Vitality

Moore Square in downtown Raleigh
Raleigh, North Carolina 27604

Sample ID: 131911
Date: 18-Aug-10
A&L: 10-229-0511

Results

Soil pH	5.5	Acceptable	Ideal pH range for Other: 5.5 to 6.5
Nitrogen (ENR)	73.0		
Phosphorous (P)	576.0	Very High	
Potassium (K)	314.0	High	
Magnesium (Mg)	178.0	* Medium	
Calcium (Ca)	1360.0	* Low	
			Molybdenum (Mo) 0.0
Soil Organic Matter (OM)	2.4	* Very Low	Nutrient Retention Capacity 6.9 Medium

Recommendations

Fertilization Area: 1000 sq.ft or 93 sq. m. - Mix in 30 gallons or 113 liters of water Soil inject 1 Quart per site

Prescription Fertilization		cc/ml	cups	quarts	gallons	grams	pounds
Nitrogen	Nitro 30	3.8 L	16.0	4.0	1.0		
	Nitroform	5.5 L	23.3	5.8	1.5	3.6 Kg	7.5
Phosphorus	Liquid Phosphorus						
Potassium	Potassium Sulfate						
Gypsum	pelletized	18.5 L			4.9	24.0 Kg	50.0
Lime	pelletized						
	powdered						
Sulfur	pelletized						
	powdered						
Magnesium Sulfate	Epsom salt	2.0 L	8.4	2.1		2.4 Kg	5.0
Iron chelate	gallons						
	pounds						
Manganese chelate	gallons						
	pounds						
Conventional Fertilization							
Boost Natural		189.5 L			50.0		
Boost		94.7 L			25.0		
Boost Granular		5.0 L	21.0	5.3	1.3	4.8 Kg	10.0
Organic Milorganite		17.8 L			4.7	12.0 Kg	25.0
Mulch or incorporate organic matter:		Yes					

Comments:

* indicates a deficiency ** indicates a potential toxicity

***Limestone Maximum Rate for a single application to soil surface is 100 lbs for powdered or for pelletized lime, with Root Invigoration apply up to 150 lbs.

Nutrient Test Location 7:

Nutrient Test Location 8:

Soil Analysis Report - Technician Copy

Bartlett Tree Research Laboratories

Chris Counts Studio

Bartlett Arborist: Jeffery Kish
Plant Species: Other
Location/ELM ID: #8 under tree #21
Fertilization Goal: Maintain Vitality

Moore Square in downtown Raleigh
Raleigh, North Carolina 27604

Sample ID: 131920
Date: 18-Aug-10
A&L: 10-229-0511

Results

Soil pH	6.2	Acceptable	Ideal pH range for Other: 5.5 to 6.5
Nitrogen (ENR)	110.0		
Phosphorous (P)	116.0	High	
Potassium (K)	418.0	High	
Magnesium (Mg)	542.0	High	
Calcium (Ca)	4820.0	* Medium	
Soil Organic Matter (OM)	4.3	Medium	Nutrient Retention Capacity 17.2 Very High

Recommendations

Fertilization Area: 1000 sq.ft or 93 sq. m. - Mix in 30 gallons or 113 liters of water Soil inject 1 Quart per site

Prescription Fertilization		cc/ml	cups	quarts	gallons	grams	pounds
Nitrogen	Nitro 30	2.5 L	10.6	2.6			
	Nitroform	3.7 L	15.5	3.9	1.0	2.4 Kg	5.0
Phosphorus	Liquid Phosphorus						
Potassium	Potassium Sulfate						
Gypsum	pelletized	36.9 L			9.8	48.0 Kg	100.0
Lime	pelletized						
	powdered						
Sulfur	pelletized						
	powdered						
Magnesium Sulfate	Epsom salt						
Iron chelate	gallons						
	pounds						
Manganese chelate	gallons						
	pounds						
Conventional Fertilization							
Boost Natural		121.2 L			32.0		
Boost		60.6 L			16.0		
Boost Granular		2.5 L	10.5	2.6		2.4 Kg	5.0
Organic Milorganite		7.1 L	30.0	7.5	1.9	4.8 Kg	10.0
Mulch or incorporate organic matter:		Yes					

Comments:

* indicates a deficiency ** indicates a potential toxicity

***Limestone Maximum Rate for a single application to soil surface is 100 lbs for powdered or 150 lbs for pelletized lime, with Root Invigoration apply up to 200 lbs.

