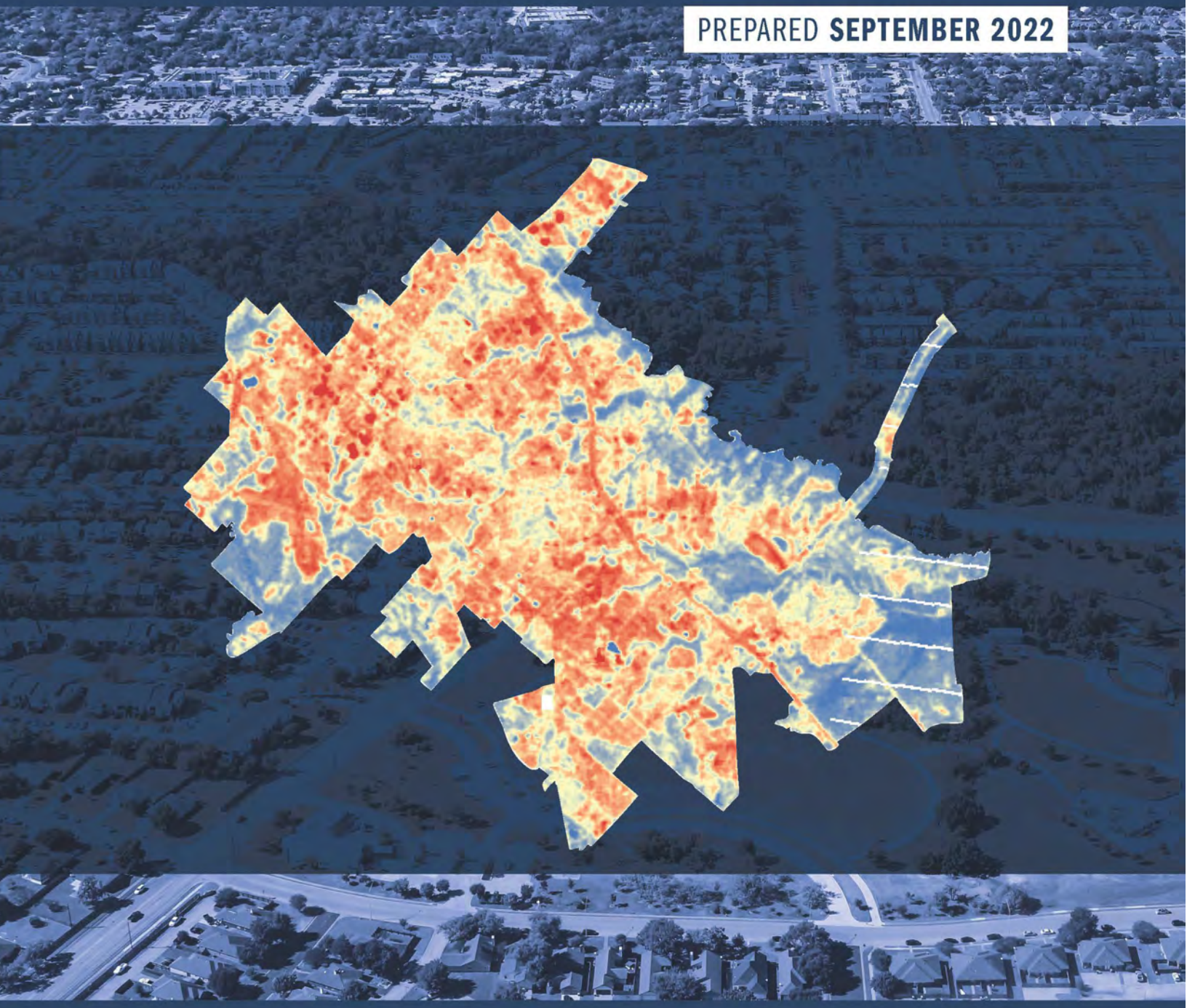
"COOLING" COLLEGE STATION:
A FIVE-YEAR PLANTING PLAN FOR URBAN HEAT MITIGATION

PREPARED **SEPTEMBER 2022**



CITY OF COLLEGE STATION
Home of Texas A&M University®

Overview

In September 2021, the College Station City Council directed staff to research urban heat islands and determine costs for mitigation strategies focused on tree planting. This report provides an overview of the urban heat island phenomenon, maps and analysis on the City's vegetative cover and surface area temperatures, and proposes priority locations for tree planting over the next five years. The report recommends specific tree species and estimates program costs, methods of monitoring implementation, and additional strategies the Council may wish to consider. The report is organized as follows:

- Urban Heat Island Effect
- Methodology & Analysis
- Recommendations
    - Priority Planting Areas
    - Buffers & Spacing
    - Tree Species & Program Costs
    - Monitoring Implementation
- Additional Mitigation Strategies
    - Residential Tree Planting Program
    - Partnership Opportunities
    - HUD Climate Communities Technical Assistance Program
    - Regulatory Changes & Non-Planting Approaches
- Appendices: Texas A&M Forest Service Proposal to Reduce Urban Heat Islands & Planting Area Maps

Urban Heat Island Effect

The Environmental Protection Agency (EPA) states: "Urban heat islands" occur when cities replace natural land cover with dense concentrations of pavement, buildings, and other surfaces that absorb and retain heat. This effect increases energy costs (e.g., for air conditioning), air pollution levels, and heat-related illness and mortality.[1]

The heat island effect essentially creates "islands" of higher temperatures in urbanized areas as compared with less developed surrounding areas. Across the U.S., daytime temperatures in urban areas tend to be about 1–7°F higher than in surrounding areas and nighttime temperatures are approximately 2–5°F higher. These differences are typically even greater for humid regions.[2]

Cities are using a myriad of strategies to mitigate urban heat and its impacts. These include more trees and vegetation, green roofs, cool roofs, cool pavements, and smart growth approaches to urban planning.[3] Other localities around Texas and the U.S. are exploring the issue of urban heat islands and working toward mitigation. Trees provide a wide spectrum of benefits, including: energy conservation, enhanced air quality, improved water quality, enhanced aesthetics, and increased property values.[4]

[1] www.epa.gov/heatislands/learn-about-heat-islands
[2] Ibid
[3] www.epa.gov/heatislands/heat-island-cooling-strategies
[4] wrrc.arizona.edu/sites/wrrc.arizona.edu/files/Urban%20Forest%20Values.pdf

This figure from the EPA provides a conceptual illustration of the urban heat island effect. While College Station does not have a defined downtown core as shown in the figure, the diagram illustrates the variation of temperatures depending on land use cover (such as buildings, water bodies, and open land). The Bryan/College Station area has an average intensity score of 6°F, according to an analysis undertaken by Climate Central – this implies that temperatures in B/CS urbanized areas are an average of 6°F higher than in surrounding areas.[5]

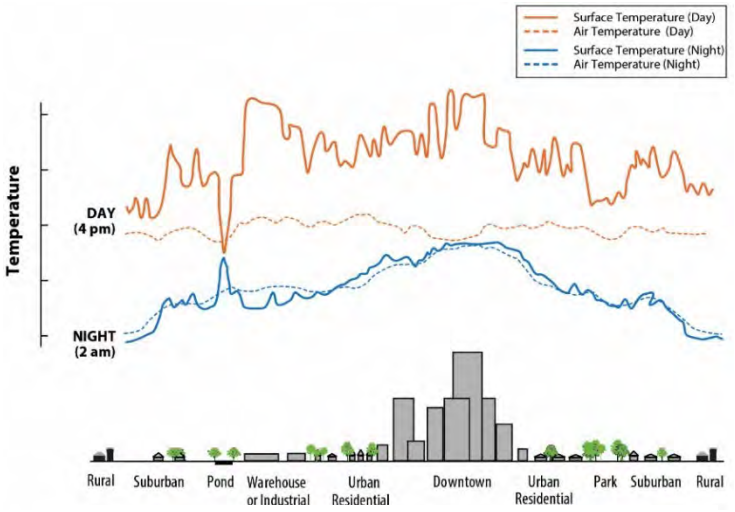
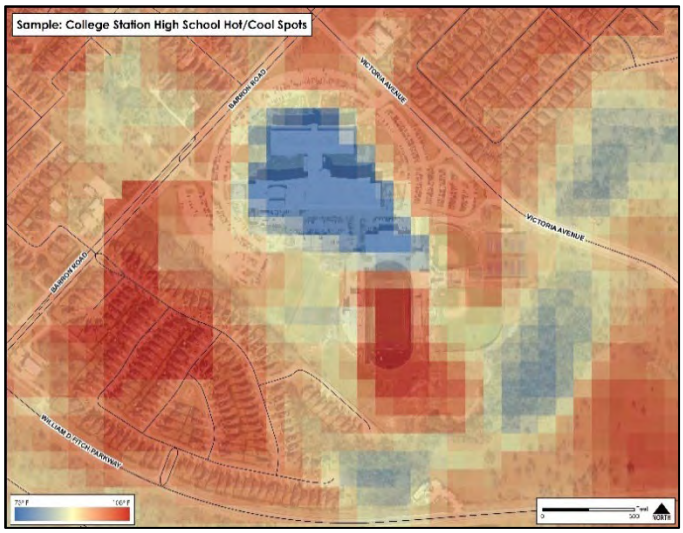


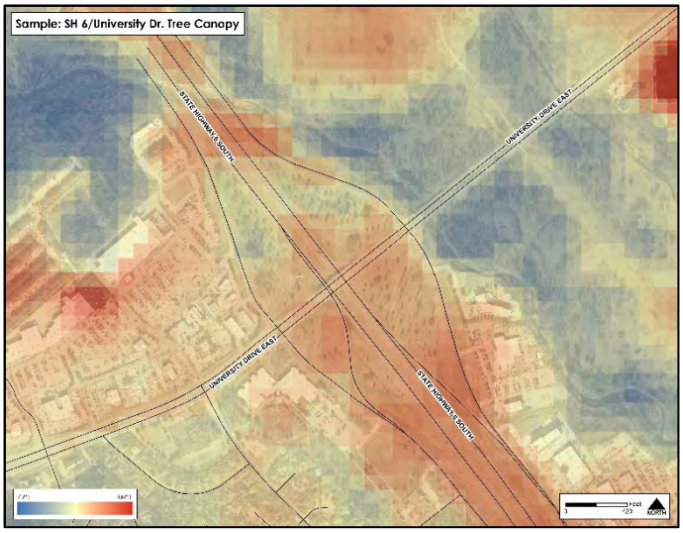
Figure 1. Urban Heat Island Effect. Source: EPA

Open or barren land (even with grass or turf) is often associated with high levels of heat due to a lack of shading and greater absorption of heat. Conversely, metal and light-colored roofs and bodies of water appear as cool areas, since more heat is reflected off these surfaces.

The first sample image on the right is the College Station High School campus. The estimated surface temperatures clearly show hot areas on the turf football field, tennis courts, baseball and softball fields, and surrounding parking areas. The darkest blue area matches the building footprint, indicating reflective or light-colored roofing materials. The vegetated and floodplain areas to the east and southeast also render as shades of blue, indicating cooler spots due to existing tree canopy.



The second sample image on the right is the State Highway (SH) 6 and University Drive interchange. The cooling benefit of the tree canopy is viewable on the north side of the interchange where there is a significant established tree canopy, compared to the south side of the interchange where the tree canopy is younger and smaller. The pending TxDOT widening project necessitates tree relocations for much of the existing tree canopy in this location. There are opportunities to relocate these trees to identified areas using the new Public Works tree spade.



[5] https://ccimgs-2021.s3.amazonaws.com/2021UHI/2021UHI_Intensity_bryan_en_title_lg.jpg

Methodology & Analysis

Following City Council direction, staff have analyzed heat levels throughout the City and prepared recommendations on areas where the heat mitigation strategy of tree-planting may be most cost-effective and yield the greatest benefits.

Staff used publicly available remote sensing data from United States Geological Survey (USGS) Landsat satellites. Specifically, Landsat 7 Analysis Ready Data (ARD) was used to create the Estimated Surface Temperature Map, and this data was collected on September 23, 2021 at 3:53 p.m. The Surface Temperature Map was created using a ratio to convert from the arbitrary digital numbers (DNs) collected at the satellite into temperature, at a spatial resolution of 60 square meters per "pixel".

Staff examined heat throughout the City using several different spatial perspectives. Staff preliminarily identified hot spots on the Landsat raw data heat map with the 60 square meter "pixels", and then created two additional maps that aggregated the data in different ways: first according to a grid with half-mile by half-mile squares, and then according to Census blocks. These two maps aggregated the data by averaging the raw temperature data within each half-mile grid square or Census block.

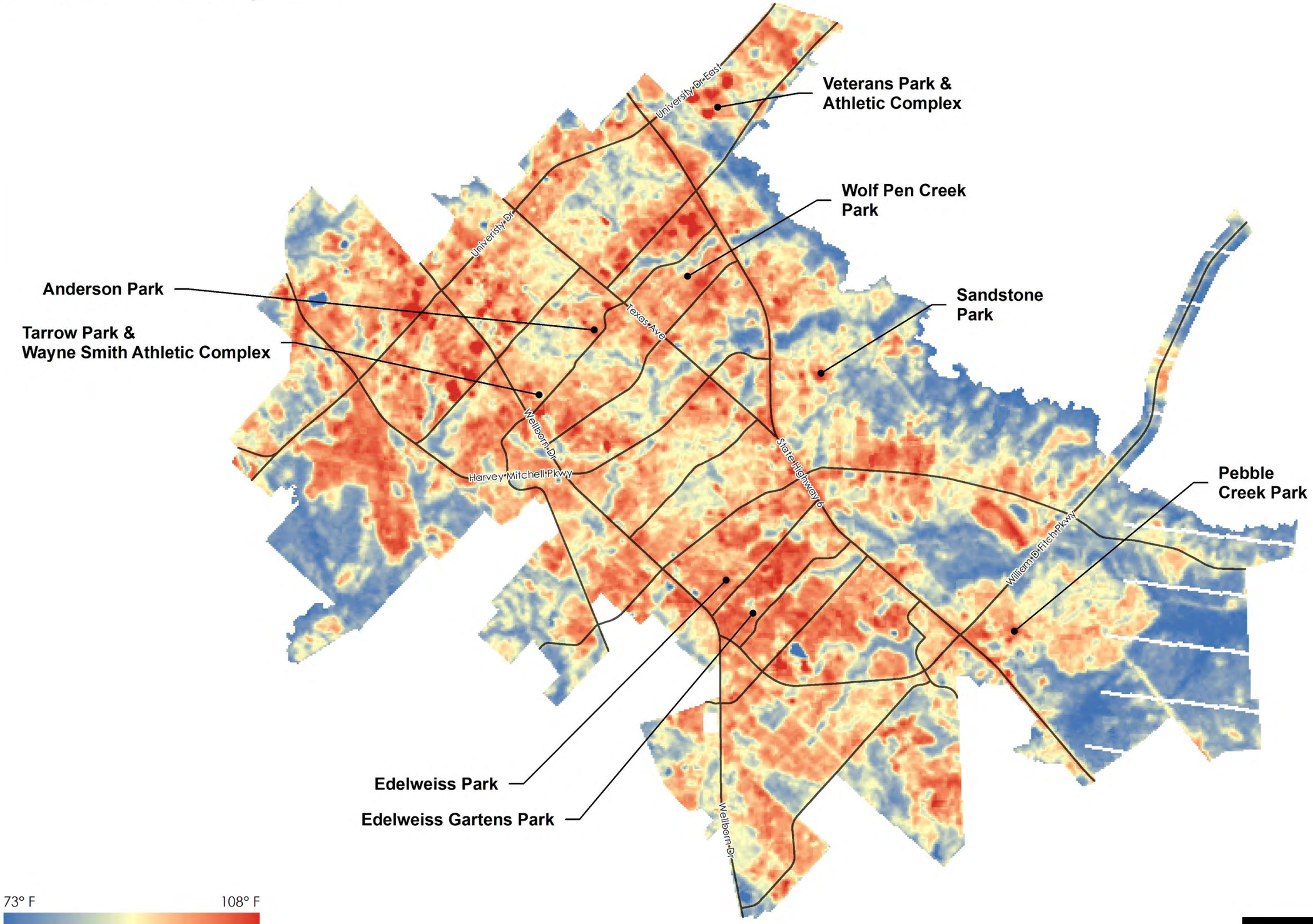
The top 10 hottest half-mile grid squares included portions of Texas A&M University and particularly West Campus, Post Oak Mall and the Harvey Road corridor, Northgate, Easterwood Airport, and newer residential developments in south College Station. The hottest 10 percent of Census blocks showed similar results, with hot temperatures on the Texas A&M University campus, Post Oak Mall and Harvey Road, Northgate, and south College Station subdivisions. Additionally, the Census blocks map showed hot spot areas along Highway 6 and at the Aggieland Driving Range, the Wellborn/ Deacon/ Fraternity Row area, and several multi-family complexes east of Easterwood Airport.

The City has limited planting opportunities on privately-owned and state-owned properties that were identified as some of the hottest areas within the city. Recognizing the need for continued discussions and partnerships with other entities, staff recommends that City-owned properties be the focus of this initial planting program. To this end, Planning & Development Services staff determined the top 10 percent of City-owned properties and met with Parks & Recreation, Public Works, and CSU Electric to ensure that proposed planting locations were feasible.

In summary, the following steps were taken in the analysis:

1. Preliminary visual spot check to identify hot spots on the Landsat raw data heat map
2. Created aggregate maps averaging the data by half-mile grid squares and Census blocks. Identified top 10 hottest grid squares and the top 10 percent of Census blocks
3. Determined top 10 percent hottest City-owned properties
4. Combined parcels within the list where appropriate (for example, W.A. Tarrow Park is composed of different parcels and these were combined for simplicity)
5. Met with other City departments to consider constraints including parks planning, drainage, infrastructure and utilities, and planned capital projects
6. Developed list of priority planting areas within City-owned properties

Estimated Surface Temperature



Recommendations

The following Priority Planting Areas were proposed based on the hot spots where planting can produce the most beneficial outcomes for heat mitigation. Furthermore, these areas were identified as ones that provide greater certainty for the prolonged growth of the trees. Staff identified areas that would not likely be subject to future disturbance, such as street widenings, which may cause the removal of the trees before they reach maturity and provide the desired benefits. This list focused on existing park properties and is listed in descending order, from hottest to less hot.

