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May 4, 2020

THE RETREAT AT CRAIG RANCH
C/o Ms. Stephanie Gantt
Neighborhood Management, Inc,
1024 S. Greenville Ave., Suite 230
Allen, Texas 75002

Re: **The Retreat at Craig Ranch – Tree Report**

Dear Ms. Gantt,

## INTRODUCTION

The purpose of this inspection and report is to evaluate the current condition of the community regarding trees around the homes at The Retreat at Craig Ranch and to determine their potential for negative impact on the building foundations. This limited visual inspection was performed and report written by David Dotson, P.E.

This written report is the complete response to your request for an inspection of this property and should be read in full. Any verbal statements made during the inspection are made as a courtesy only and are not considered a part of this report. If you have any questions about this report or our inspection, please call our office immediately for clarification. If there is any area of this property where you have a particular concern based either on this report or your own personal observations, please let us know.

### Limitations

This inspection report is limited to observations made from visual evidence. No surface materials were removed and no destructive or invasive testing was performed. The report is not to be considered a guarantee of condition and no warranty is implied. This inspection and report does not include code compliance, municipal regulatory compliance, subsurface investigation, or records research related to this property.

## DESCRIPTION

The Retreat at Craig Ranch is a townhome community located at Stacy Rd. and Custer Road in McKinney, Texas. The 33.89 acre site is made up of 150 townhome units, including 128 one-unit, 12 two-unit, and 10 four-unit buildings, plus one (1) clubhouse. The property was built in stages beginning in 2006 and still under development at the time of this report.

Townhomes are one and two-story, with stone and brick veneer and Hardi-plank siding on the exterior walls, on post-tension slab foundations.

At the time of the site visit on May 1, 2020, visual observations were taken from the exterior only.

## SITE /TREES

In many areas of North Texas, soils have high contents of expansive clays that swell when wet and shrink when dry. Building foundation and structural damage can result from the shrink-swell pressure exerted by the soil. More or less uniform moisture levels can help preclude cyclic expansion and contraction of the soil with its resulting foundation movement.

### Observations and Recommendations

At The Retreat at Craig Ranch, there are many trees that are within close proximity to the foundation of the homes/buildings. Trees and vegetation in close proximity to the foundation can potentially have a detrimental effect as they draw moisture from the soil causing shrinkage of the expansive soils, particularly during dry periods. Below are supporting documentation to the effects of trees and building foundations.

Because of the highly expansive nature of the soil, trees can significantly contribute to differential settlement of any residential foundation or structure. The roots of trees and large plants consume the moisture from the soil, causing the soil to shrink much faster than other soil areas exposed to the weather. The soil where the moisture is lost more rapidly will sink lower than the surrounding soil, causing evidences and consequences of differential settlement in building structures. Research studies indicate that a tree should be at least as far away from a building as the mature height of the tree to minimize the effect of drying caused by the tree.

The following paper(s) support these conclusions on trees effects on foundations:

*Tree Root Influence on Soil-Structure Interaction in Expansive Clay Soils*

by **John T. Bryant**, (Bryant Consultants, Inc., 4393 Westgrove Drive, Addison, Texas 75001. E-mail: jbryant@geoneering.com), **Derek V. Morris**, (Bryant Consultants, Inc., 4393 Westgrove Drive, Addison, Texas 75001), **Sean P. Sweeney**, (Bryant Consultants, Inc., 4393 Westgrove Drive, Addison, Texas 75001), **Michael D. Gehrig**, (Bryant Consultants, Inc., 4393 Westgrove Drive, Addison, Texas 75001), and **J. Derick Mathis**, (Bryant Consultants, Inc., 4393 Westgrove Drive, Addison, Texas 75001)

pp. 110-131, (doi: http://dx.doi.org/10.1061/40592(270)7)