Nutrient Test Location 9:

Soil Analysis Report - Technician Copy

Bartlett Tree Research Laboratories

Chris Counts Studio

Bartlett Arborist: Jeffery Kish
Plant Species: Other
Location/ELM ID: #9 Gathering area at Hargett
Fertilization Goal: Maintain Vitality

Moore Square in downtown Raleigh
Raleigh, North Carolina 27604

Sample ID: 131906
Date: 18-Aug-10
A&L: 10-229-0511

Results

Soil pH	4.9	Too Acidic	Ideal pH range for Other: 5.5 to 6.5
Nitrogen (ENR)	76.0		
Phosphorous (P)	542.0	Very High	
Potassium (K)	160.0	* Low	
Magnesium (Mg)	106.0	* Low	
Calcium (Ca)	980.0	* Low	
			Molybdenum (Mo) 0.0
Soil Organic Matter (OM)	2.6	* Low	Nutrient Retention Capacity 5.5 Medium

Recommendations

Fertilization Area: 1000 sq.ft or 93 sq. m. - Mix in 30 gallons or 113 liters of water Soil inject 1 Quart per site

Prescription Fertilization		cc/ml	cups	quarts	gallons	grams	pounds
Nitrogen	Nitro 30	2.5 L	10.6	2.6			
	Nitroform	3.7 L	15.5	3.9	1.0	2.4 Kg	5.0
Phosphorus	Liquid Phosphorus						
Potassium	Potassium Sulfate	549.4	2.3			960.0	2.0
Gypsum	pelletized						
Lime	pelletized	21.3 L			5.6	36.0 Kg	75.0
	powdered	14.2 L			3.8	24.0 Kg	50.0
Sulfur	pelletized						
	powdered						
Magnesium Sulfate	Epsom salt						
Iron chelate	gallons						
	pounds						
Manganese chelate	gallons						
	pounds						
Conventional Fertilization							
Boost Natural		189.5 L			50.0		
Boost		94.7 L			25.0		
Boost Granular		5.0 L	21.0	5.3	1.3	4.8 Kg	10.0
Organic Milorganite		14.2 L			3.8	9.6 Kg	20.0
Mulch or incorporate organic matter:		Yes					

* indicates a deficiency ** indicates a potential toxicity

***Limestone Maximum Rate for a single application to soil surface is 100 lbs for powdered or for pelletized lime, with Root Invigoration apply up to 150 lbs.

Nutrient Test Location 10:

Soil Analysis Report - Technician Copy

Bartlett Tree Research Laboratories

Chris Counts Studio

Bartlett Arborist: Jeffery Kish
Plant Species: Other
Location/ELM ID: Along Blount between trees 5 and 30
Fertilization Goal: Maintain Vitality

Moore Square in downtown Raleigh
Raleigh, North Carolina 27604

Sample ID: 131914
Date: 18-Aug-10
A&L: 10-229-0511

Results

Soil pH	6.1	Acceptable	Ideal pH range for Other: 5.5 to 6.5
Nitrogen (ENR)	110.0		
Phosphorous (P)	152.0	Very High	
Potassium (K)	434.0	High	
Magnesium (Mg)	594.0	High	
Calcium (Ca)	4596.0	* Medium	

Soil Organic Matter (OM)	4.3	Medium	Nutrient Retention Capacity	17.0	Very High

Recommendations

Fertilization Area: 1000 sq.ft or 93 sq. m. - Mix in 30 gallons or 113 liters of water Soil inject 1 Quart per site

Prescription Fertilization		cc/ml	cups	quarts	gallons	grams	pounds
Nitrogen	Nitro 30	2.5 L	10.6	2.6			
	Nitroform	3.7 L	15.5	3.9	1.0	2.4 Kg	5.0
Phosphorus	Liquid Phosphorus						
Potassium	Potassium Sulfate						
Gypsum	pelletized	36.9 L			9.8	48.0 Kg	100.0
Lime	pelletized						
	powdered						
Sulfur	pelletized						
	powdered						
Magnesium Sulfate	Epsom salt						
Iron chelate	gallons						
	pounds						
Manganese chelate	gallons						
	pounds						
Conventional Fertilization							
Boost Natural		121.2 L			32.0		
Boost		60.6 L			16.0		
Boost Granular		2.5 L	10.5	2.6		2.4 Kg	5.0
Organic Milorganite		7.1 L	30.0	7.5	1.9	4.8 Kg	10.0
Mulch or incorporate organic matter:		Yes					

* indicates a deficiency ** indicates a potential toxicity

***Limestone Maximum Rate for a single application to soil surface is 100 lbs for powdered or 150 lbs for pelletized lime, with Root Invigoration apply up to 200 lbs.