Original Priority Planting Areas

1. Edelweiss Park
2. Sandstone Park
3. Edelweiss Gartens Park
4. Anderson Park
5. Pebble Creek Park
6. Tarrow Park & Wayne Smith Athletic Complex
7. Wolf Pen Creek Park
8. Veterans Park & Athletic Complex

In April 2022, staff presented the five-year planting plan that recommended planting 376 trees on City-controlled properties and creating a residential tree planting program that would provide 500 trees per year to area residents to plant on their properties. Following this, the City Council directed staff to increase the number of plantings.

Additional Priority Planting Areas & Right-of-Way (ROW)

Since April, staff have identified additional planting areas in parks, City-owned property, and right-of-way (ROW), as well as increased the density of previously proposed planting areas. With the additional areas and increased density, the program could increase the number of trees to approximately 4,800 over five years. In addition, the 500 trees per year for the residential program would also continue, bringing the total number of trees to about 7,300 over five years.

The additional tree density comes from decreasing the spacing requirements for the trees from 55-feet to 25-feet. The 55-feet initial spacing value was selected to allow a mature spread of the trees, which would take many years to occur. By reducing the spacing to 25-feet, this will create a denser canopy and provide for coverage protection when some of the trees die from disease or drought. The 25-foot spacing requirement is also consistent with the City's streetscaping requirements along all major arterials.

Much of the additional planting areas come from additional City-controlled properties, such as parks, or properties that are controlled by the Texas Department of Transportation (TxDOT). Staff has reached out to TxDOT and they have indicated general agreement to allow planting in these areas, subject to keeping clear zone areas. Furthermore, there are some areas that will require more detailed analysis, such as medians, if the City Council decides to move forward with this program and planting plan.

Beyond the identified additional priority planting areas, there are other "hot" areas of the City where tree planting may be highly beneficial to mitigate the urban heat island effect, but significant constraints exist at present. These constraints include land ownership, easements, drainage concerns, limited right-ROW widths, and future road improvement projects. These locations are not included within the recommended planting areas within the scope of this report but could be considered as future initiatives.

Future Planting Opportunities & Constraints:

- Harvey Road corridor – requires TxDOT coordination, has constrained ROW, and a pending TxDOT median project
- Barron Road corridor – has constrained ROW and visibility concerns
- Graham Road corridor – has constrained ROW
- Harvey Mitchell Parkway (FM 2818) at Texas near Walmart – requires TxDOT coordination and determination of future intersection project(s)

Buffers & Spacing

Within each planting area, City staff analyzed existing constraints including utilities, drainage, and future parks projects/fields. Staff also identified buffer areas needed between planting areas and existing infrastructure, such as utilities and sidewalks, to prevent root intrusion and/or destabilization of soils in areas designated for drainage purposes. Typical spacing requirements are included within Table 1.

Table 1. Typical Spacing Requirements

Tree Type	Public Utility Easements	Detention pond berm or bank of drainage way	Within drainage conveyance path	Sidewalks / trails
Canopy	Not allowed. 10-15 feet buffer distance*	Not allowed within 10-15 feet	Not allowed	Not allowed within 5 feet
Non-Canopy	Not preferred. Minimum 5 feet from utility line			

* Farther for more critical infrastructure like transmission lines – a tree that will grow to 60 feet in height at maturity should be planted 60 feet from the outside edge of the transmission right-of-way

Through discussions with City staff and CSU Electric, constraints regarding spacing from utilities were addressed. Figure 2 shows ideal planting buffers from utility lines (figure from Oncor).

Figure 2. Buffer Distances from Utilities

Staff recommends that trees should be planted at specific locations within each park that maximize the cooling properties of trees at the human scale. This can be accomplished by planting

“respite trees” that mitigate heat island effect and simultaneously provide heat relief for pedestrians, where cooling is needed most. In general, trees should be evenly spaced in a way that breaks up hot spots, much like road crosswalks are designed to include pedestrian refuges within the medians. Further research could be beneficial in determining the ideal distance that a pedestrian should have to walk without the “respite” provided by tree cover, and this could become a target number for the City’s ongoing efforts to grow and maintain an urban forest, with the health, aesthetic, and financial benefits that this amenity brings.

The following specific locations are recommended and were used as guidelines for this initial phase of targeted planting:

1. Along the edges of sports fields and other open areas where children and adults congregate and are gathered for an extended period of time while exposed to the elements
2. Along walking paths and other heavily-used areas of each park, as shown by “desire lines” (informal pathways where the grass is trodden down due to foot traffic over time)
3. Any large open area without trees that is not actively used for recreational purposes (such as sports or practice fields)

Tables 2.A and 2.B below provide narrative descriptions of the planting locations and constraints within each (original and additional) Priority Planting Area location. Maps depicting the total plantable area, estimated number of trees, and total cost per Priority Planting Area can be found in the **Appendix.** The parks in Table 2.A are organized by priority number in descending order, from hottest to less hot. Table 2.B represents the additional planting areas that staff identified based on Council’s request for additional areas, which do not necessarily correlate with the hottest areas of the City but are opportunities for plantings. These are listed in alphabetical order, with cemeteries included at the end since they are managed by the City’s Parks & Recreation Department.

Table 2.A. Tree Placement – Original Priority Planting Areas

Priority	Park Name	Hottest 10 Half-Mile Grids	Planting Locations	Constraints / Considerations
1	Edelweiss Park	Yes	Along walking paths, near the parking lot and playground structure, in between the sports fields, and replant existing dead trees along Victoria Ave.	Underground utilities along Victoria Ave. and the western park boundary, overhead utilities along the southeastern park boundary, and underground lines near parking lot and basketball courts
2	Sandstone Park		Along the walking path, between the parking area and T-ball and soccer fields, and near the park perimeter	Overhead and underground utilities on the perimeter
3	Edelweiss Gartens Park	Yes	Along walking paths, near the playground, and new large planting area by the basketball court (near the stormwater detention area)	Underground utilities along the park perimeters, stormwater detention in middle portion
4	Anderson Park		Near the park perimeter and replant any dead trees along Anderson St.	Overhead and underground utilities on the perimeter and in the basketball court / playground area
5	Pebble Creek Park		Along the walking path and around the sports fields	Underground utilities along the perimeter
6	Tarrow Park & Wayne Smith Athletic Complex		Along the east side of the walking path and near the basketball court on the north side of park, small planting area near maintenance building	Overhead utilities along Holleman and serving the Lincoln Recreation Center, underground utilities along the perimeters and along the walking path
7	Wolf Pen Creek Park	Yes	Along the parking area and walking path closest to the Meyers Senior Center	Underground utilities criss-cross the park, overhead electric along Dartmouth St., floodplain and floodway near the Dartmouth St. and Holleman Dr. intersection (closest to amphitheater)
8	Veterans Park & Athletic Complex		Along parking lots and fields where possible, replant dead trees, and work with Public Works to relocate trees from the University Dr. / SH 6 interchange prior to TxDOT project using tree spade	Underground utilities along University Dr. and within the park serving facilities and irrigation lines for fields, avoid areas planned for future fields and/or memorial projects

Note: None of the hottest 10 percent of City-owned properties fell within the hottest 10 percent of Census blocks

Table 2.B. Tree Placement – Additional Priority Planting Areas & ROW

Name	Planting Locations	Constraints / Considerations
Art & Myra Bright Park	Along the north side of Wolf Pen Creek and the existing utilities	Existing underground wastewater line
Bee Creek Park	Along the parking areas & boundary with College Station Cemetery	Underground utilities
Brison Park	Along the walking paths	Underground utilities and existing drainage areas
Castle Rock Park	Along the walking paths	Underground utilities and sports fields
Crescent Pointe Park	Northwest corner of park	n/a
Eastgate Park	Open grassy areas	Underground and overhead utilities
Gabbard Park	Along the walking paths	Underground utilities and sports fields
Jack & Dorothy Miller Park	Along the western property boundary and in the northern corner	Sports fields
John Crompton Park	Along the parking areas and in the northern corner	Underground and overhead utilities along Holleman Dr. W.
Oaks Park	Along the walking paths	Existing drainage areas and disc golf course
Reatta Meadows Park	Along the walking paths	Underground utilities
Richard Carter Park	Northwest corner of park	n/a
Stephen C. Beachy Central Park	Along the periphery of sports fields and drive aisles	Underground utilities and sports fields
Aggie Field of Honor & Memorial Cemetery	Along the western property line	Underground utilities, future cemetery plot areas, and viewshed
College Station Cemetery	Along the boundary facing Texas Ave.	Utilities and unmarked graves
Miscellaneous ROWs	Varies	Depends on specific area, but typically utilities and clear sight lines

Tree Species & Program Costs

The tree species below are recommended for the College Station area by the Texas A&M AgriLife Extension's Forest Service. The Forest Service recommends that a diversity of species be planted in each selected area to mitigate impacts of tree diseases that target certain tree species. Planting a diversity of trees helps prevent the canopy in a given area from being destroyed by species-specific diseases.

The Texas A&M Forest Service cultivates small batches of "test" seedlings that have proven to be hardy species and have indicated they may be able to give the City 20-30 seedlings each year and cultivate them in an adaptive way based on results. These potential donations are an alternative the City could explore to potentially save costs and collaborate with local organizations and institutions.

For the purposes of estimating program costs below, all trees were assumed to be purchased at government contract pricing rates. The costs of trees vary widely across species and size. Staff calculated the average mature spread range between 49.2-56.9 feet and the average price per tree of $271.37 (not including installation, materials, and labor – see Table 4). Exact quantities of each tree species and the specific planting locations will be determined in future phases of this project, if recommended to proceed by the City Council.

Table 3. Proposed Tree Species (based on Texas A&M Forest Service recommendations)

Tree Species	Mature Height Range (ft)*		Mature Spread Range (ft)*		Caliper Inches (estimated)	Gallon Size	Price **	Notes
Live oak	40	80	60	100	2	30 g	$177.00	Fast-growing but growth rate slows with age
					2.5	45 g	$295.00	
					3	65 g	$495.00	
Mexican white oak	50	80	50	80	2	30 g	$179.00	Adaptable, resistant to drought, abundant flowers and acorns
					2.5	45 g	$300.00	
Desert willow	15	25		10	0.5-1	15 g	$100.00	
Chinquapin / chinkapin	40	50	50	60	2.5-3	45 g	$408.99	Chinquapin acorns are a preferred food source for many wildlife
Bald cypress	50	70		25	2	30 g	$179.00	Root nodes can be an issue for maintenance and mowing
					2.5-3	45 g	$295.00	
Pecan	70	100	40	75	1.5-2.5	30 g	$304.50	
					2.5-3	45 g	$334.07	
Sycamore	40	100	70	70	2-2.5	30 g	$195.00	Prices for Mexican Sycamore; Mexican and American varieties are best for the B/CS region
					2.5-3	45 g	$325.00	
Loblolly pine	60	90	25	35	2	30 g	$179.00	Loblolly pines from the "Lost Pines of Bastrop" area are best suited for the B/CS region
					3	45 g	$304.00	
Average	**45**	**74.4**	**49.2**	**56.9**			**$271.37**	

*Mature height and spread information collected from the Arbor Day Foundation

**Prices are from a local landscape supply store at their government contract pricing rates

Staff from the Parks & Recreation and Planning & Development Services departments collaborated to determine the estimated "all-in" total cost per tree price, tree installation (without volunteer labor), additional planting materials, and irrigation materials and line installation. Table 4 depicts those assumptions. Costs savings could be realized through partnerships with student and volunteer organizations, such as Aggie Replant and Keep Brazos Beautiful, at tree planting events and potential future maintenance programs. In addition, economies of scale can be realized for larger planting areas.

Table 4. Estimated Total Cost per Tree

Avg. cost of tree	**$271.37**
Avg. cost of installation per tree	$100.00
Costs of additional materials (tree posts, mulch, etc.)	$100.00
Avg. irrigation costs per tree (material + labor)	$200.00
Estimated total per tree	**$671.37**

The program cost calculations included in Tables 5.A, 5.B, and 5.C below used the assumptions of the estimated "all-in" total per tree of **$671.37** and a spacing of **25-feet** to allow for an adequate canopy spread. The plantable area of each park, City property, or ROW was calculated in square feet for larger planting areas and linear feet for areas where trees would be planted in a linear row. Staff then calculated the estimated number of trees per plantable area.

The original program proposal presented in April 2022 totaled 376 trees over the next five-year period. By reducing the tree planting spacing from 55-feet to 25-feet, the total number of trees within the Original Priority Planting Areas increased from 376 to 1,289. The Additional Priority Planting Areas that staff identified add another 692 trees within other parks and City-owned properties. The planting opportunities within ROWs and other areas increases the program's impact by adding another 2,806 trees.

In total, staff identified the opportunity to plant **4,787 trees** across the Original Priority Planting Areas, Additional Priority Planting Areas, and ROWs and other areas. The total costs amount to **$3,213,850**. If the program is implemented over a 5-year period, this **totals 958 trees per year** (rounded up to the nearest tree), **costing $643,172 per year.** Please note, these costs are in FY22 dollars and did not account for inflation due to the unknown year(s) of purchasing and implementing the program. Adjusting for inflation, the estimated total cost of this program over five years would be **$3,711,299** (see Table 6).

Table 5.A Estimated Program Cost – Original Priority Planting Areas at 25-feet planting spacing

Priority #	Park Name	Plantable Area (Sq Ft or Linear Ft)	Estimated # of Trees	FY22 Estimated Cost per Park
1	Edelweiss	92,108 SF & 739 LF	198	$132,931
2	Sandstone	141,079 SF & 80 LF	288	$193,355
3	Edelweiss Gartens	73,340 SF & 314 LF	155	$104,062
4	Anderson	31,355 SF & 1,887 LF	75	$50,353
5	Pebble Creek	56,736 SF & 229 LF	115	$77,208
6	Tarrow & Wayne Smith Athletic Complex	27,161 SF & 345 LF	56	$37,597
7	Wolf Pen Creek	6,563 SF & 376 LF	18	$12,085
8	Veterans Park & Athletic Complex*	183,422 & 2,072 LF	384	$257,806
		TOTAL	**1,289**	**$865,397**

** Veterans Park costs could be significantly less based on number of trees relocated from SH6 / University Dr. TxDOT project*

Table 5.B Estimated Program Cost – Additional Priority Planting Areas at 25-feet planting spacing

Park Name	Plantable Area (Sq Ft or Linear Ft)	Estimated # of Trees	FY22 Estimated Cost per Park
Art & Myra Bright	36,170 SF	74	$49,681
Bee Creek	26,064 SF & 183 LF	61	$40,954
Brison	5,316 SF & 42 LF	13	$8,728
Castle Rock	5,192 SF & 164 LF	17	$11,413
Crescent Pointe	4,180 SF	9	$6,042
Eastgate	14,199 SF	29	$19,470
Gabbard	13,971 SF	28	$18,798
Jack & Dorothy Miller	73,005 SF	149	$100,034
John Crompton	13,122 SF	27	$18,127
Oaks	2,935 SF	6	$4,028
Reatta Meadows	10,138 SF	21	$14,099
Richard Carter	15,387 SF	31	$20,812
Stephen C Beachy Central	10,447 SF & 455 LF	39	$26,183
Aggie Field of Honor & Memorial Cemetery	79,452 SF	162	$108,762
College Station Cemetery	657 LF	26	$17,456
	TOTAL	**692**	**$464,587**

Table 5.C Estimated Program Cost – Other Planting Areas at 25-feet planting spacing

Name	Plantable Area (Sq Ft or Linear Ft)	Estimated # of Trees	FY22 Estimated Cost
ROW / Other City Property	1,255,470 SF & 6,152 LF	**2,806**	**$1,883,866**

Program Total: 4,787 trees, $3,213,850, Per Year: 958 trees, $643,172

Table 6. Estimated Five-Year Planting Program Cost*

FY2023	$688,194
FY2024	$722,604
FY2025	$744,282
FY2026	$766,610
FY2027	$789,609
Estimated total five-year cost	**$3,711,299**

**Adjusted for inflation - assumptions of 7% for FY23, 5% for FY24, and 3% for FY25 through FY27.*

Monitoring Implementation

Monitoring temperatures in the planting areas over time will help ensure that targeted tree planting is having the desired result of mitigating heat islands. The Texas A&M Forest Service recommends using infrared thermometers, which cost about $50 each, to measure ambient air temperatures a few feet off the ground. This is more accurate to how humans experience heat islands than satellite methods that measure temperature on Earth's surface. It would be recommended to get two thermometers per planting area. Thermometers could be placed permanently at locations within the planting areas as well as a control area without plantings. Alternatively, thermometers could be moved around to spot-check different locations at different points in time. There are also data sources that may be available for purchase to measure temperatures across the City, but these typically measure surface temperatures rather than ambient air temperatures.

Additional Mitigation Strategies

In addition to planting trees primarily on City-owned properties and secondarily within other areas such as street rights-of-way, there are additional options that the City Council may consider that could mitigate areas of high heat within the city. These include a residential tree planting program, partnership opportunities, regulatory changes, and other non-planting approaches.

Residential Tree Planting Program

Another program that City Council asked staff to investigate was a residential tree planting program. Under this program, the City would provide trees to residents who request them, up to a certain amount. Included with this program, residents would go through a brief training program (could be online) and agree to maintain the trees to help ensure their survival.

TreeFolks operates a similar program in Central Texas called NeighborWoods. More information about this program can be found at the following link: https://www.treefolks.org/get-a-tree/neighborwoods/. Under this program, citizens are able to request a tree through an online form. From there, TreeFolks will provide home delivery of the trees. Applicants have the ability to choose from a list of available species. TreeFolks also hosts free tree adoption events each year throughout the Texas tree planting season from October through March. Planning and Development Services staff has discussed this program with Parks and Recreation staff and they have interest in administering a similar type program for College Station if the City Council wishes to proceed with this type of program. In addition, staff has contacted Keep Brazos Beautiful about administering this type or a similar type of program and they have expressed interest as well, but further conversations and specifics would be needed.