**Document type:** Conference Proceeding Paper

**Part of:** Expansive Clay Soils and Vegetative Influence on Shallow Foundations

**Abstract:** Tree roots have been documented to withdraw volumes of water from expansive clay soils causing slab distress under certain circumstances. However, patterns of distress, areas of influence and potential distress magnitudes have not been systematically considered from a soil-structure interaction perspective. This Paper describes research into the soil-structure interaction between trees and heavy vegetation and at-grade structures including pavements and slab-on-grade foundation systems. Several areas of distressed pavements and slab-on-grade foundation systems in the North Texas area have been documented, with estimates and measurements of soil properties, tree geometry and proximity to the structure, tree concentration, relative elevation surveys and distress patterns to confirm the influence pattern of the root systems. Conclusions indicate concentrations of trees tend to have the most significant effects with influence patterns occurring radially to approximately the tree drip line. Confirmation of the horizontal and vertical influence pattern is provided by Geo-Electrical Moisture Material Imaging Resistivity (GMMIR) surveys using soil borings to help characterize the influence pattern of trees. The GMMIR plots indicate influences between about 1.2 and 3 meters in depth. Root influence models were constructed using unsaturated soil mechanics theory and the VOLFLO algorithm. Analysis of these models indicates that the influence of tree roots is a function of the soil type and that the influence at the extreme perimeter of the structure is as significant as the penetration of the tree roots significantly beneath the foundation with differential downward movements on the order of 127 to 152 millimeters (5 to 6 inches) at the perimeter moving from a wet condition (total soil suction pG = 4.3 (pF = 3.3)) to a desiccated tree condition (total soil suction pG = 5.6 (pF=4.6)) reducing to approximately 5.1 centimeters (2 inches) or less when the tree roots are at least 0.6 meters (2 feet) from the structure perimeter.

There is countless research, worldwide on the effects of trees on expansive soils and foundations. Perhaps no individual has performed more research on the subject in the State of Texas than Robert L. Lytton, Ph.D, P.E., Professor and Endowed Chair at the Zachry Department of Civil Engineering at Texas A&M University. Dr. Lytton presented at the Foundation Performance Association:

## DECEMBER 2010 MEETING

Wednesday, December 8, 2010

## TECHNICAL PROGRAM

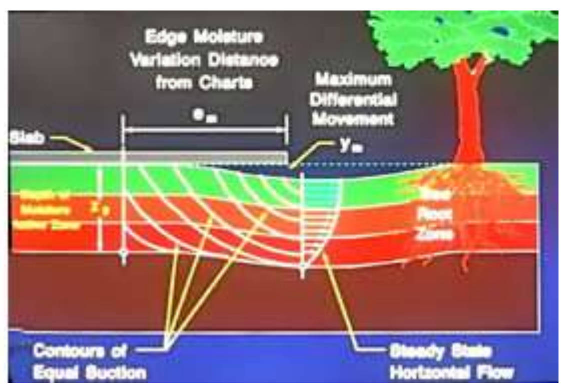
### Effects of Trees on Foundations

***Speaker:*** Professor Robert L. Lytton, Ph.D., P.E., D.GE, with Texas A&M University, Bryan, TX, Tel. 979-845-9964

Dr. Lytton is an Honorary FPA Life Member, Professor of Civil Engineering in the Zachry Civil Engineering Department of the Texas A&M University, and a Licensed Professional Engineer in Texas with a Ph.D. in Civil Engineering from the University of Texas (1967). He is internationally famous for his work in the study of expansive soils on foundations, giving presentations on the subject worldwide. He has selflessly presented to this forum at least 8 times in the last 10 years and has also presented in past FPA seminars.

## PRESENTATION SUMMARY

To an audience of about 120 at the HESS Club, Dr. Lytton presented "Effects of Trees on Foundations". Dr. Lytton provided new technical data on trees and their effects on the soils supporting foundations. Dr. Lytton integrated this new information into existing understandings of soil mechanics and foundations.




Dr Lytton opened his presentation with an overview of trees and their effects on soils and the surrounding environment. Tree characteristics were discussed at length, including what they need to survive (water, air and nutrients), root zones, water uptake and utilization, and the effect these factors have on the surrounding soils. Roots have an uncanny ability to grow into moist areas but according to Dr. Lytton root barriers are extremely effective at inhibiting root growth.