Nutrient Test Location 11:

Soil Analysis Report - Technician Copy

Bartlett Tree Research Laboratories

Chris Counts Studio

Bartlett Arborist: Jeffery Kish
Plant Species: Other
Location/ELM ID: Along Blount between trees 30 and 63
Fertilization Goal: Maintain Vitality

Moore Square in downtown Raleigh
Raleigh, North Carolina 27604

Sample ID: 131913
Date: 18-Aug-10
A&L: 10-229-0511

Results

Soil pH	5.9	Acceptable	Ideal pH range for Other: 5.5 to 6.5
Nitrogen (ENR)	110.0		
Phosphorous (P)	144.0	Very High	
Potassium (K)	436.0	High	
Magnesium (Mg)	674.0	Very High	
Calcium (Ca)	5162.0	* Medium	

Soil Organic Matter (OM)	4.3	Medium	Nutrient Retention Capacity	19.1	Very High

Recommendations

Fertilization Area: 1000 sq.ft or 93 sq. m. - Mix in 30 gallons or 113 liters of water Soil inject 1 Quart per site

Prescription Fertilization		cc/ml	cups	quarts	gallons	grams	pounds
Nitrogen	Nitro 30	2.5 L	10.6	2.6			
	Nitroform	3.7 L	15.5	3.9	1.0	2.4 Kg	5.0
Phosphorus	Liquid Phosphorus						
Potassium	Potassium Sulfate						
Gypsum	pelletized	36.9 L			9.8	48.0 Kg	100.0
Lime	pelletized						
	powdered						
Sulfur	pelletized						
	powdered						
Magnesium Sulfate	Epsom salt						
Iron chelate	gallons						
	pounds						
Manganese chelate	gallons						
	pounds						
Conventional Fertilization							
Boost Natural		121.2 L			32.0		
Boost		60.6 L			16.0		
Boost Granular		2.5 L	10.5	2.6		2.4 Kg	5.0
Organic Milorganite		7.1 L	30.0	7.5	1.9	4.8 Kg	10.0
Mulch or incorporate organic matter:		Yes					

* indicates a deficiency ** indicates a potential toxicity

***Limestone Maximum Rate for a single application to soil surface is 100 lbs for powdered or 150 lbs for pelletized lime, with Root Invigoration apply up to 200 lbs.

Nutrient Test Location 12:

Soil Analysis Report - Technician Copy

Bartlett Tree Research Laboratories

Chris Counts Studio

Bartlett Arborist: Jeffery Kish
Plant Species: Other
Location/ELM ID: between trees 66 and 68
Fertilization Goal: Maintain Vitality

Moore Square in downtown Raleigh
Raleigh, North Carolina 27604

Sample ID: 131918
Date: 18-Aug-10
A&L: 10-229-0511

Results

Soil pH	5.9	Acceptable	Ideal pH range for Other: 5.5 to 6.5
Nitrogen (ENR)	110.0		
Phosphorous (P)	120.0	Very High	
Potassium (K)	500.0	Very High	
Magnesium (Mg)	516.0	High	
Calcium (Ca)	4318.0	* Medium	
Soil Organic Matter (OM)	4.3	Medium	Nutrient Retention Capacity 16.8 Very High

Recommendations

Fertilization Area: 1000 sq.ft or 93 sq. m. - Mix in 30 gallons or 113 liters of water Soil inject 1 Quart per site

Prescription Fertilization		cc/ml	cups	quarts	gallons	grams	pounds
Nitrogen	Nitro 30	2.5 L	10.6	2.6			
	Nitroform	3.7 L	15.5	3.9	1.0	2.4 Kg	5.0
Phosphorus	Liquid Phosphorus						
Potassium	Potassium Sulfate						
Gypsum	pelletized	36.9 L			9.8	48.0 Kg	100.0
Lime	pelletized						
	powdered						
Sulfur	pelletized						
	powdered						
Magnesium Sulfate	Epsom salt						
Iron chelate	gallons						
	pounds						
Manganese chelate	gallons						
	pounds						
Conventional Fertilization							
Boost Natural		121.2 L			32.0		
Boost		60.6 L			16.0		
Boost Granular		2.5 L	10.5	2.6		2.4 Kg	5.0
Organic Milorganite		7.1 L	30.0	7.5	1.9	4.8 Kg	10.0
Mulch or incorporate organic matter:		Yes					

* indicates a deficiency ** indicates a potential toxicity

***Limestone Maximum Rate for a single application to soil surface is 100 lbs for powdered or 150 lbs for pelletized lime, with Root Invigoration apply up to 200 lbs.