For a budgetary estimate, five-gallon trees generally range from $50 - $100 each depending on species and quantity purchased. Using an average cost of $75 (FY22 dollars), 500 trees will cost $37,500. A quantity of 500 trees per year is a reasonable amount to distribute, depending on how many adoption events are done each year. Over five years, this would equate to 2,500 trees being planted throughout the City, with an anticipated five-year cost of approximately $217,000 using inflationary assumptions of 7% for FY23, 5% for FY24, and 3% for FY25 through FY27.

Table 7. Estimated Residential Planting Program Cost

FY2023	$40,125
FY2024	$42,131
FY2025	$43,395
FY2026	$44,697
FY2027	$46,038
Estimated total five-year cost	**$216,386**

Partnership Opportunities

Chapter 9 of the City of College Station Comprehensive Plan, titled Collaborative Partnerships, lays out the importance of collaborating with local experts and other jurisdictions on combatting regional problems that the City faces. To this end, staff have identified numerous local non-profits and parts of the Texas A&M System that provide partnership opportunities to combat rising urban heat. Staff propose working with some or all of these to implement the tree planting programs, while identifying and evaluating alternative solutions they may propose to work together towards a cooler community.

The Texas A&M Forest Service collaborated on the methodology of this project, an early example of how staff are already beginning to implement the goals of Chapter 9. This initial collaboration can and should be further developed as the Texas A&M Forest Service may have updated data or new solutions that may be helpful to the City. They have indicated an interest in training City staff and residents on tree care or potentially providing scholarships for City staff to become certified arborists. The Forest Service also provides a community handbook describing how to protect trees during urban growth and sample language for a tree preservation and care ordinance. As it relates to educating residents, the Forest Service provides forest health indicators and a tree planting guide for how to better landscape private homes. They have quality information and opportunities that the City should take full advantage of.

After being consulted on the methodology, the Texas A&M Forest Service drew up a Proposal to Reduce Urban Heat Island in College Station (see **Appendix**) that offers the City $15,000 per year over two years to purchase and plant trees across the City. This generous offer could help offset the cost of the first two years of a future planting program to address urban heat while offering another opportunity for collaboration on where and what to plant. In addition to the financial benefit, the Texas A&M Forest Service has 250 seedlings which they are offering to furnish a residential tree distribution event. These additional trees could fold into existing or future Parks & Recreation, Community Services, or Neighborhood Services programming to help address the heat island effect on private property. The Texas A&M Forest Service offer provides an early chance to create a partnership on addressing tree plantings in both the public and private realms.

The City could also bring the specialized knowledge of Texas A&M University students to the community by engaging with the Society for Ecological Restoration and Society of American Foresters. Both are student organizations with a strong ecological ethic with specialized knowledge of tree health, biodiversity, and the intersection of nature and culture. Specifically, students with the Society for Ecological Restoration come from Texas A&M University's Ecology and Conservation Biology

department, which educates students across all ecological levels on conservation and resource protection. Engaging these students on locating and collocating plantings could help promote greater health outcomes, reducing the need for replanting costs in the future. In the Society of American Foresters, students engage with managing the nation's forested areas and protected national resources. They advocate for forest policies using the latest in forest science and work to keep our countries precious forests from being clearcut and developed. Engaging with the Society for American Foresters brings the opportunity for healthier planting locations, better distancing recommendations based on individual tree species needs, and a better tree care ordinance, if Council decides to go that route. Tapping into these resources brings local students' knowledge into their communities, resulting in better outcomes for the spending Council authorizes.

There are also many local organizations with regional planting and gardening knowledge that could serve as resources to City staff and residents. The Brazos County Master Gardeners (brazosmg.com) has a list of plants that flourish and contribute to gardens in the region, as well as how to care for trees in the local biome. Many of the Master Gardeners learning materials are available online. If the City were to pursue a residential tree planting program, the Master Gardeners program could bring valuable knowledge to it. Keep Brazos Beautiful, mentioned previously, has planted over 500 trees this year alone. They bring planting knowledge and infrastructure to the table that would be useful to collaborate with for planting in public parks. Similarly, Aggie Replant is a student-led organization at Texas A&M University committed to improving the local community and participating in many plantings over the past 30 years. This not only brings another partnership opportunity, but the inclusion of students in plantings may also help them feel more connection to their local community through sweat equity. Additionally, students at Texas A&M University participate every year in the Big Event, a one-day service event every spring that brings college students into the community to help with volunteer needs across the communities they live in. The City could take advantage of this day of volunteering by organizing a day of plantings across the community.

Finally, the City may also consider partnering with K-12 schools, businesses, and apartment communities identified as hot spots in the analysis for additional planting areas beyond those controlled or owned by the City. This should be long-term goal of the City, to collaborate with private developments on the placing of trees. This could include hosting partners in a tree education workshop at City Hall, connecting them with local community leaders, and distributing materials at outreach events around the City. The scope of this project is City-owned properties, but many opportunities exist in private developments.

HUD Climate Communities Technical Assistance Program

The City recently applied for and received a spot in the Department of Housing and Urban Development's (HUD) Climate Communities Technical Assistance Program. HUD's goal for the program is to provide communities with the necessary tools to successfully implement resilience activities to mitigate and adapt to climate hazards. Staff submitted this "Cooling" College Station report and planting plan for consideration and is looking forward to shared expertise from HUD and other communities to address the effects of urban heat islands and climate change more holistically in our community.

The City of College Station was one of 45 municipal and county governments chosen to participate in the program, including four other Texas communities. Participants will be able to participate in free one-on-

one technical assistance with a HUD consultant as well as engage with peer groups from other communities to learn from them and share our knowledge. This is an excellent opportunity to collaborate with other jurisdictions.

Regulatory Changes

Another approach for consideration could include amending the City's ordinances and site design guidelines to require more tree preservation and planting. For example, landscape design guidelines based on canopy coverage at maturity, rather than number of trees, may more effectively mitigate urban heat. Another option includes granting additional site requirement reliefs in exchange for additional plantings.

Non-Planting Approaches

Should the Council wish to consider heat mitigation strategies and opportunities beyond tree-planting, broader approaches like green or cool roofs, cool pavements, and smart growth planning[6] that favors land-conserving development patterns over urban sprawl may be explored. These types of strategies could also help to proactively prevent heat islands in College Station from becoming more sever

[6] www.epa.gov/heatislands

Appendix

Proposal to Reduce Urban Heat Island in College Station

We Can Help!

Texas A&M Forest Service is offering the City of College Station $15,000/year for two years to purchase and plant trees in areas to help combat urban heat island. This is roughly equivalent to 150 15-gallons trees (actual number is dependent on size and availability). Additionally, Texas A&M Forest Service offers 250 Texas Tested, Texas Tough seedlings for annual residential tree distribution events. These seedlings, a product of the Texas A&M Forest Service Urban Tree Improvement Program, are selected and improved to withstand harsh urban environments. This event could be independent or held in conjunction with a city recycling day or arbor day event. As much of the urban tree canopy in College Station is on private property, providing residents with trees to plant in yards can aid in the reduction of the urban heat island.

Where to Plant

Trees strategically planted in locations that generate or collect the most heat, such as roads and unshaded sidewalks, can mitigate the effects of urban heat islands. Consequently, areas within the city that will benefit the most from tree planting include:

- Right of Ways & Medians
- Greenspace Pathways
- Underplanted Parks
- Residential Yards

For Right of Ways and Medians, 15-gallon trees are recommended, while 3–5-gallon trees can be planted in Greenways and Parks. Residential trees are first-year seedlings in D-60 to D-40 containers, or similar.

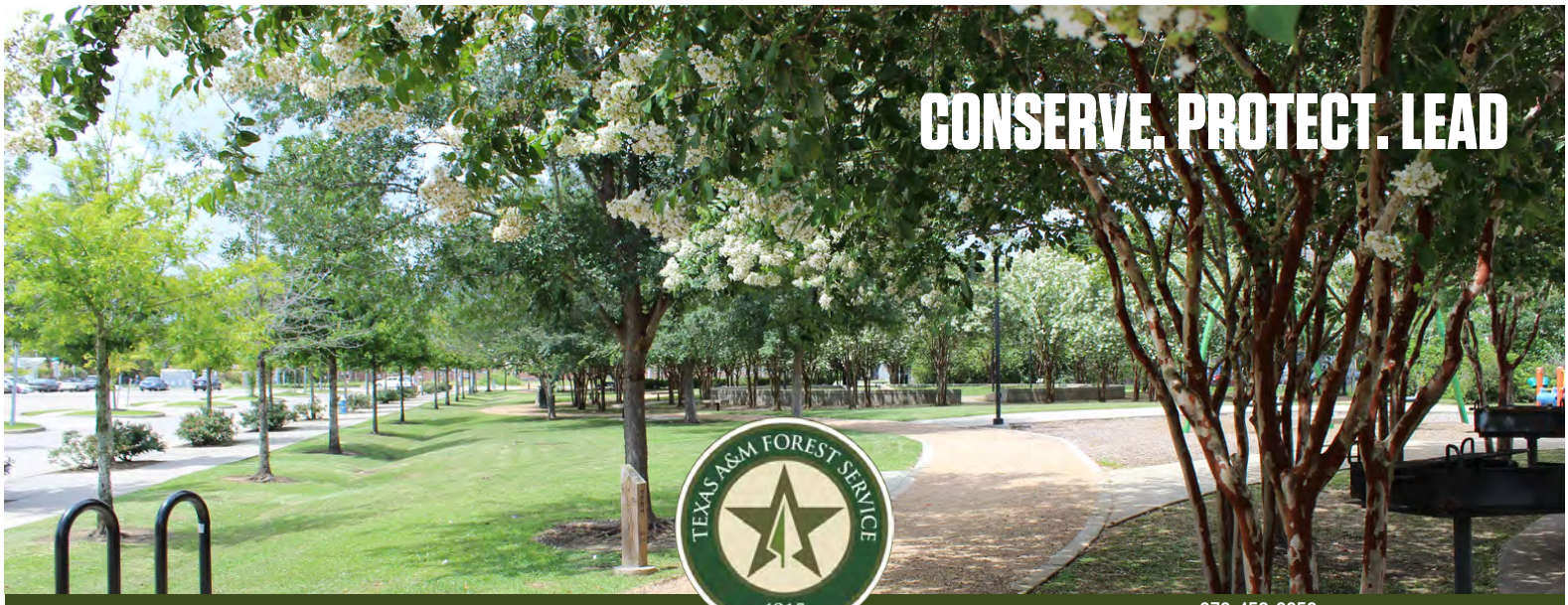
Great Species for Brazos County

- Pecan
- Bur Oak
- Cedar Elm
- Chinkapin Oak
- American Elm
- Sycamore
- Texas Redbud
- Mexican White Oak
- Live Oak
- Shumard Oak
- Bald Cypress

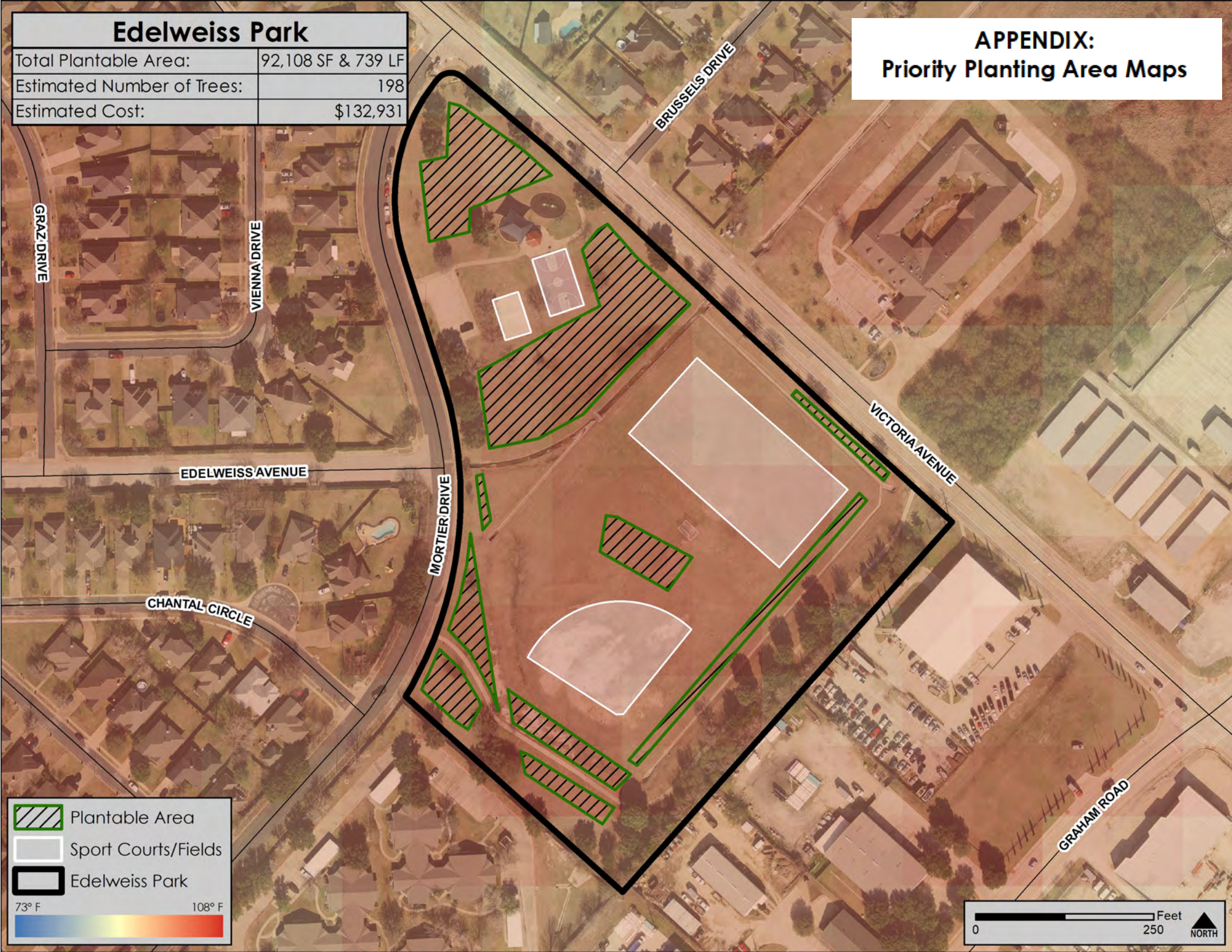
Did You Know?

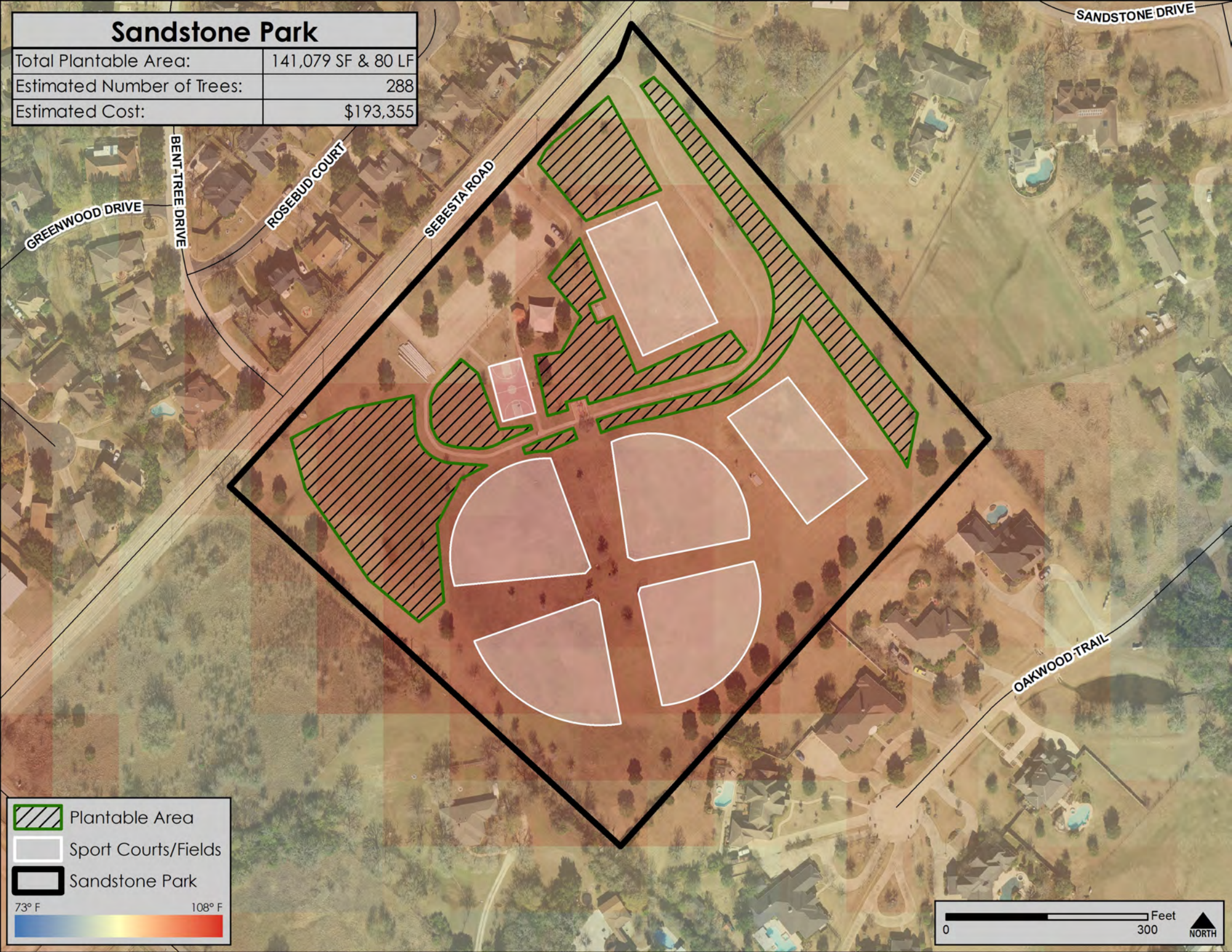
Mature trees can reduce air temperatures by up to 10° F and provide $243 million in energy savings yearly to Texas residents.