Dr. Lytton described how a tree's flexible hairlike root fibers are able to propagate in hard clays: the root fiber extracts water from the more moist clay in front of it, causing a shrinkage crack to appear. It is this shrinkage crack space that the root fiber can then grow into, in search of more moisture ahead, and so on. He said this action creates clay soils that are about 100 times more pervious than the moisture inactive zone below.

Dr. Lytton also pointed out that the effect of these factors varies between the different types of soils. Additionally, different trees have different shaped root balls and different water demands. The root ball has also been proven to far outreach the drip zone of the tree. Some trees are better able to draw moisture from the soil in drought conditions and therefore have a more dramatic effect on soil moisture changes. It was interesting to note that often the shape of the root ball mimics the shape of the crown, depending the tree species, soil type, climatic conditions and surrounding competition. E.G., conifers do not fight hard for moisture as compared to other tree species and so they do grow well in clay soils.

All of these factors affect the active moisture zone of the soils. The moisture activity zone is that depth of soil that must be taken into account when designing the depth, type and strength of the foundation including drilled piers. Real world soil sampling at existing healthy trees shows that suction (pF) extends down to the depth of root fibers. Measurements around a medium sized Post Oak tree in Central Texas indicated root fibers as deep as 15 feet.

In addition to slab on ground foundations, Dr. Lytton discussed the effects of tree induced moisture changes on soils surrounding and supporting drilled piers. The factors affecting the design of drilled piers included the moisture active zone, Zm, the required anchor length, La, of the shaft below the active zone, the need to account for unsymmetrical bending due to lateral forces from swelling soils and the need for tensile reinforcing.  Since many of the forces acting on piers occur in all directions and induce compression, tension and moment, these forces require the designer to extend the pier bottom below the soil active zone, and to account for shaft uplift tensile forces and lateral forces due to wet-dry variances on opposite sides of the pier which in turn induce moment in the pier.

Dr. Lytton gave an example of the foregoing where the suction along the pier shaft varied from pF 4.5 (wilting point) to pF 2.5 (higher than field capacity) because a nearby tree had been removed. This situation created a differential horizontal pressure on the pier of over 10 KSF, which was 4 times the vertical pressure and enough to cause passive earth pressure on the pier shaft.

Dr. Lytton also presented case histories, with photos, where drilled and underreamed cast-in-place piers were excavated and proven to have lifted as much as 4 inches because the skin friction from the swelling upper movement active soil was inadequately resisted by passive skin friction below the movement active zone. He also showed a case study by Dr. O'Neill at

UH where the skin friction of a test pier at the NGES-UH site measured more than 8 PSI (1.2 KSF) in the moisture active zone.

Some good points made by Dr. Lytton were:

- The moisture active zone is dictated by site conditions, ***not*** regional conditions.
- The moisture active zone can vary substantially when trees are present.
- The moisture active zone can vary based on the type of tree present since different trees have different root ball shapes and depths.
- The geotechnical engineer should ***always*** log the root fibers since the depth of the shrinkage cracks are created by roots.
- The depth of the moisture active zone depends on the depth of the shrinkage crack zone.
- The depth of the ***movement*** active zone, needed to compute Ym, will ***always*** be less than the depth of the ***moisture*** active zone.
- Soil movement does ***not*** form a uniform pressure on foundations.
- Root barriers work because they are moisture barriers in that they stop the propensity for root propagation in that direction.
- Water, which has surface tension, has a measurable tensile strength which is between 3000 and 3600 PSI, or about 5.3 pF suction pressure.