Soil Bulk Density testing:

At 12 locations, marked 1 thru 12, on the Soil Bulk Density and Nutrient Test Location plan, soil was collected by the Bartlett Tree Experts from the top layer of the soil for bulk density testing. Samples were processed by Bartlett Tree Expert soil labs. The purpose of the testing was to gain an understanding of background bulk density level profile of the upper layer of the soil. The following are the test results and lab recommendations for modifications to soil bulk density. A general review of the soil testing results and recommendations follows later in section **Interpretation of the soils information.**

Bulk Density Test Location 1:

BARTLETT TREE EXPERTS

Bartlett Tree Research Laboratories

Diagnostic Report

Sample Number:	131896	Submission Date:	12-Aug-10
Sample Type:	Physical Only	Test Requested:	Bulk Density
Plant Name:	Other, Willow oak	Submitter:	Jeffery Kish
Loc. in Landscape:	#1 under tree 65	Office:	Raleigh
Client:	Chris Counts Studio Moore Square in downtown Raleigh Raleigh North Carolina 27604	Date Collected:	06-Aug-10

Diagnosis:
The texture and bulk density of your sample was as follows:

Peat / Mulch – .454 g/cc

This soil is not compacted.

REMEDIAL TREATMENT RECOMMENDATIONS:
No treatment for compaction is required on this tree.

Fertilize according to soil analysis results is recommended.

Application of a 2 to 4" thick layer of mulch from near the trunk to near the drip line of the tree will provide soil moisture conservation and soil temperature moderation to improve tree vitality.

Diagnostician:
George Palmer

Bulk Density Test Location 2:

BARTLETT TREE EXPERTS

Bartlett Tree Research Laboratories

Diagnostic Report

Sample Number:	131899	Submission Date:	12-Aug-10
Sample Type:	Physical Only	Test Requested:	Bulk Density
Plant Name:	Other, Willow oak	Submitter:	Jeffery Kish
Loc. in Landscape:	#2 adjacent to #69	Office:	Raleigh
Client:	Chris Counts Studio Moore Square in downtown Raleigh Raleigh North Carolina 27604	Date Collected:	06-Aug-10

Diagnosis:
The texture and bulk density of your sample was as follows:

Sandy Loam / Sandy Clay – 1.166 g/cc

This soil is not compacted.

REMEDIAL TREATMENT RECOMMENDATIONS:
No treatment for compaction is required on this tree.

Fertilize according to soil analysis results is recommended.

Application of a 2 to 4" thick layer of mulch from near the trunk to near the drip line of the tree will provide soil moisture conservation and soil temperature moderation to improve tree vitality.

Diagnostician:
George Palmer

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Bulk Density Test Location 3:

BARTLETT TREE EXPERTS

Bartlett Tree Research Laboratories

Diagnostic Report

Sample Number:	131895	Submission Date:	12-Aug-10
Sample Type:	Physical Only	Test Requested:	Bulk Density
Plant Name:	Other, Willow oak	Submitter:	Jeffery Kish
Loc. in Landscape:	#3 common are between trees 31 and 32	Office:	Raleigh
Client:	Chris Counts Studio Moore Square in downtown Raleigh Raleigh North Carolina 27604	Date Collected:	06-Aug-10

Diagnosis:
The texture and bulk density of your sample was as follows:

Loam / Sandy clay 1.308 g/cc

Sample is slightly compacted.

REMEDIAL TREATMENT RECOMMENDATIONS:
Application of a 2 to 4" thick layer of mulch from near the trunk to near the drip line of the tree will provide soil moisture conservation, soil temperature moderation and in the long run, to a reduction in bulk density. This treatment combined with prescription fertilization should help improve water uptake and promote tree growth.

Soil moisture is a major factor in compacted soils and with declining trees. Compaction reduces penetration of water into the soil and reduces percolation out of the soil once water does get in. To monitor soil moisture at this site tensiometers are recommended. A soil wetting agent may be used if the soil does not wet easily.

Diagnostician:
George Palmer

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Bulk Density Test Location 4:

BARTLETT TREE EXPERTS

Bartlett Tree Research Laboratories

Diagnostic Report

Sample Number:	131898	Submission Date:	12-Aug-10
Sample Type:	Physical Only	Test Requested:	Bulk Density
Plant Name:	Other, Willow oak	Submitter:	Jeffery Kish
Loc. in Landscape:	#4 under tree 36	Office:	Raleigh
Client:	Chris Counts Studio Moore Square in downtown Raleigh Raleigh North Carolina 27604	Date Collected:	06-Aug-10

Diagnosis:
The texture and bulk density of your sample was as follows:

Peat / Mulch – .384 g/cc

This soil is not compacted.

REMEDIAL TREATMENT RECOMMENDATIONS:
No treatment for compaction is required on this tree.

Fertilize according to soil analysis results is recommended.

Application of a 2 to 4" thick layer of mulch from near the trunk to near the drip line of the tree will provide soil moisture conservation and soil temperature moderation to improve tree vitality.