(Texas Statewide Assessment of Urban Forest Ecosystem Services, Texas A&M Forest Service 2022)

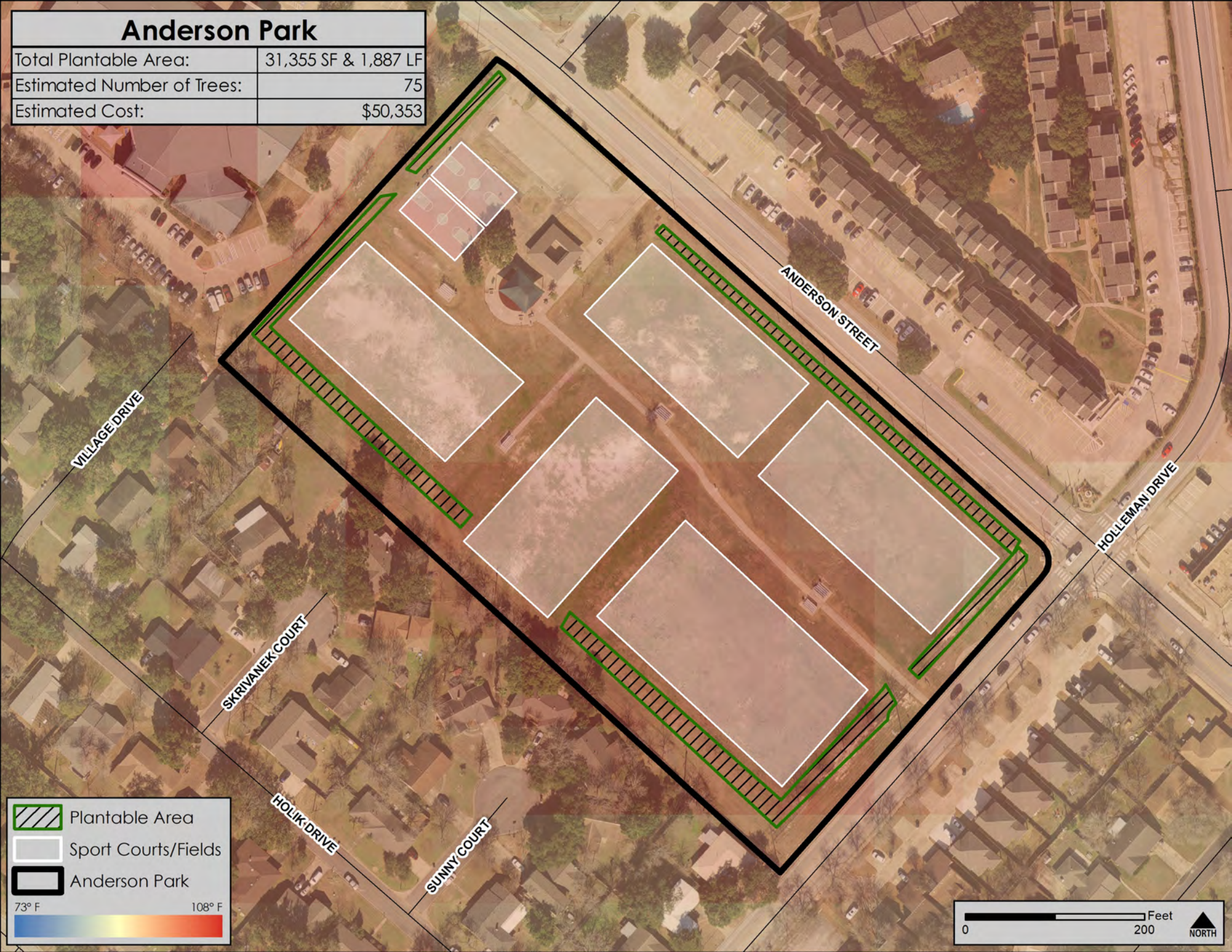


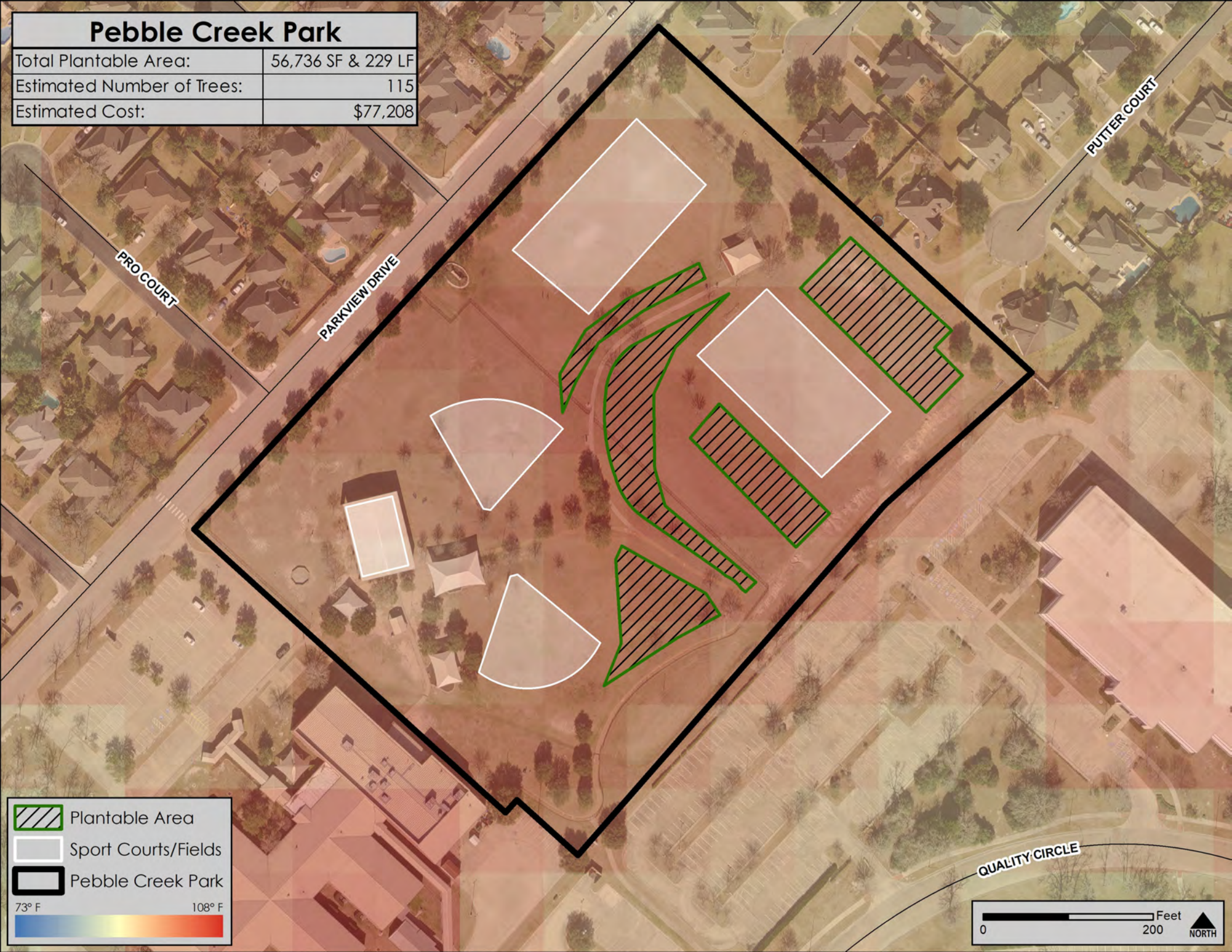
Contact: Mickey Merritt
979-458-6650
MMERRITT@TFS.TAMU.EDU

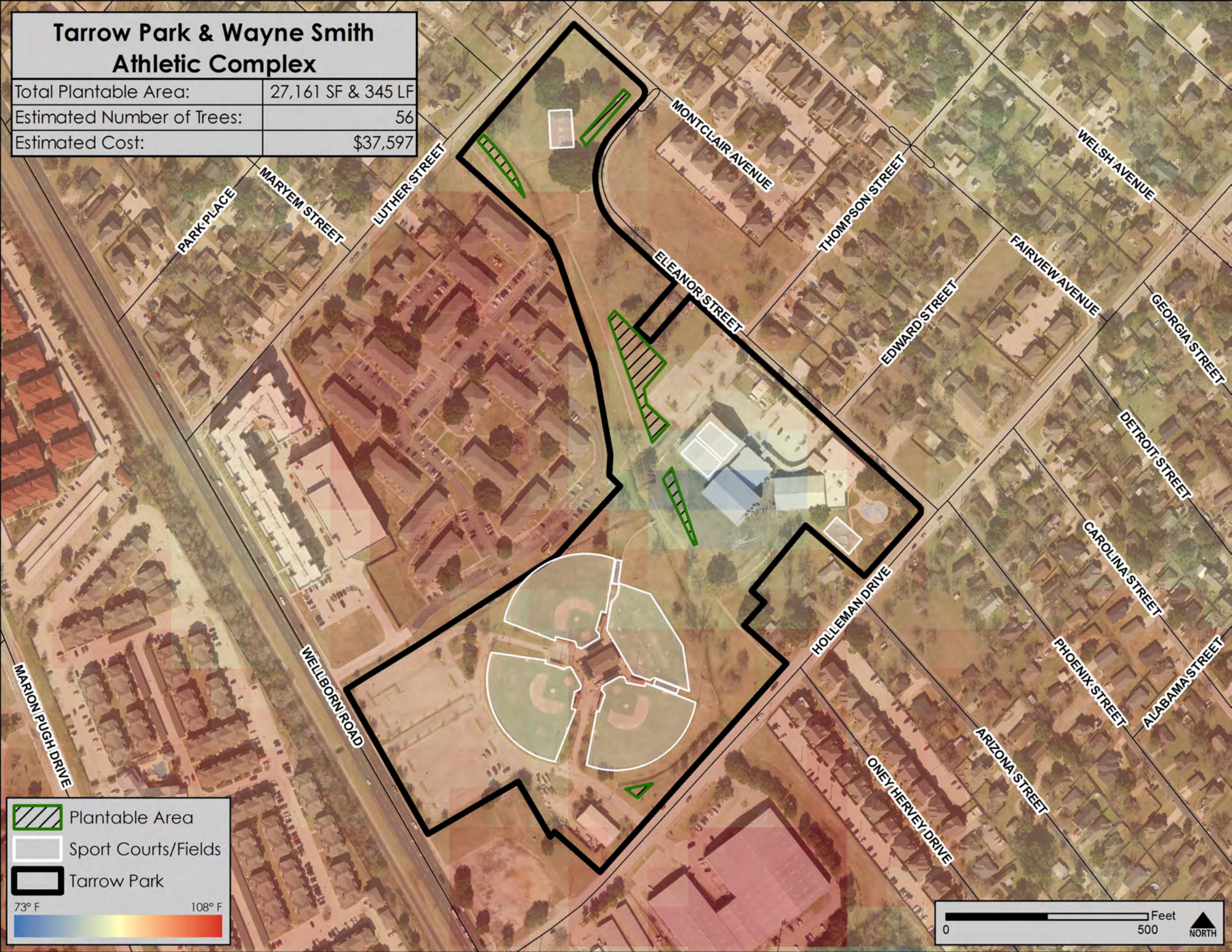

Edelweiss Park
Total Plantable Area: 92,108 SF & 739 LF
Estimated Number of Trees: 198
Estimated Cost: $132,931
APPENDIX:
Priority Planting Area Maps
BRUSSELS DRIVE
GRAZ DRIVE
VIENNA DRIVE
EDELWEISS AVENUE
MORTIER DRIVE
VICTORIA AVENUE
CHANTAL CIRCLE
GRAHAM ROAD
Plantable Area
Sport Courts/Fields
Edelweiss Park
73° F
108° F
Feet
0
250
NORTH

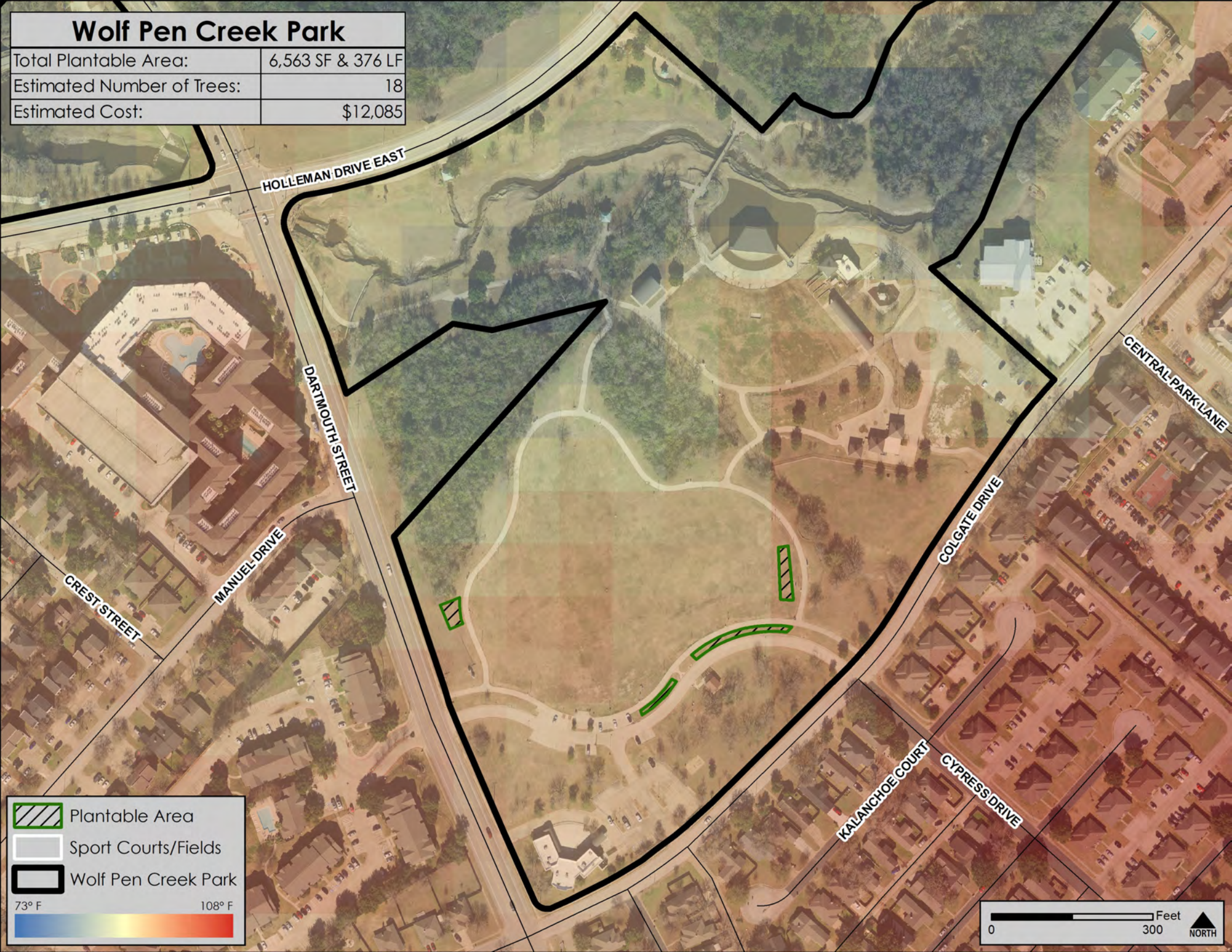

Sandstone Park
Total Plantable Area: 141,079 SF & 80 LF
Estimated Number of Trees: 288
Estimated Cost: $193,355
GREENWOOD DRIVE
BENT TREE DRIVE
ROSEBUD COURT
SEBESTA ROAD
SANDSTONE DRIVE
OAKWOOD TRAIL
Plantable Area
Sport Courts/Fields
Sandstone Park
73° F
108° F
0
300
Feet
NORTH

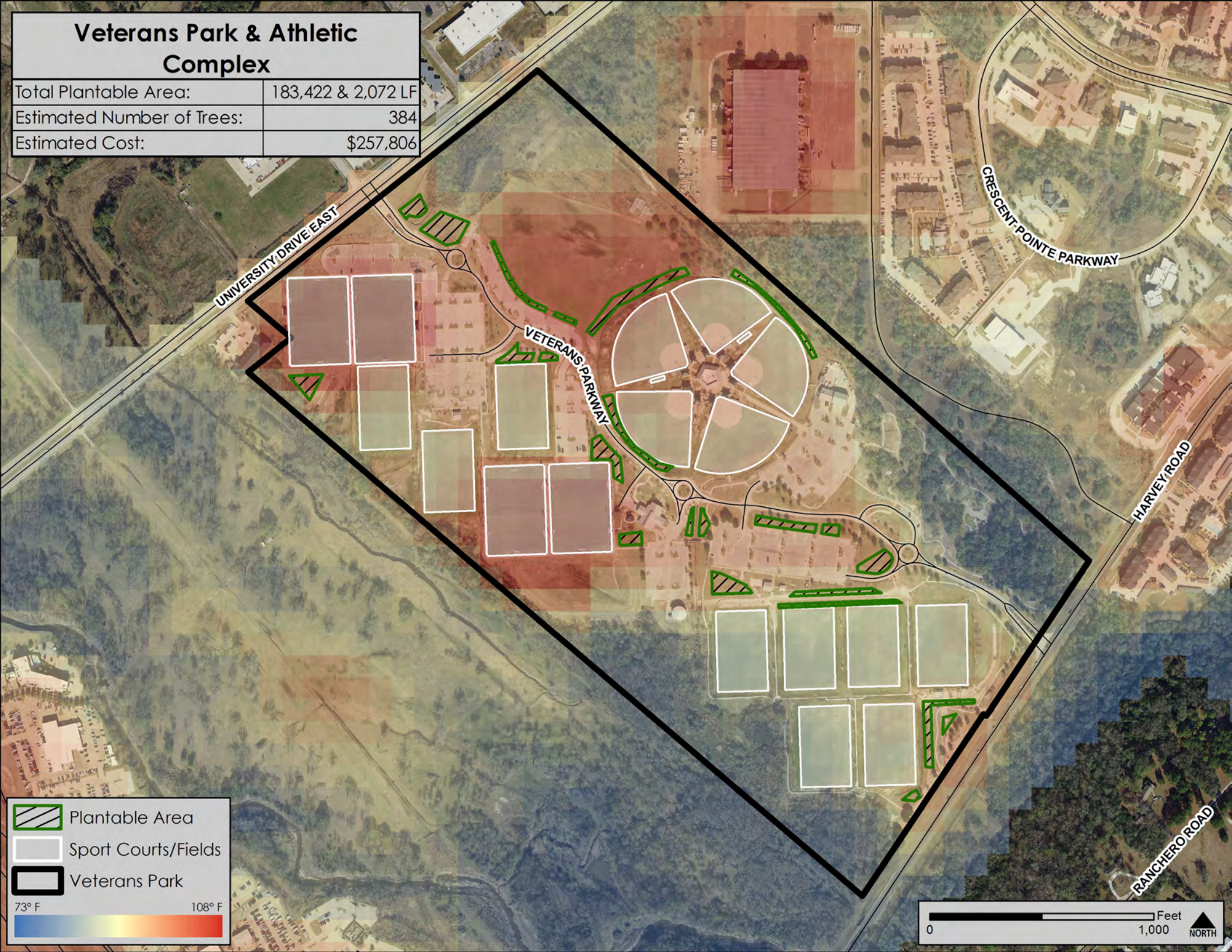

Edelweiss Gartens Park
Total Plantable Area: 73,340 SF & 314 LF
Estimated Number of Trees: 155
Estimated Cost: $104,062
VICTORIA AVENUE
NIGHT RAIN DRIVE
SNOWDANCE COURT
ESSEN LOOP
RANSBERG COURT
KARTEN LANE
HARTFORD DRIVE
ROBELMONT DRIVE
EAGLE AVENUE
FAIMES COURT
RUGEN LANE
SANTOUR COURT
LATINNE COURT
MEIR LANE
RENEE LANE
LATINNE LANE
BRANDENBURG LANE
PASSENDALE LANE
WALCOURT LOOP
DEVRNE DRIVE
LIENZ LANE
Plantable Area
Sport Courts/Fields
Edelweiss Gartens Park
73° F
108° F
0
400
Feet
NORTH