In summary the science of trees and soils is very complex and the designers must take all factors into account to ensure good performance of the foundation. Refer to click:
December 2009 - Contrasting Design Approaches for Slabs-on-Ground and Raised Floor Foundations on Expansive Soils
December 2008 - How to use the PTI-3rd Edition to Design Foundations in Houston
December 2007 - Design of Structures to Resist the Pressures and Movements of Expansive Soils
December 2006 - Revisitation of Expansive Soils
December 2004 - Case Studies of Residential Foundation Movements in Southern Houston Area
August 2003 - How to Run Soil Suction Tests
August 2002 - Shallow Slope Failures and Suction from Vegetation
August 2001 - Methods to Aid Structural and Geotechnical Engineers in Designing Slab-on-Grade

In addition these opinions are supported by ASCE Geotechnical Special Publication Number 115 *"Expansive Soils and Vegetative Influence on Shallow Foundation" which states "Conclusions indicate concentrations of trees tend to have the most significant effects with influence patterns occurring radially to approximately the tree drip line."*

# CONCLUSION

In our opinion, trees in close proximity to the foundation at The Retreat at Craig Ranch pose a significant threat to the foundations of the homes and must be removed to prevent foundation damage to the buildings. The attached spreadsheet identifies trees found to be too close to the foundation with the potential for future damaging effects.

As Professional Engineers, it is our responsibility to evaluate available evidence relevant to the structural systems of the building(s). We are not, however, responsible for conditions that could not be seen or were not within the scope of our service at the time of the inspection.

If you have any questions about this report or inspection, please feel free to call our engineer for clarification. There is no additional charge for a reasonable number of phone consultations.

Thank you for the opportunity to be of assistance to you.

Report reviewed by,

David Dotson, P.E.

Enclosures: Elevation Survey

| Address | | Tree Quantity/Location |
|---|---|---|
| 8605 Grassland | | 2 - Front |
| 8601 Grassland | | 1 - Front |
| 5245 Kentwood | | 1 - Front, 1 - West Side |
| 5241 Kentwood | | 1 (Red Oak) - Front |
| 5225 Kentwood | | 1 - Front |
| 5217 Kentwood | | 1 - Front, 1 - South Side |
| 5213 Kentwood | | 1 - West Side |
| 5141 Kentwood | | 1 - Front |
| 8600 Dewland | | 2 - East Side |
| 8601 Dewland | | 1 - Front |
| 8605 Dewland | | 2 - Front |
| 8609 Dewland | | 1 - Front |
| 8613 Dewland | | 1 - Front |
| 8617 Dewland | | 1 - Front |
| 8621 Dewland | | 1 - Front |
| 8625 Dewland | | 1 - Front |
| 8613 Gracewood | | 1 - North Side |
| 8641 Gracewood | | 1 (Oak) - Front |
| 8629 Gracewood | | 2 (Oak) - Front |
| 8637 Gracewood | | 1 - Front |
| 8621 Gracewood | | 1 - Front |
| 8645 Gracewood | | 1 - North Side |
| 8608 Arrow | | 1 - Front |
| 5313 Cornerstone | | 1 - Front |
| 5312 Cornerstone | | 1 (Oak) - Front |
| 5301 Cornerstone | | 1 - Front |
| 5305 Cornerstone | | 2 - Front |
| 5316 Cornerstone | | 2 - Front |
| 5309 Cornerstone | | 1 - Front |
| 5320 Cornerstone | | 2 - Front |
| 5304 Cornerstone | | 2 - Front |
| 5300 Sutton | | 1 (Bradford Pear) - Front, 1 - North Side |
| 5305 Sutton | | 1 (Bradford Pear) - Front |
| 5304 Sutton | | 2 (Red Oak) - South Side |
| 8808 Dewland | | 1 - South Side |

| | | |
|---|---|---|
| 5305 Lockwood | | 1 -  Front |
| 5329 Lookwood | | 1 - North Side |
| 8901 Dewland | | 1 - North Side |
| 8909 Dewland | | 1 -  Front |
| 8913 Dewland | | 1 -  Front |
| 8929 Dewland | | 1 -  Front |
| 8917 Dewland | | 1 -  Front |
| 8800 Dewland | | 1 -  Southwest |
| 8820 Dewland | | 1 (Bradford Pear) - Front |
| 8812 Dewland | | 1 - Southeast |
| Clubhouse | | Live Oak at Southeast Corner |
| 8800 Dewland/5204 Sutton | | 3-South |
| 8608 Shallowford | | 4 Trees |
| 5145 Kentwood | | 2 Cottonwoods - Near Fence line |