Diagnostician:
George Palmer

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Bulk Density Test Location 5:

BARTLETT TREE EXPERTS

Bartlett Tree Research Laboratories

Diagnostic Report

Sample Number:	131897	Submission Date:	12-Aug-10
Sample Type:	Physical Only	Test Requested:	Bulk Density
Plant Name:	Other, Willow oak	Submitter:	Jeffery Kish
Loc. in Landscape:	#5 adjacent to tree #44	Office:	Raleigh
Client:	Chris Counts Studio Moore Square in downtown Raleigh Raleigh North Carolina 27604	Date Collected:	06-Aug-10

Diagnosis:
The texture and bulk density of your sample was as follows:

Sandy Loam / Sandy Clay – 1.046 g/cc

This soil is not compacted.

REMEDIAL TREATMENT RECOMMENDATIONS:
No treatment for compaction is required on this tree.

Fertilize according to soil analysis results is recommended.

Application of a 2 to 4" thick layer of mulch from near the trunk to near the drip line of the tree will provide soil moisture conservation and soil temperature moderation to improve tree vitality.

Diagnostician:
George Palmer

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Bulk Density Test Location 6:

BARTLETT TREE EXPERTS

Bartlett Tree Research Laboratories

Diagnostic Report

Sample Number:	131900	Submission Date:	12-Aug-10
Sample Type:	Physical Only	Test Requested:	Bulk Density
Plant Name:	Other, Willow oak	Submitter:	Jeffery Kish
Loc. in Landscape:	Adjacent to tree #47	Office:	Raleigh
Client:	Chris Counts Studio Moore Square in downtown Raleigh Raleigh North Carolina 27604	Date Collected:	06-Aug-10

Diagnosis:
The texture and bulk density of your sample was as follows:

Loam / Sandy clay 1.414 g/cc

Sample is slightly compacted.

REMEDIAL TREATMENT RECOMMENDATIONS:
Application of a 2 to 4" thick layer of mulch from near the trunk to near the drip line of the tree will provide soil moisture conservation, soil temperature moderation and in the long run, to a reduction in bulk density. This treatment combined with prescription fertilization should help improve water uptake and promote tree growth.

Soil moisture is a major factor in compacted soils and with declining trees. Compaction reduces penetration of water into the soil and reduces percolation out of the soil once water does get in. To monitor soil moisture at this site tensiometers are recommended. A soil wetting agent may be used if the soil does not wet easily.

Diagnostician:
George Palmer

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Bulk Density Test Location 7:

BARTLETT TREE EXPERTS

Bartlett Tree Research Laboratories

Diagnostic Report

Sample Number:	131901	Submission Date:	12-Aug-10
Sample Type:	Physical Only	Test Requested:	Bulk Density
Plant Name:	Other, Willow oak	Submitter:	Jeffery Kish
Loc. in Landscape:	#7 between trees 24 and 25	Office:	Raleigh
Client:	Chris Counts Studio Moore Square in downtown Raleigh Raleigh North Carolina 27604	Date Collected:	06-Aug-10

Diagnosis:
The texture and bulk density of your sample was as follows:

Sandy Loam / Sandy Clay – 1.170 g/cc

This soil is not compacted.

REMEDIAL TREATMENT RECOMMENDATIONS:
No treatment for compaction is required on this tree.

Fertilize according to soil analysis results is recommended.

Application of a 2 to 4" thick layer of mulch from near the trunk to near the drip line of the tree will provide soil moisture conservation and soil temperature moderation to improve tree vitality.

Diagnostician:
George Palmer

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Bulk Density Test Location 8:

BARTLETT TREE EXPERTS

Bartlett Tree Research Laboratories

Diagnostic Report

Sample Number:	131894	Submission Date:	12-Aug-10
Sample Type:	Physical Only	Test Requested:	Bulk Density
Plant Name:	Other, Willow oak	Submitter:	Jeffery Kish
Loc. in Landscape:	#8 under tree #3	Office:	Raleigh
Client:	Chris Counts Studio Moore Square in downtown Raleigh Raleigh North Carolina 27604	Date Collected:	06-Aug-10

Diagnosis:
The texture and bulk density of your sample was as follows:

Sandy Loam / Sandy clay 1.382 g/cc

Sample is slightly compacted.

REMEDIAL TREATMENT RECOMMENDATIONS:
Application of a 2 to 4" thick layer of mulch from near the trunk to near the drip line of the tree will provide soil moisture conservation, soil temperature moderation and in the long run, to a reduction in bulk density. This treatment combined with prescription fertilization should help improve water uptake and promote tree growth.

Soil moisture is a major factor in compacted soils and with declining trees. Compaction reduces penetration of water into the soil and reduces percolation out of the soil once water does get in. To monitor soil moisture at this site tensiometers are recommended. A soil wetting agent may be used if the soil does not wet easily.