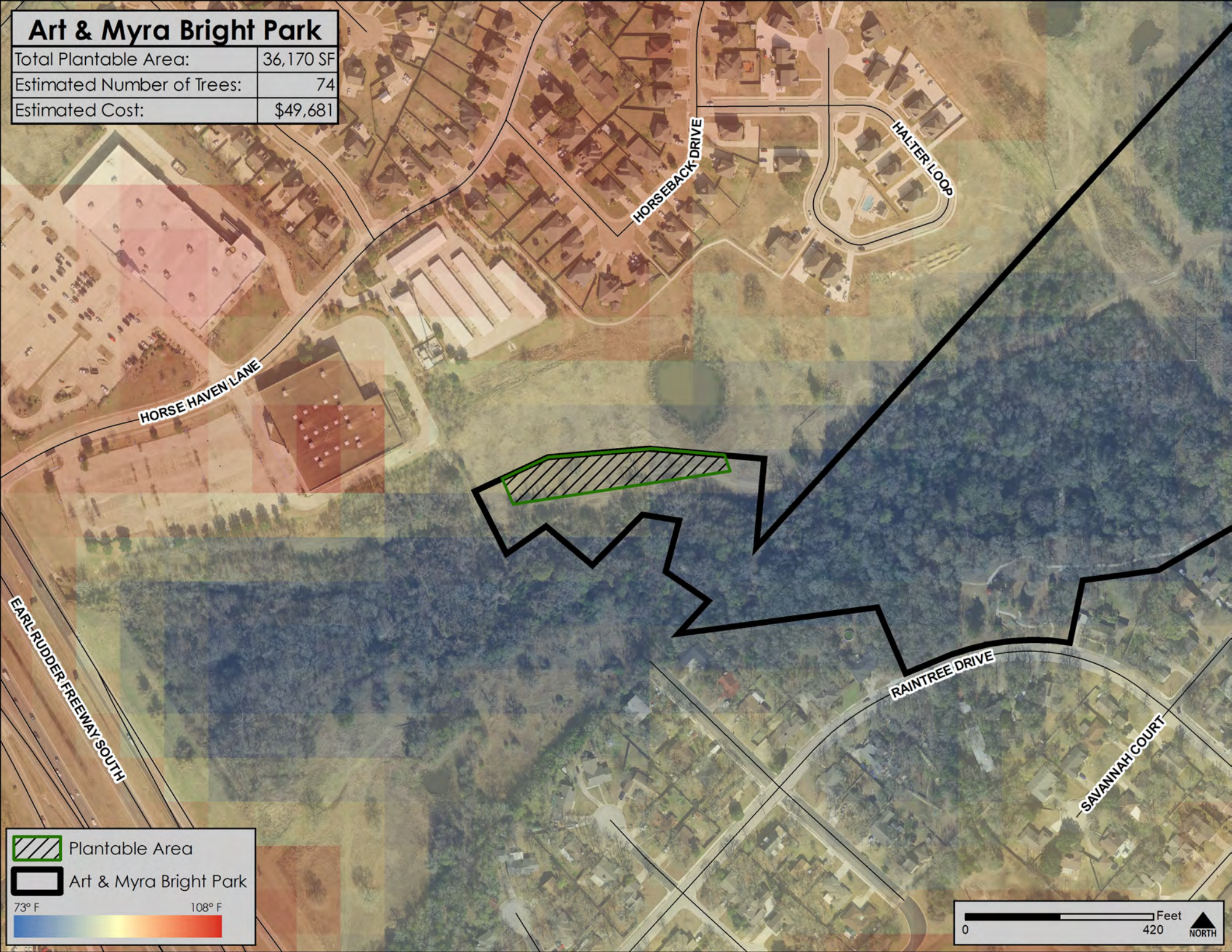

Anderson Park
Total Plantable Area: 31,355 SF & 1,887 LF
Estimated Number of Trees: 75
Estimated Cost: $50,353
ANDERSON STREET
VILLAGE DRIVE
HOLLEMAN DRIVE
SKRIVANEK COURT
HOLIK DRIVE
SUNNY COURT
Plantable Area
Sport Courts/Fields
Anderson Park
73° F
108° F
0
200
Feet
NORTH

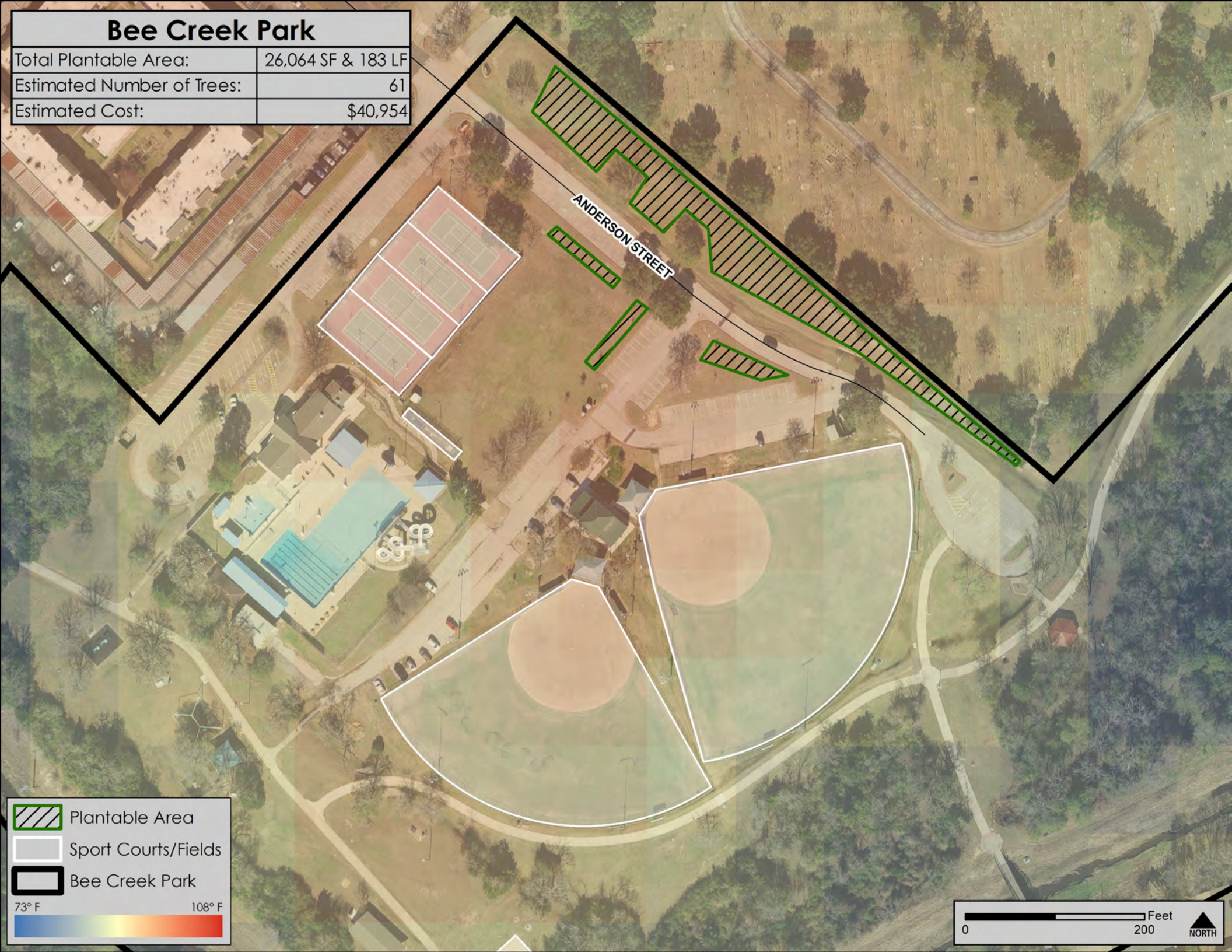

Pebble Creek Park
Total Plantable Area: 56,736 SF & 229 LF
Estimated Number of Trees: 115
Estimated Cost: $77,208
PRO COURT
PARKVIEW DRIVE
PUTTER COURT
QUALITY CIRCLE
Plantable Area
Sport Courts/Fields
Pebble Creek Park
73° F
108° F
Feet
0
200
NORTH

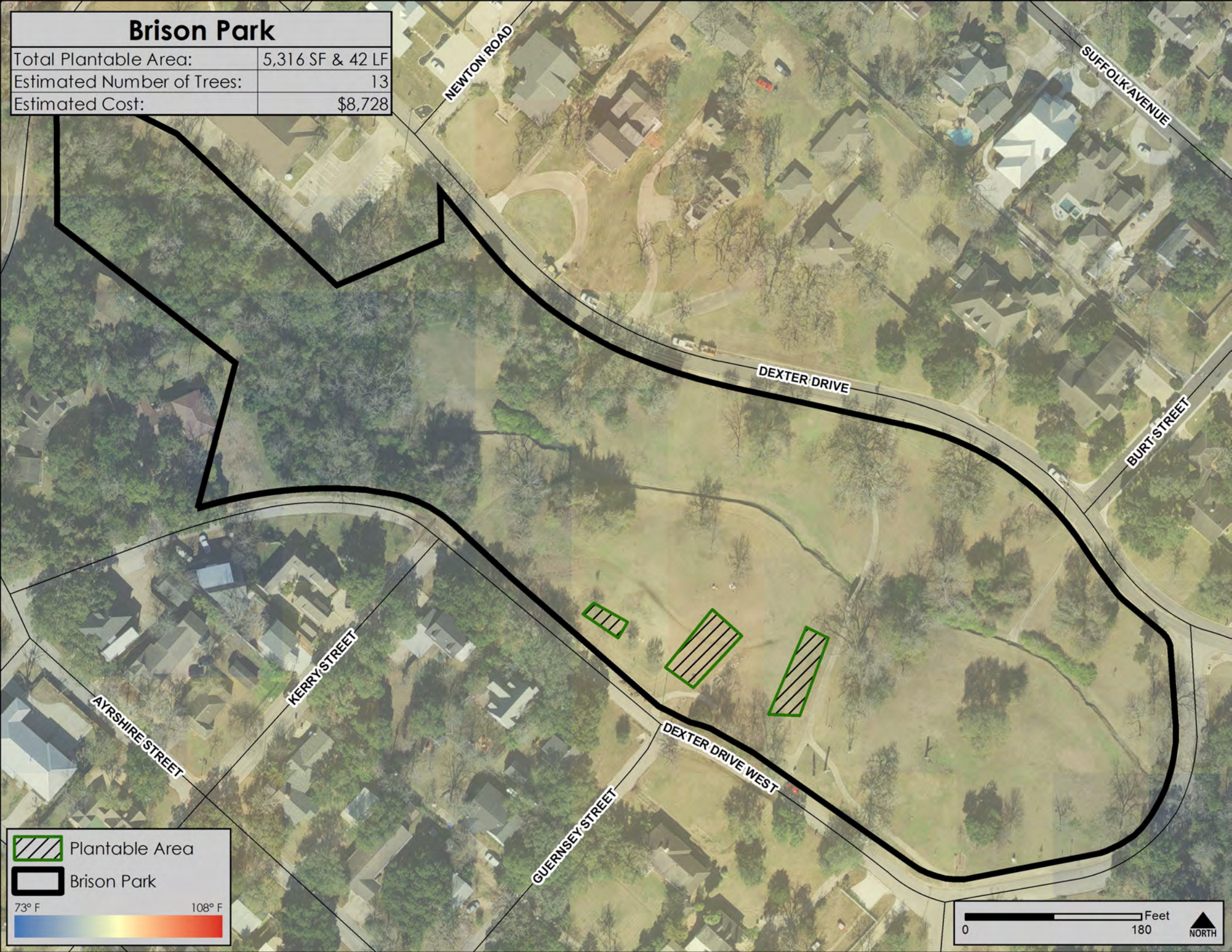

Tarrow Park & Wayne Smith Athletic Complex
Total Plantable Area: 27,161 SF & 345 LF
Estimated Number of Trees: 56
Estimated Cost: $37,597
MONTCLAIR AVENUE
WELSH AVENUE
THOMPSON STREET
FAIRVIEW AVENUE
EDWARD STREET
GEORGIA STREET
DETROIT STREET
CAROLINA STREET
PHOENIX STREET
ALABAMA STREET
ARIZONA STREET
ONEY HERVEY DRIVE
HOLLEMAN DRIVE
ELEANOR STREET
LUTHER STREET
MARYEM STREET
PARK PLACE
WELLBORN ROAD
MARION PUGH DRIVE
Plantable Area
Sport Courts/Fields
Tarrow Park
73° F
108° F
Feet
0
500
NORTH

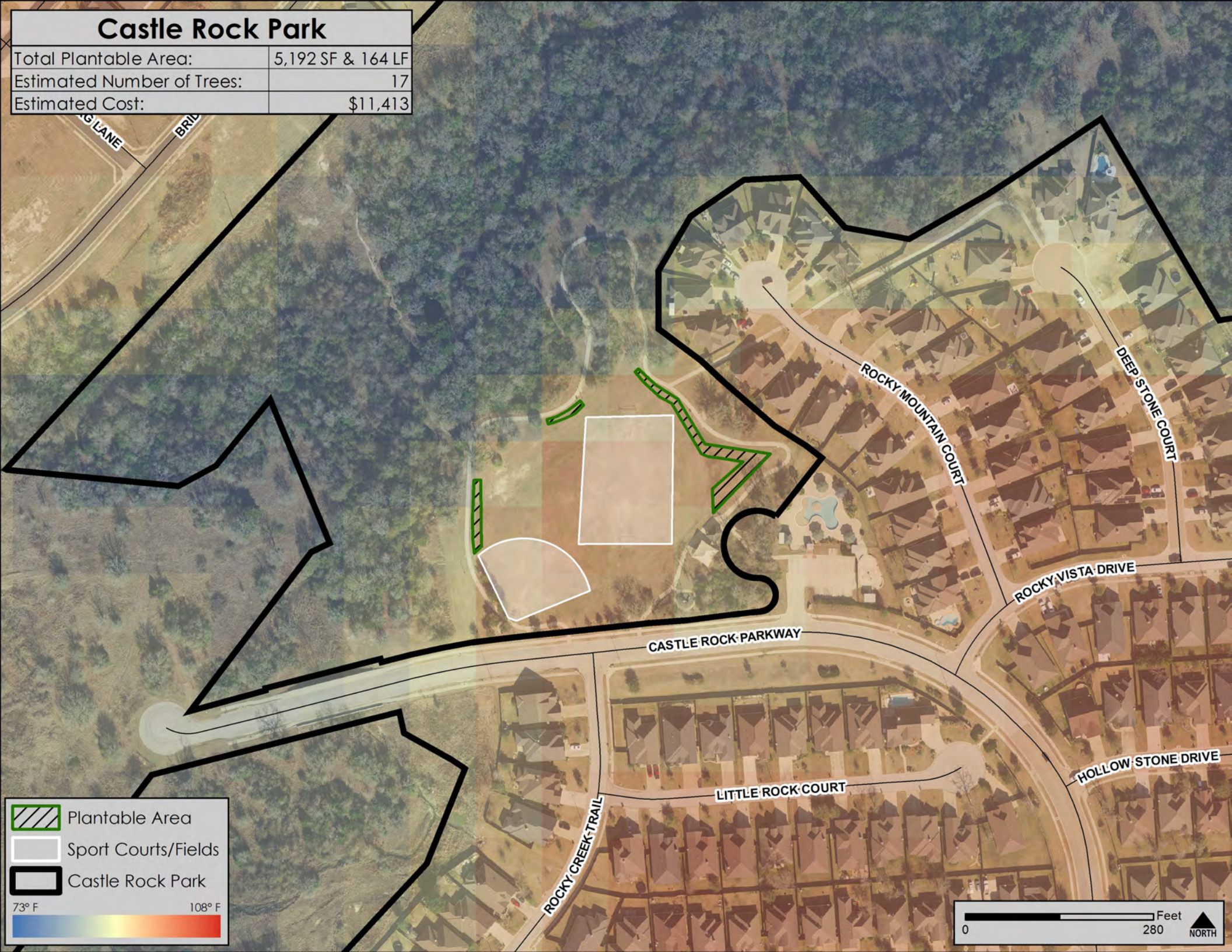

Wolf Pen Creek Park
Total Plantable Area: 6,563 SF & 376 LF
Estimated Number of Trees: 18
Estimated Cost: $12,085
HOLLEMAN DRIVE EAST
DARTMOUTH STREET
MANUEL DRIVE
CREST STREET
COLGATE DRIVE
CENTRAL PARK LANE
KALANCHOE COURT
CYPRESS DRIVE
Plantable Area
Sport Courts/Fields
Wolf Pen Creek Park
73° F
108° F
Feet
0
300
NORTH

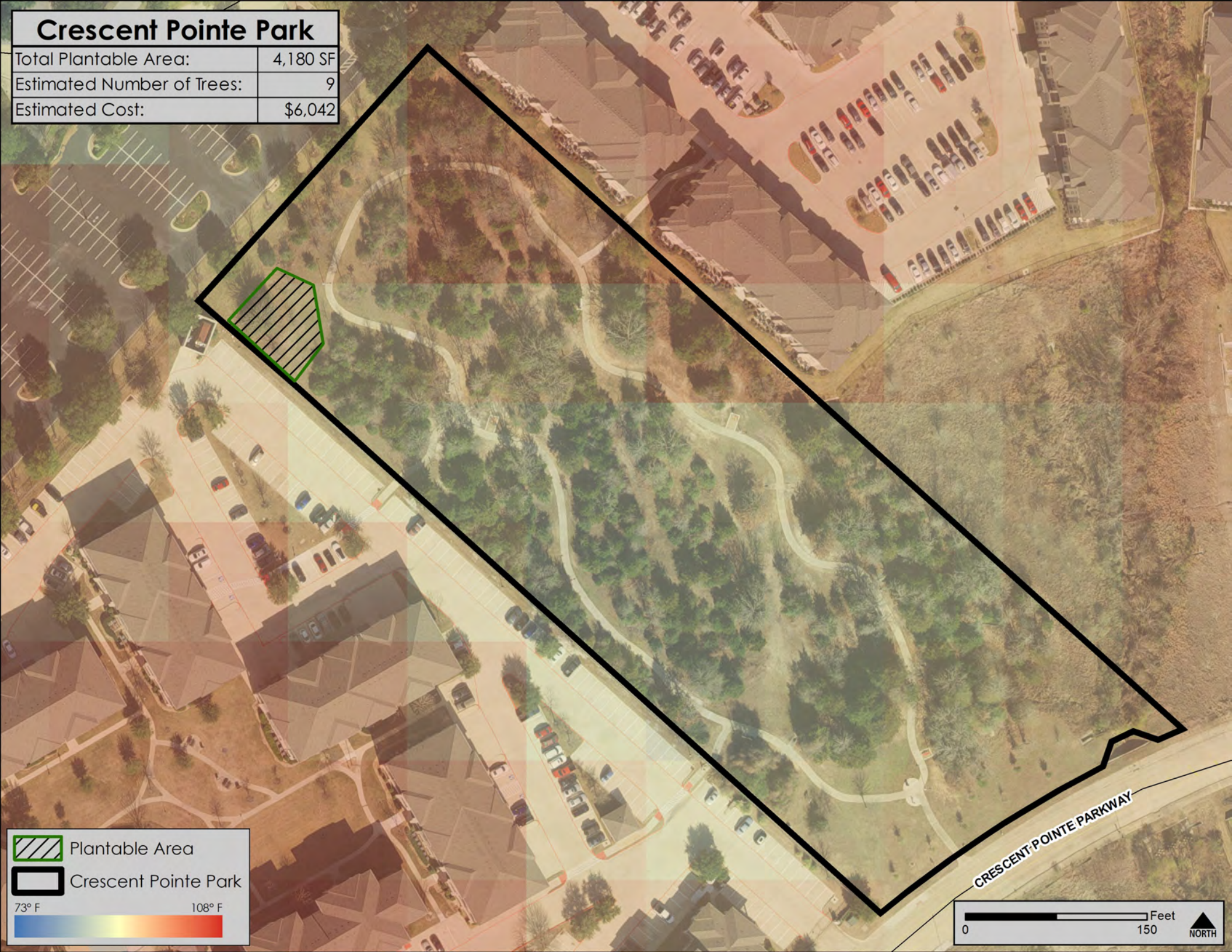

Veterans Park & Athletic Complex
Total Plantable Area: 183,422 & 2,072 LF
Estimated Number of Trees: 384
Estimated Cost: $257,806
UNIVERSITY DRIVE EAST
VETERANS PARKWAY
CRESCENT POINTE PARKWAY
HARVEY ROAD
RANCHERO ROAD
Plantable Area
Sport Courts/Fields
Veterans Park
73° F
108° F
0
1,000
Feet
NORTH

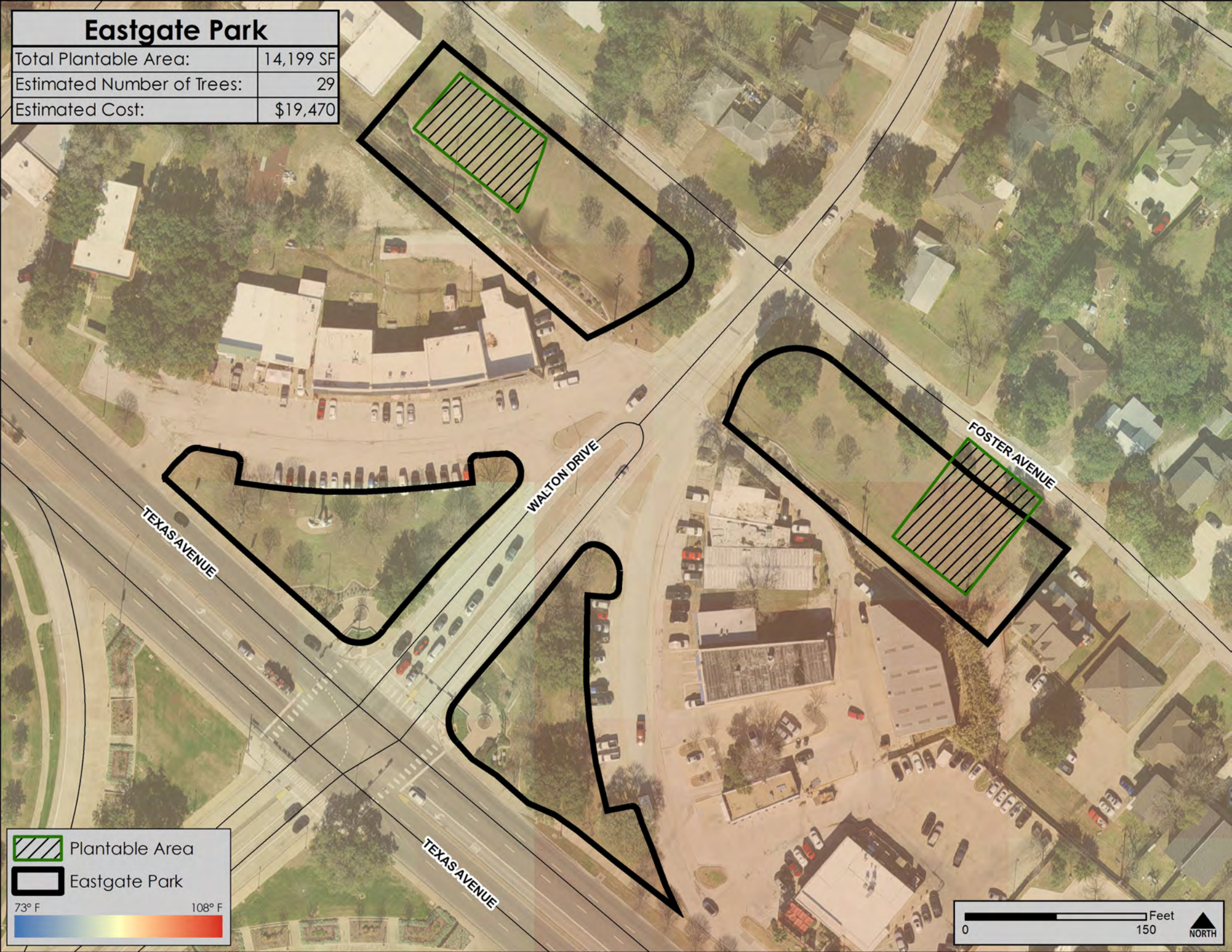

Art & Myra Bright Park
Total Plantable Area: 36,170 SF
Estimated Number of Trees: 74
Estimated Cost: $49,681
HORSEBACK DRIVE
HALTER LOOP
HORSE HAVEN LANE
EARL RUDDER FREEWAY SOUTH
RAINTREE DRIVE
SAVANNAH COURT
Plantable Area
Art & Myra Bright Park
73° F
108° F
Feet
0
420
NORTH

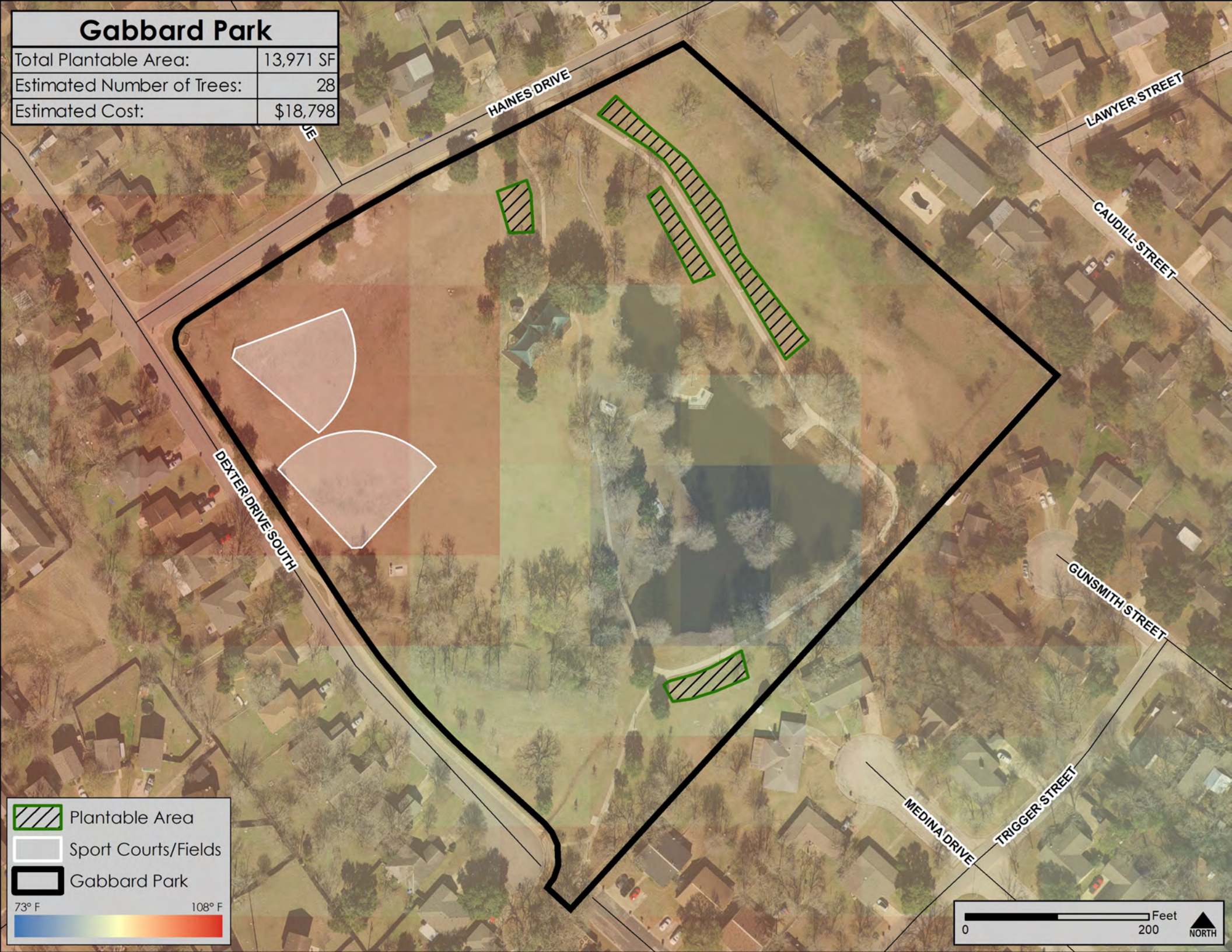

Bee Creek Park
Total Plantable Area: 26,064 SF & 183 LF
Estimated Number of Trees: 61
Estimated Cost: $40,954
ANDERSON STREET
Plantable Area
Sport Courts/Fields
Bee Creek Park
73° F
108° F
Feet
0
200
NORTH

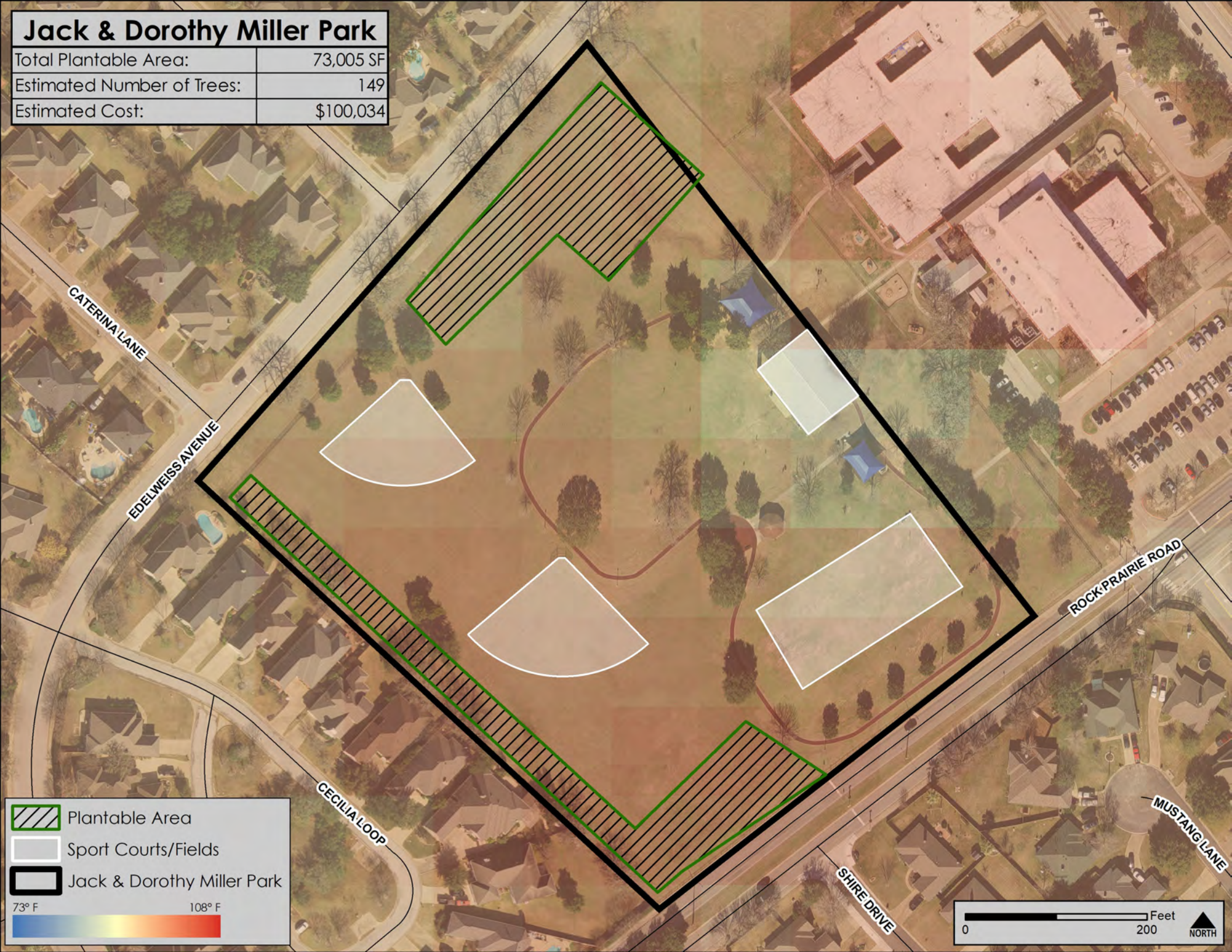

Brison Park
Total Plantable Area: 5,316 SF & 42 LF
Estimated Number of Trees: 13
Estimated Cost: $8,728
NEWTON ROAD
SUFFOLK AVENUE
DEXTER DRIVE
BURT STREET
KERRY STREET
AYRSHIRE STREET
DEXTER DRIVE WEST
GUERNSEY STREET
Plantable Area
Brison Park
73° F
108° F
0
180
Feet
NORTH