Diagnostician:
George Palmer

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Bulk Density Test Location 9:

BARTLETT TREE EXPERTS

Bartlett Tree Research Laboratories

Diagnostic Report

Sample Number:	131891	Submission Date:	12-Aug-10
Sample Type:	Physical Only	Test Requested:	Bulk Density
Plant Name:	Other, Willow oak	Submitter:	Jeffery Kish
Loc. in Landscape:	#9 gathering area at Hargett	Office:	Raleigh
Client:	Chris Counts Studio Moore Square in downtown Raleigh Raleigh North Carolina 27604	Date Collected:	06-Aug-10

Diagnosis:
The texture and bulk density of your sample was as follows:

Loam / Sandy clay 1.210 g/cc

Sample is slightly compacted.

REMEDIAL TREATMENT RECOMMENDATIONS:
Application of a 2 to 4" thick layer of mulch from near the trunk to near the drip line of the tree will provide soil moisture conservation, soil temperature moderation and in the long run, to a reduction in bulk density. This treatment combined with prescription fertilization should help improve water uptake and promote tree growth.

Soil moisture is a major factor in compacted soils and with declining trees. Compaction reduces penetration of water into the soil and reduces percolation out of the soil once water does get in. To monitor soil moisture at this site tensiometers are recommended. A soil wetting agent may be used if the soil does not wet easily.

Diagnostician:
George Palmer

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Bulk Density Test Location 10:

BARTLETT TREE EXPERTS

Bartlett Tree Research Laboratories

Diagnostic Report

Sample Number:	131893	Submission Date:	12-Aug-10
Sample Type:	Physical Only	Test Requested:	Bulk Density
Plant Name:	Other, Willow oak	Submitter:	Jeffery Kish
Loc. in Landscape:	#10 between 5 and 30	Office:	Raleigh
Client:	Chris Counts Studio Moore Square in downtown Raleigh Raleigh North Carolina 27604	Date Collected:	06-Aug-10

Diagnosis:
The texture and bulk density of your sample was as follows:

Sand / Loamy Sand – .929 g/cc

This soil is not compacted.

REMEDIAL TREATMENT RECOMMENDATIONS:
No treatment for compaction is required on this tree.

Fertilize according to soil analysis results is recommended.

Application of a 2 to 4" thick layer of mulch from near the trunk to near the drip line of the tree will provide soil moisture conservation and soil temperature moderation to improve tree vitality.

Diagnostician:
George Palmer

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Bulk Density Test Location 11:

BARTLETT TREE EXPERTS

Bartlett Tree Research Laboratories

Diagnostic Report

Sample Number:	131890	Submission Date:	12-Aug-10
Sample Type:	Physical Only	Test Requested:	Bulk Density
Plant Name:	Other, Willow oak	Submitter:	Jeffery Kish
Loc. in Landscape:	Along Blount between trees 30 and 63	Office:	Raleigh
Client:	Chris Counts Studio Moore Square in downtown Raleigh Raleigh North Carolina 27604	Date Collected:	06-Aug-10

Diagnosis:
The texture and bulk density of your sample was as follows:

Peat / Mulch – .590 g/cc

This soil is not compacted.

REMEDIAL TREATMENT RECOMMENDATIONS:
No treatment for compaction is required on this tree.

Fertilize according to soil analysis results is recommended.

Application of a 2 to 4" thick layer of mulch from near the trunk to near the drip line of the tree will provide soil moisture conservation and soil temperature moderation to improve tree vitality.

Diagnostician:
George Palmer

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Bulk Density Test Location 12:

BARTLETT TREE EXPERTS

Bartlett Tree Research Laboratories

Diagnostic Report

Sample Number:	131889	Submission Date:	12-Aug-10
Sample Type:	Physical Only	Test Requested:	Bulk Density
Plant Name:	Other, Willow oak	Submitter:	Jeffery Kish
Loc. in Landscape:	Along Blount between trees 66 and 68	Office:	Raleigh
Client:	Chris Counts Studio Moore Square in downtown Raleigh Raleigh North Carolina 27604	Date Collected:	06-Aug-10

Diagnosis:
The texture and bulk density of your sample was as follows:

Peat / Mulch – .441 g/cc

This soil is not compacted.

REMEDIAL TREATMENT RECOMMENDATIONS:
No treatment for compaction is required on this tree.

Fertilize according to soil analysis results is recommended.

Application of a 2 to 4" thick layer of mulch from near the trunk to near the drip line of the tree will provide soil moisture conservation and soil temperature moderation to improve tree vitality.

Diagnostician:
George Palmer

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Plant / soil observations:
The general quality of trees and other plantings indicate that the soil in Moore Square is very good and supporting long-term tree growth in almost all areas of the park. Even the disturbed soils are supporting reasonable tree and plant growth. The exceptions are the trees in planting islands at the parking spaces on the south edge of the park and in the central portion of the park. Turf decline appears to be more a problem with abrasion, shade and event use competition than compaction.