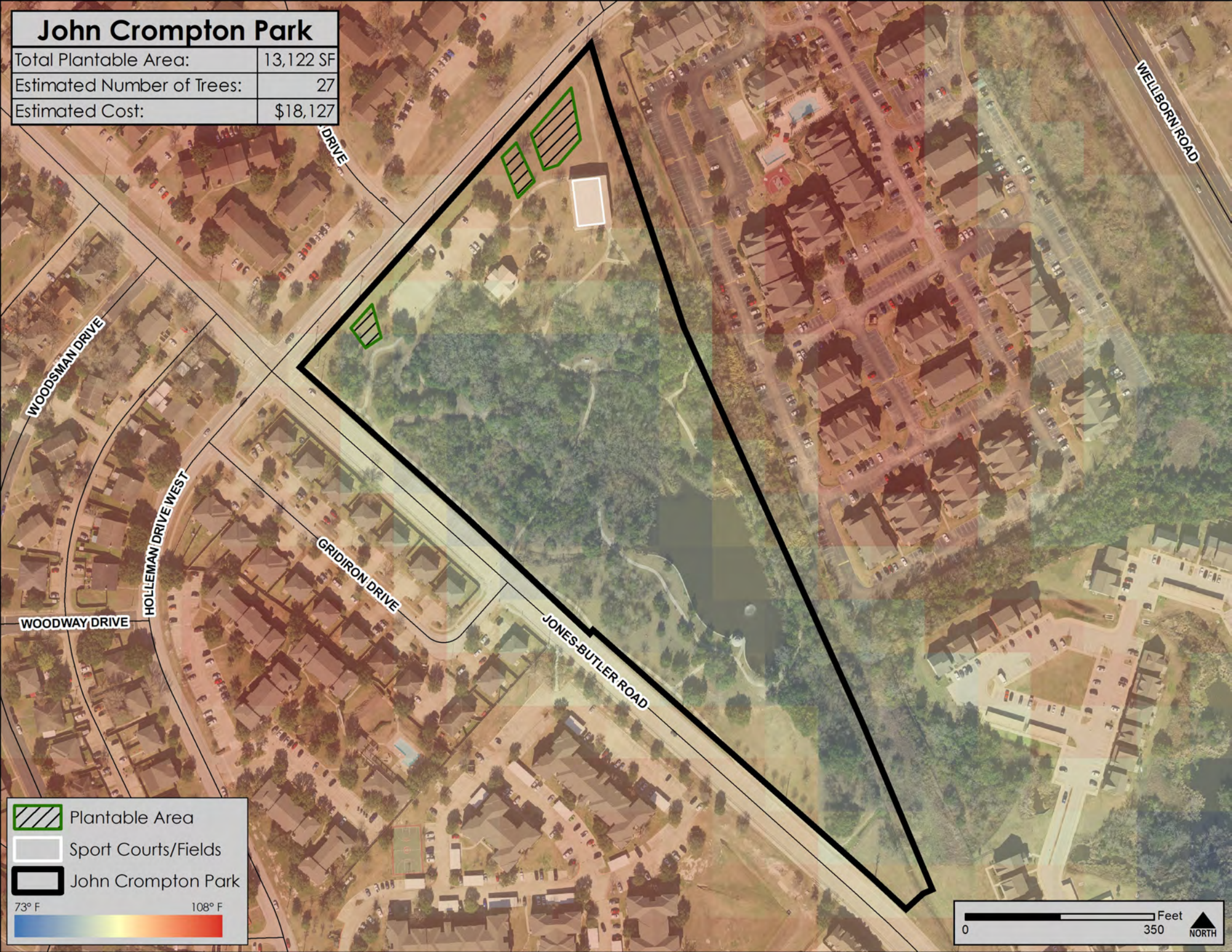

Castle Rock Park
Total Plantable Area: 5,192 SF & 164 LF
Estimated Number of Trees: 17
Estimated Cost: $11,413
ROCKY MOUNTAIN COURT
DEEP STONE COURT
ROCKY VISTA DRIVE
CASTLE ROCK PARKWAY
HOLLOW STONE DRIVE
LITTLE ROCK COURT
ROCKY CREEK TRAIL
Plantable Area
Sport Courts/Fields
Castle Rock Park
73° F
108° F
0
280
Feet
NORTH

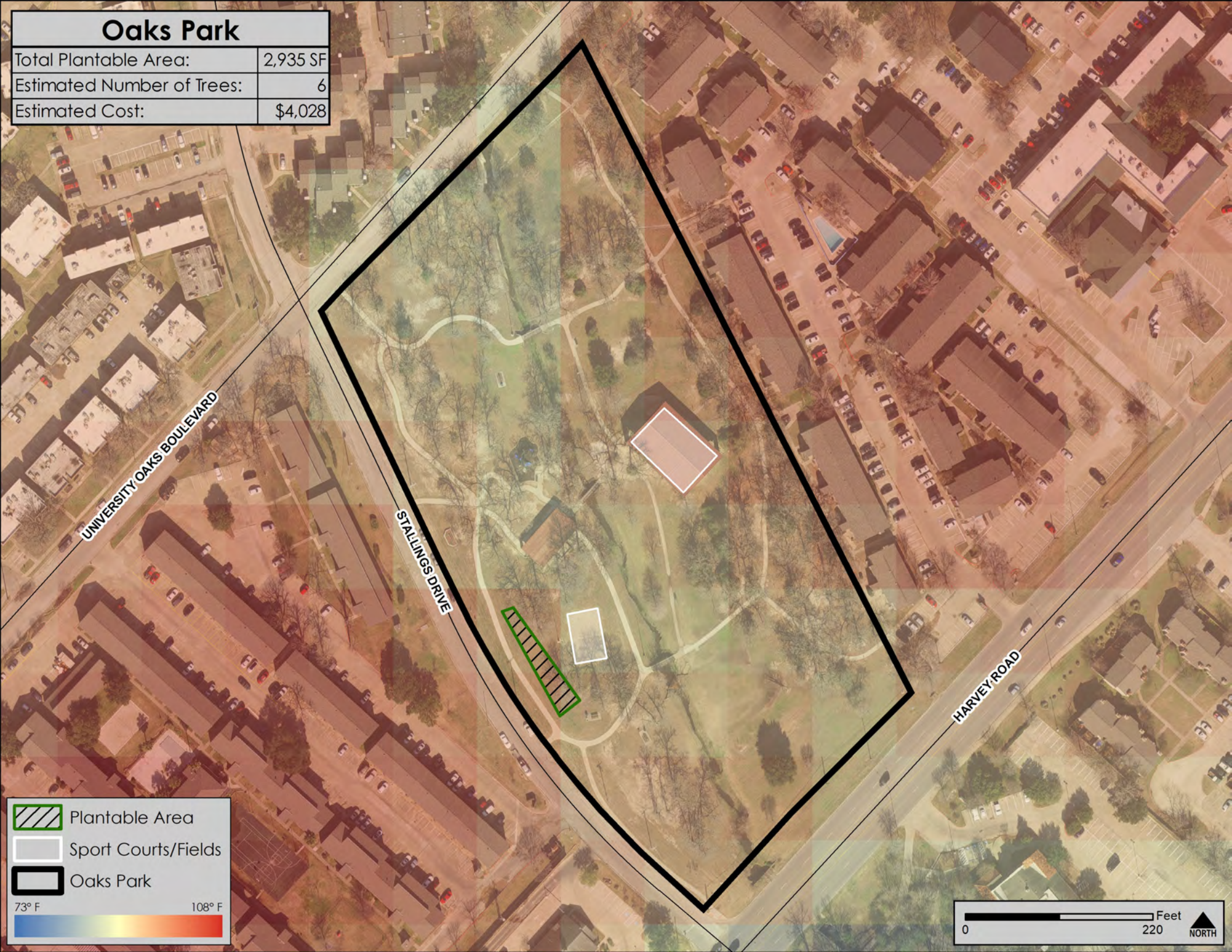

Crescent Pointe Park
Total Plantable Area: 4,180 SF
Estimated Number of Trees: 9
Estimated Cost: $6,042
Plantable Area
Crescent Pointe Park
73° F
108° F
CRESCENT POINTE PARKWAY
0
150
Feet
NORTH

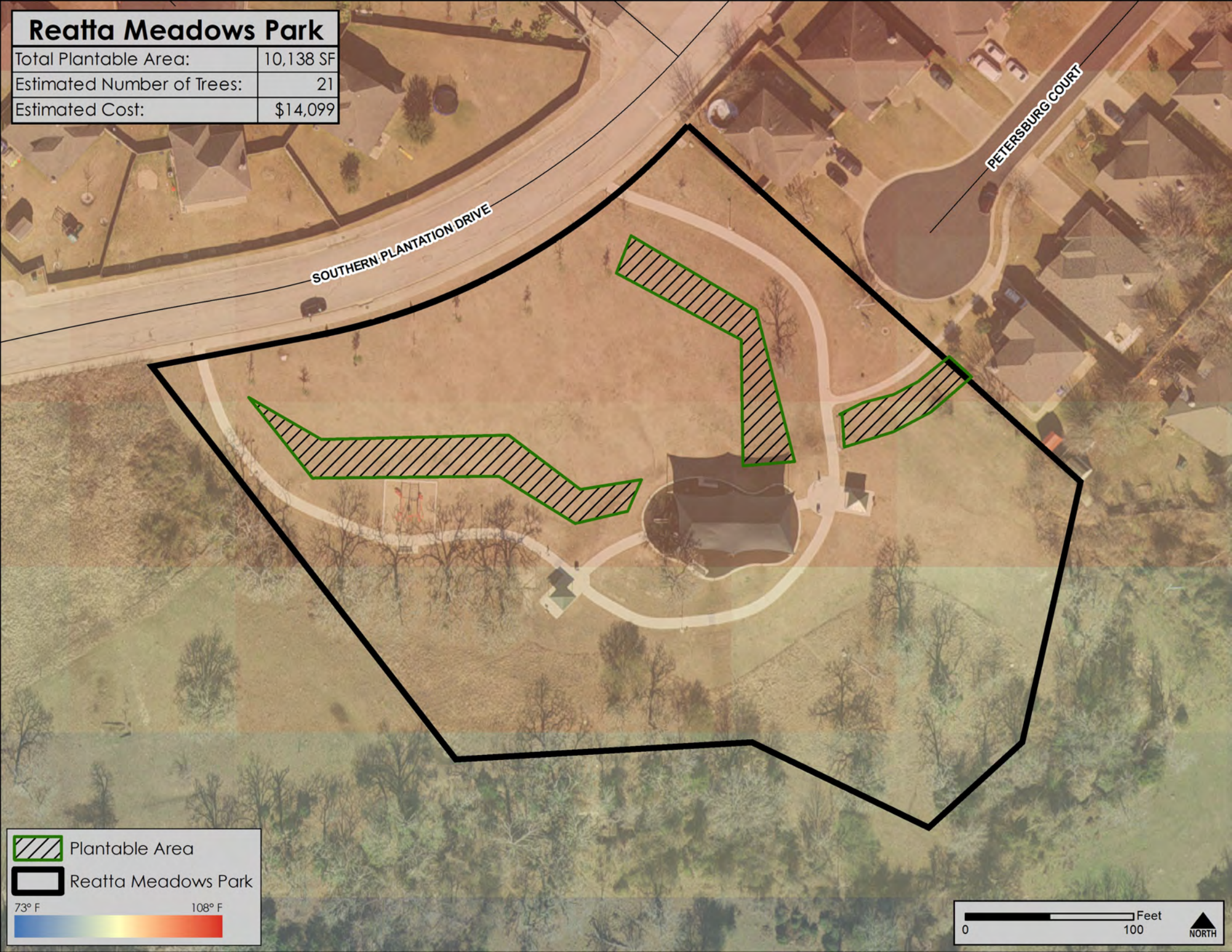

Eastgate Park
Total Plantable Area: 14,199 SF
Estimated Number of Trees: 29
Estimated Cost: $19,470
WALTON DRIVE
FOSTER AVENUE
TEXAS AVENUE
TEXAS AVENUE
Plantable Area
Eastgate Park
73° F
108° F
Feet
0
150
NORTH


Gabbard Park
Total Plantable Area: 13,971 SF
Estimated Number of Trees: 28
Estimated Cost: $18,798
HAINES DRIVE
LAWYER STREET
CAUDILL STREET
DEXTER DRIVE SOUTH
GUNSMITH STREET
MEDINA DRIVE
TRIGGER STREET
Plantable Area
Sport Courts/Fields
Gabbard Park
73° F
108° F
0
200
Feet
NORTH

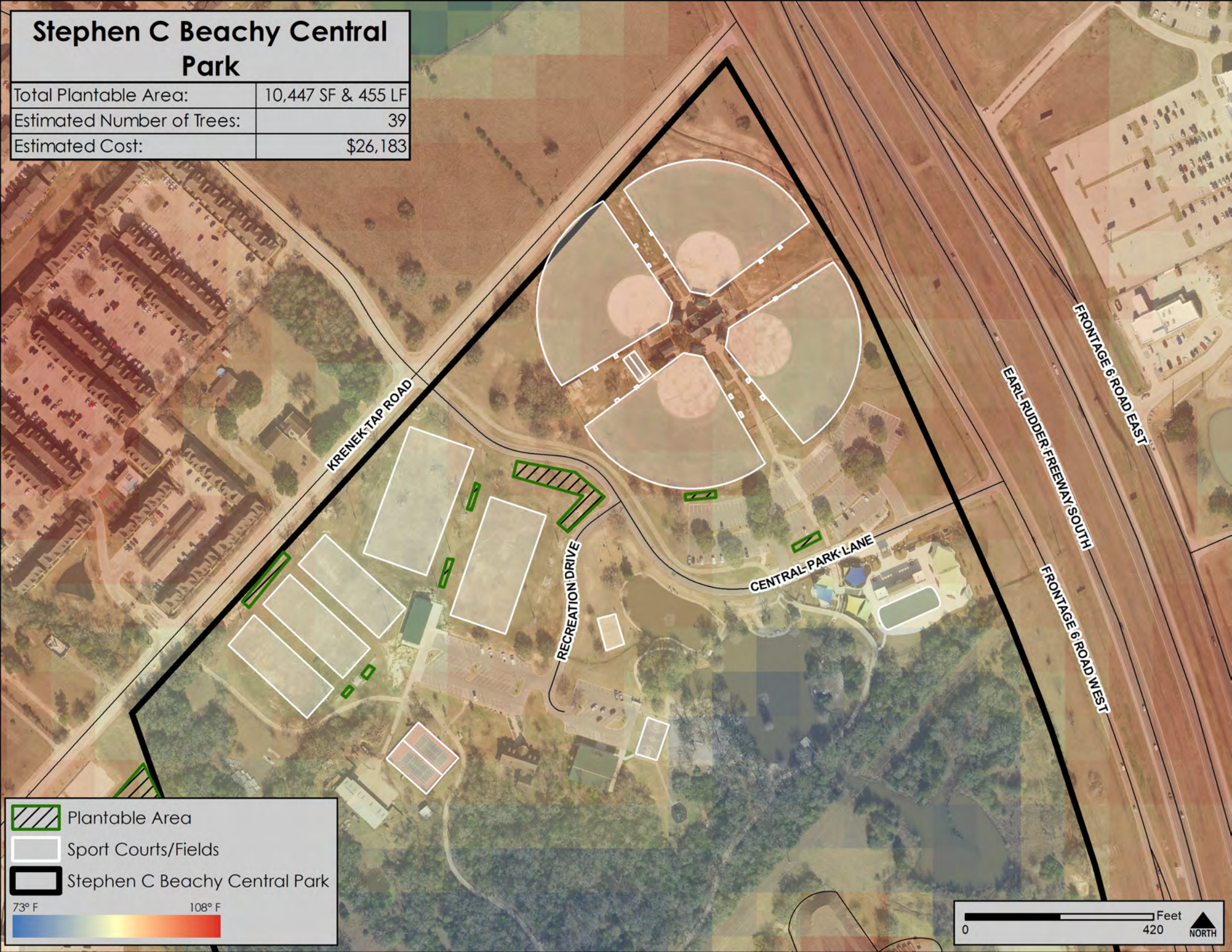

Jack & Dorothy Miller Park
Total Plantable Area: 73,005 SF
Estimated Number of Trees: 149
Estimated Cost: $100,034
CATERINA LANE
EDELWEISS AVENUE
ROCK PRAIRIE ROAD
CECILIA LOOP
SHIRE DRIVE
MUSTANG LANE
Plantable Area
Sport Courts/Fields
Jack & Dorothy Miller Park
73° F
108° F
0
200
Feet
NORTH

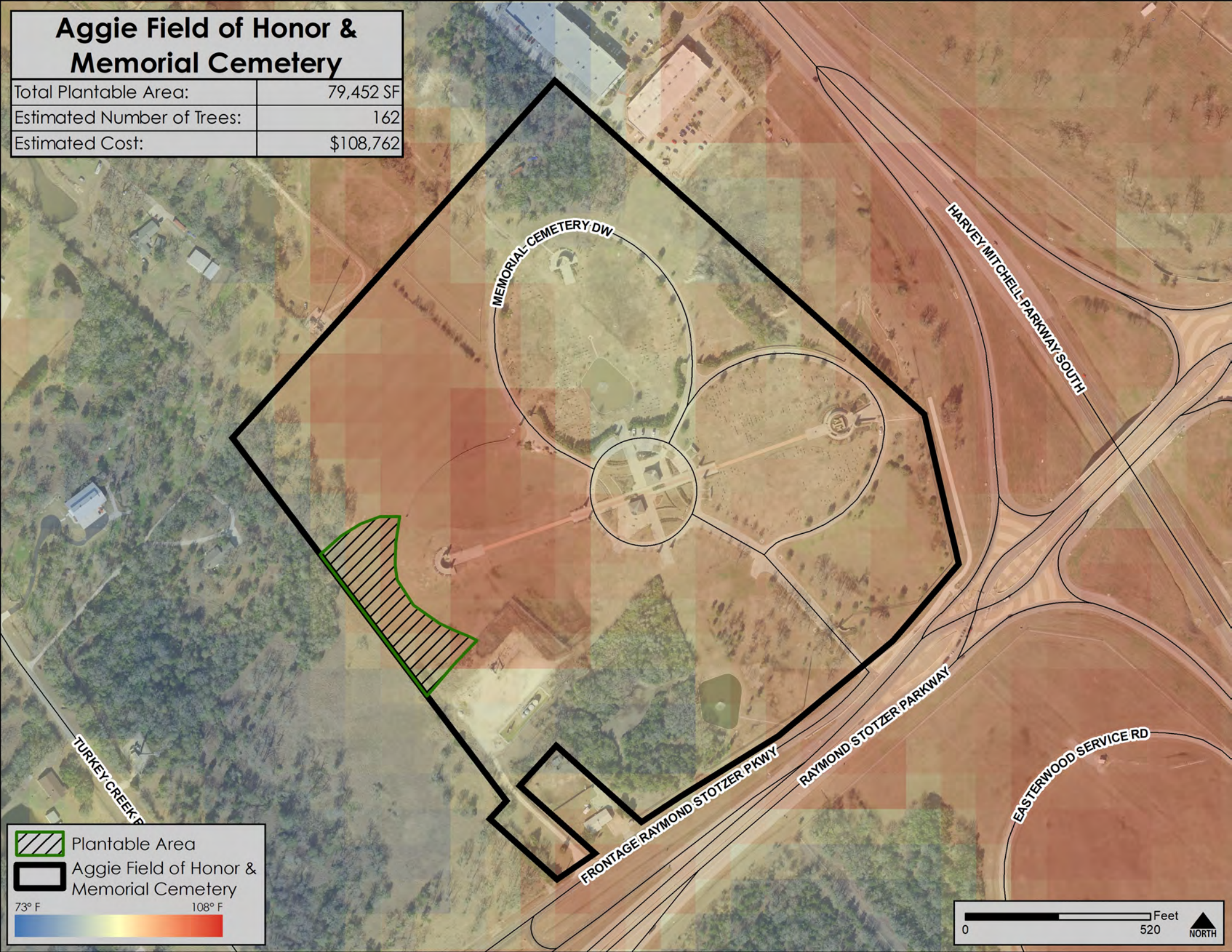

John Crompton Park
Total Plantable Area: 13,122 SF
Estimated Number of Trees: 27
Estimated Cost: $18,127
WELLBORN ROAD
WOODSMAN DRIVE
HOLLEMAN DRIVE WEST
GRIDIRON DRIVE
WOODWAY DRIVE
JONES-BUTLER ROAD
Plantable Area
Sport Courts/Fields
John Crompton Park
73° F
108° F
Feet
0
350
NORTH