Interpretation of the soils information:
Soil Testing: Both the nutrient testing and bulk density testing indicate that few problems exist in the top layer of the soil, however, much of the testing sites only examined the decomposing mulch layer common throughout much of the park. The testing also focused on soils under the canopies of the largest healthiest trees where good soils would have been expected.

The nutrient testing indicates that pH is around 5.5 to 6.4 in almost all areas of the park. This is a good range of pH for all the existing tree types. This pH is low for turf. One test site, #9, has a pH of 4.9. this is one of the few places where soil was tested in the center space where poor soils are observed. Chemical testing for phosphorus and potassium and often also Magnesium is high to very high. This may indicate that large amounts of fertilizer have been applied over the many years this ground has been managed as a public park.

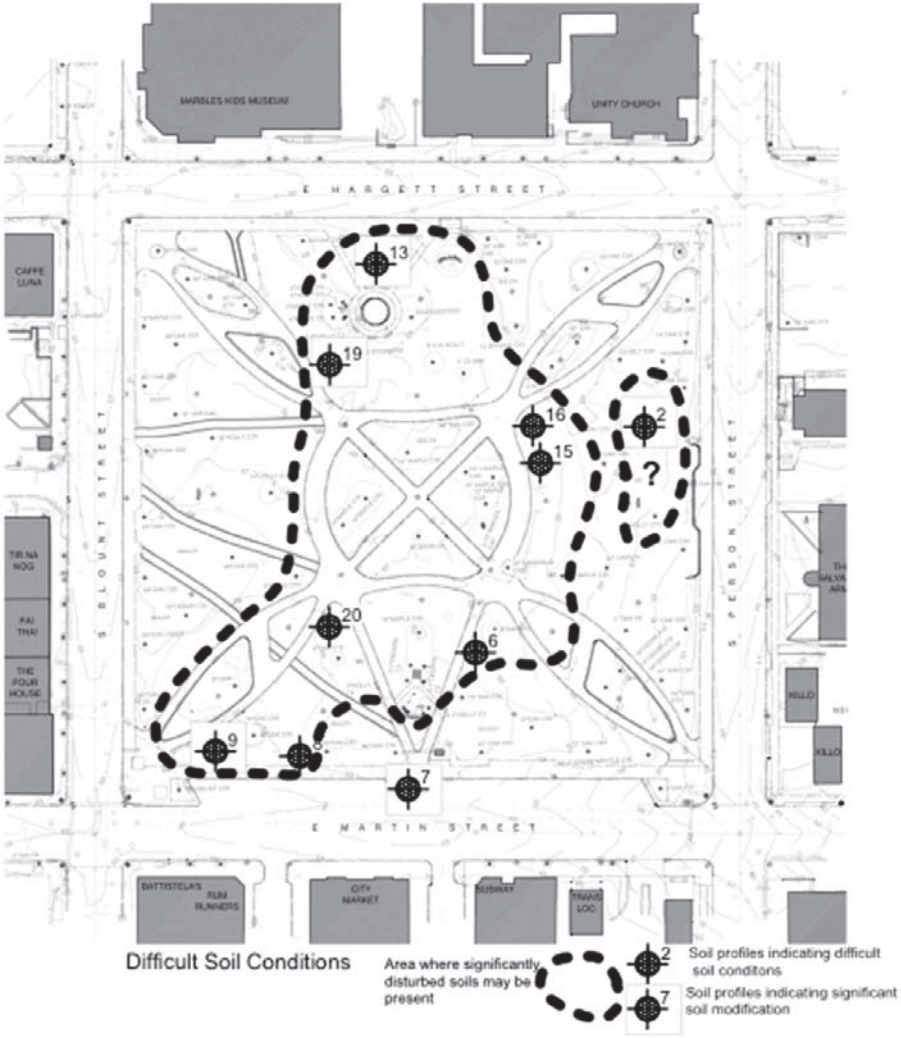
Soil Organic Matter (SOM) is normally around 4.0%. However, since much of the testing was in soil that is decomposing wood chip mulch, this high organic matter content is likely misleading to actual SOM. However the large amounts of brown soils encountered would indicate that SOM in the profile is likely adequate for most plants. SOM in the few soil test outside of the mulch beds were relatively low in SOM but not to an unreasonable level. The presence of roots in the brown soils and the healthy trees indicates that SOM is at a reasonable level even if 'low".

Soil Profiles: The soil profiles reveal that much of the soils around the perimeter of the site have seen only limited disturbance over the life of the soil. Relatively deep brown upper layer soils that included root observation are indicative of soils that support the high quality trees. Soil profiles in locations 2, 6, 7, 8, 9, 13, 15, 16, 19, and 20 are areas where soil improvement is likely to be warranted. This improvement would be reduction in bulk density, and increases in Soil Organic Matter, or blending of the decomposing organic matter into the lower soil layer. Five of these soil profiles 2, 7, 9, 13, and 19 suggest that soil replacement or other significant soil modification may be needed to assure long-term tree growth.

Problem soil location are plotted on the attached Difficult Soil Conditions plan. This plan also indicates a delineation of areas where difficult soil conditions may be present based on all factors including: the soil test and profile review; site surface features; topography; site history; and plant performance. Work within

this delineated area should consider additional soil modification requirements. The delineated area on eh east portion of the site with a question mark indicates that soil conditions may change rapidly over short distances and that generalizations may need further refinement in the design development portion of the project. Soils outside these delineated zones should be considered for soil protection or utilized design methodologies that tend to favor less grading and soil disturbance where possible.

Summary soil recommendations:



The following are recommendations for modifications to soils related to the proposed improvements in Moore Square. They are intended to guide design development of the concepts in the Master Plan.

Grading: Grading whether within or outside Tree Protection Areas is the most significant operation impacting soil quality. Grading may remove or bury important existing upper level soil profiles. It damages or destroys soil structure and modifies site hydrology. Moving soil releases organic matter. Grading, particularly cut, can damage tree root systems.

Most of these damaging impacts can be mitigated easily outside the Tree Protection Area. Within the Tree Protection Area construction strategies should focus on avoiding damage and using low impact techniques such as air spade soil tools, low ground pressure machines, and hand grading. Work areas prior to and after grading must be protected with geogrid / mulch mats and fencing.

Grading design should follow these requirements where possible.

1. Wherever existing soils are of good quality limiting the grading particularly cuts.

2. Limit cuts and fills in areas of tree protection root zones. See special provision in report “Tree Evaluations and Recommendations” for protection requirements.

3. Remove and stock pile A and B horizon soils and loosen subgrade soils before the start of any grading. Note that A and B horizon soils are those soils that are noted as being brown in color on the soil profiles. Protect soil stockpiles with breathable filter fabric.

4. In Tree Protection Area fill zones, create new A and B horizon soils and place fill using techniques that reduce the amount of compaction.

5. Respect existing site hydrology. Avoid channeling water in significantly different directions, particularly the concentration of water into small areas of the site.

6. Segregate A and B horizon soils from sub soils and restore soil profiles. See soil improvement section below.

Tree Protection: Tree protection is essentially soil protection. However, It is understood that building within the root zone of existing trees is possible if great care is taken within the root zone. Both construction and limited grading can be permissible in Tree Protection Area provided that specialized equipment and methods are utilized. Successful tree protection happens when lots of small decisions are made to fine tune the design in ways that respect the tree. A

detailed discussion on tree protection is found in the second part of this report "Tree Evaluations and Recommendations".

Soil Protection: The majority of the soil has been subjected to only minimum soil disturbances. Protecting this resource should be a critical goal of the project design. Following the grading and tree protection recommendation is an important first step.

Soil protection is similar to tree protection except prohibitions that are designed to protect existing roots are no longer critical. Larger equipment can be utilized to move soil. Cut and fill grades may be designed provided that the soils are segregated, protected, and restored.

Decomposing Mulch Layers: Across much of the site, large areas of thick mats of decomposing wood chip mulch are found. These layers were generally moist as they tend to hold too much water and not release it into the dryer soils below. Modifying these soils will be critical to long-term soil management.

1. Within tree root zone area, utilize an air spade to mix the decomposing mulch layer into the soil layer below to depths of 12 inches where possible.

2. Outside the Tree Protection Area, rip through the decomposing wood chip soil into the soil to depths of 18 inches. The ripping should mix sub soils and organic soils. Following the ripping, roto till the surface 6-8 inches of the soil and grade smooth the resulting material. Alternatively perform back hoe tilling to depths of 18 inches to mix the soil layers and fracture the lower soil profile.

Soil Improvements: in areas identified as difficult soils develop soil improvements strategies.

1. Within Tree Protection Area, loosen the soil with air spade and add compost to depths of 8-12 inches. Follow the requirements in the second part of this report under Tree Protection Plan.

2. In shrub and tree planting bed areas, outside the Tree Protection Area, utilize backhoe tilling with 4-6" of compost to depths of 18-24 inches. Apply an additional 4 inches of compost over the tilled soil and roto till the compost into the top 6-8 inches of the final grades.

3. In lawn areas develop a sand / soil / compost mix, specialized for high use turf 10" deep. Install sand choker layers and drainage. Grade soils with a minimum of 2% slopes.