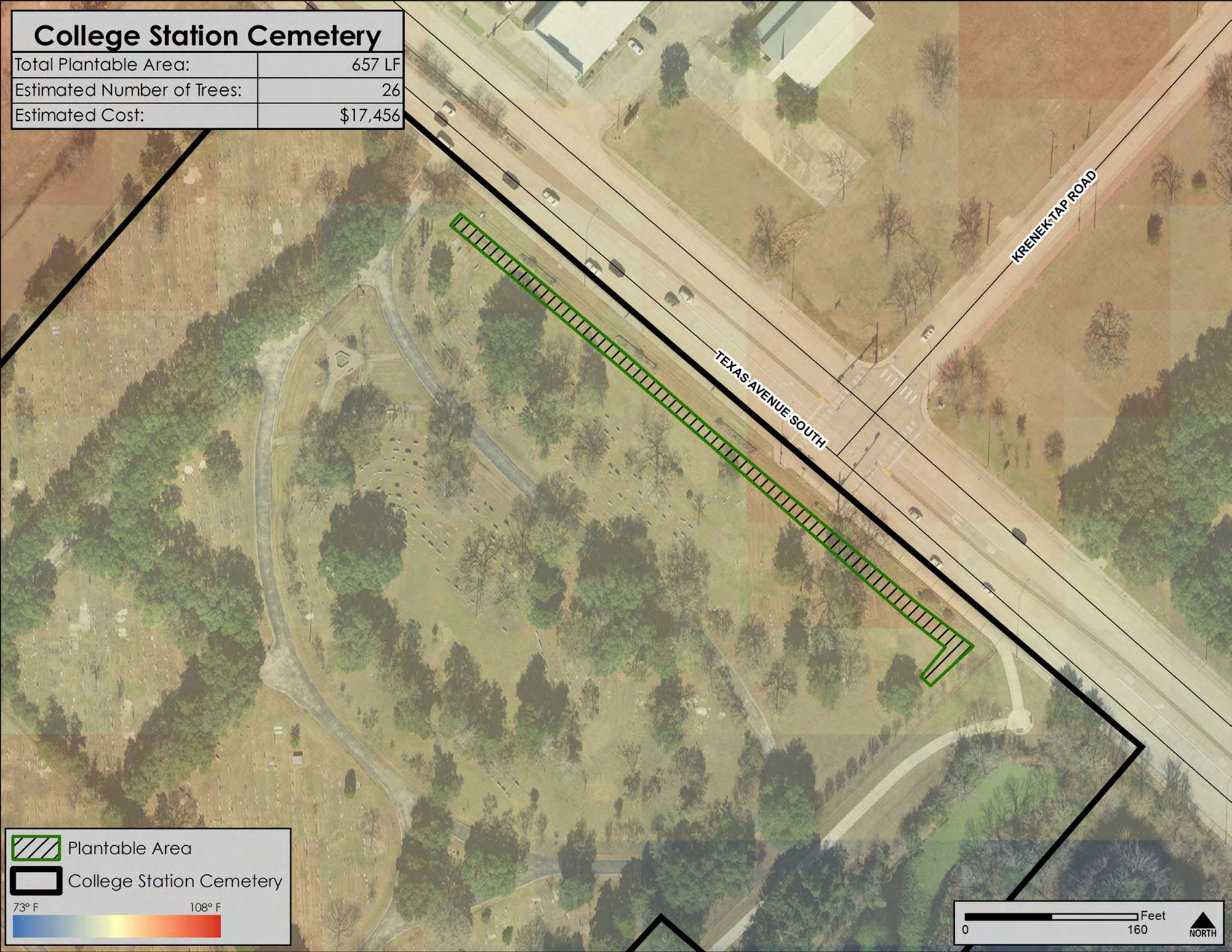

Oaks Park
Total Plantable Area: 2,935 SF
Estimated Number of Trees: 6
Estimated Cost: $4,028
UNIVERSITY OAKS BOULEVARD
STALLINGS DRIVE
HARVEY ROAD
Plantable Area
Sport Courts/Fields
Oaks Park
73° F
108° F
Feet
0
220
NORTH


Reatta Meadows Park
Total Plantable Area: 10,138 SF
Estimated Number of Trees: 21
Estimated Cost: $14,099
SOUTHERN PLANTATION DRIVE
PETERSBURG COURT
Plantable Area
Reatta Meadows Park
73° F
108° F
0
100
Feet
NORTH


Richard Carter Park
Total Plantable Area: 15,387 SF
Estimated Number of Trees: 31
Estimated Cost: $20,812
BRAZOSWOOD DRIVE
FRONTAGE 6 ROAD WEST
EARL RUDDER FREEWAY SOUTH
GLENHAVEN DRIVE
COUGAR COURT
Plantable Area
Richard Carter Park
73° F
108° F
0
160
Feet
NORTH

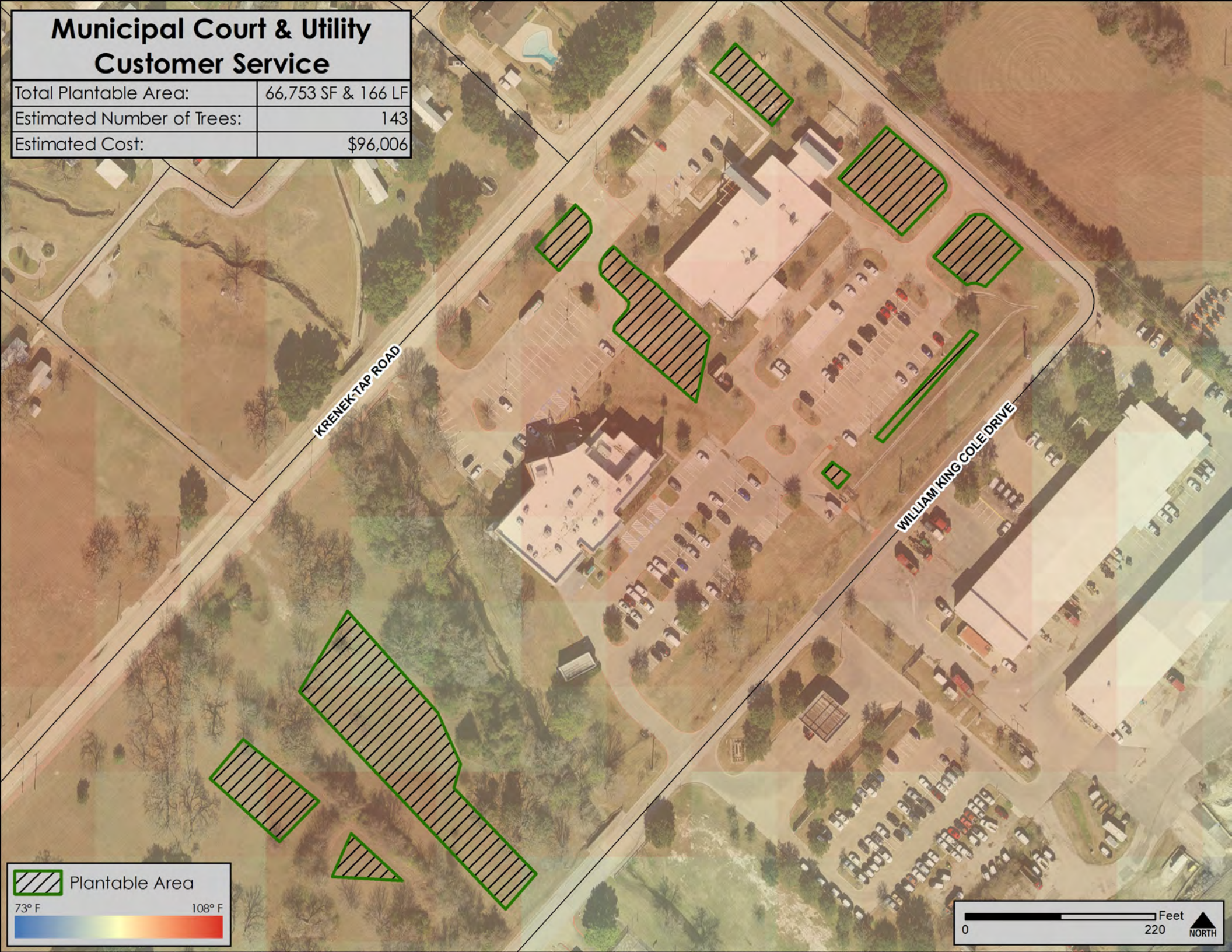

Stephen C Beachy Central Park
Total Plantable Area: 10,447 SF & 455 LF
Estimated Number of Trees: 39
Estimated Cost: $26,183
KRENEK TAP ROAD
RECREATION DRIVE
CENTRAL PARK LANE
EARL RUDDER FREEWAY SOUTH
FRONTAGE 6 ROAD EAST
FRONTAGE 6 ROAD WEST
Plantable Area
Sport Courts/Fields
Stephen C Beachy Central Park
73° F
108° F
0
420
Feet
NORTH

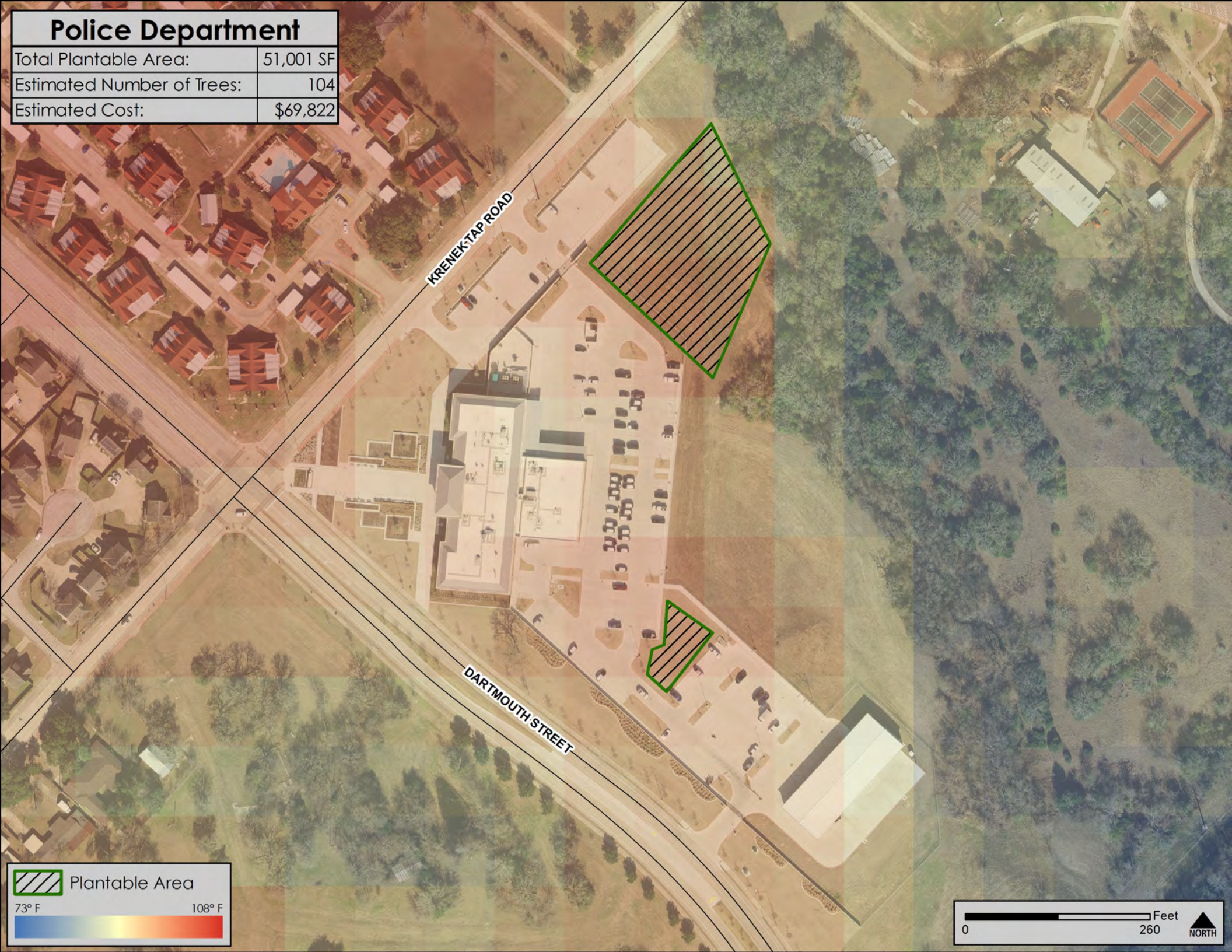

Aggie Field of Honor & Memorial Cemetery
Total Plantable Area: 79,452 SF
Estimated Number of Trees: 162
Estimated Cost: $108,762
MEMORIAL CEMETERY DW
HARVEY MITCHELL PARKWAY SOUTH
TURKEY CREEK R
FRONTAGE RAYMOND STOTZER PKWY
RAYMOND STOTZER PARKWAY
EASTERWOOD SERVICE RD
Plantable Area
Aggie Field of Honor & Memorial Cemetery
73° F
108° F
0
520
Feet
NORTH

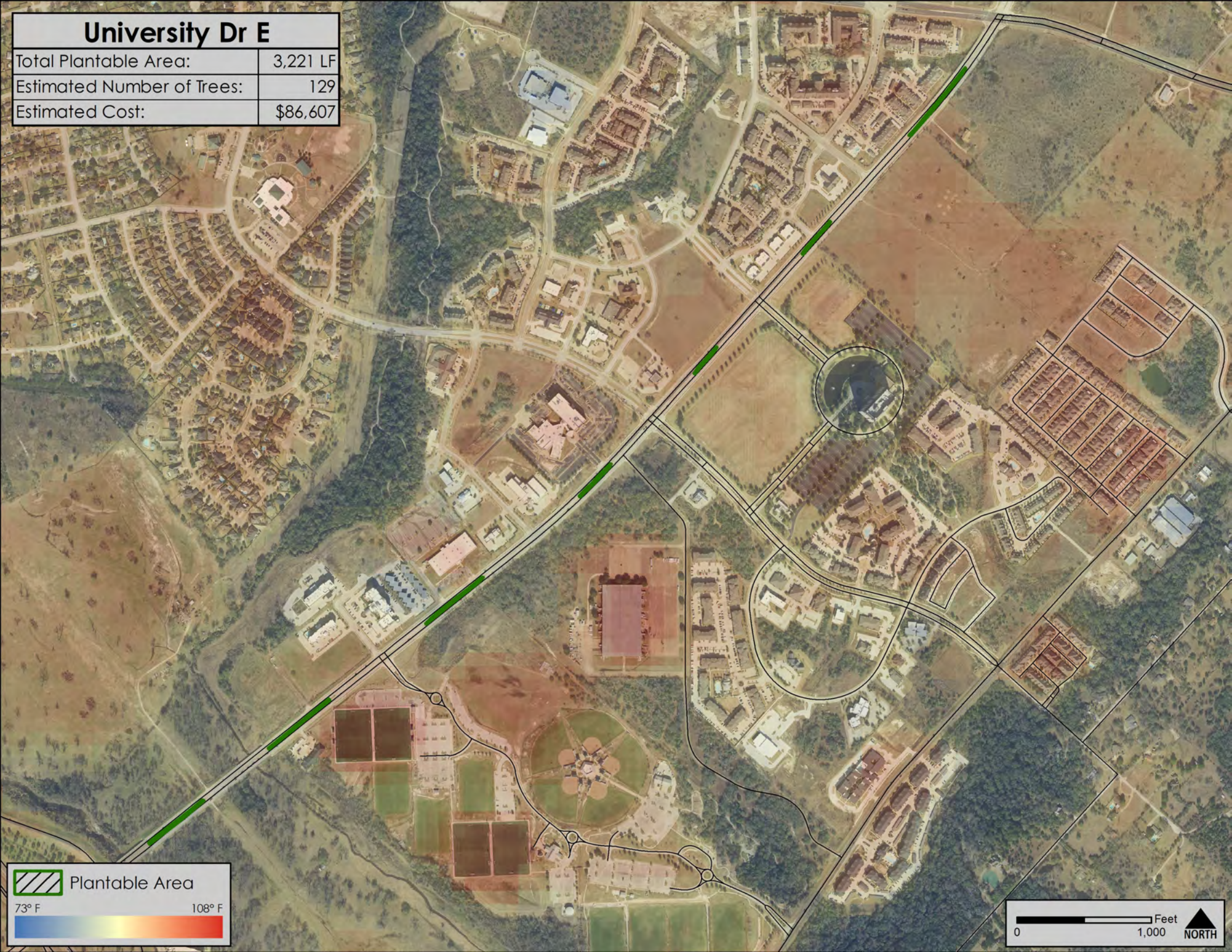

College Station Cemetery
Total Plantable Area: 657 LF
Estimated Number of Trees: 26
Estimated Cost: $17,456
TEXAS AVENUE SOUTH
KRENEK TAP ROAD
Plantable Area
College Station Cemetery
73° F
108° F
0
160
Feet
NORTH

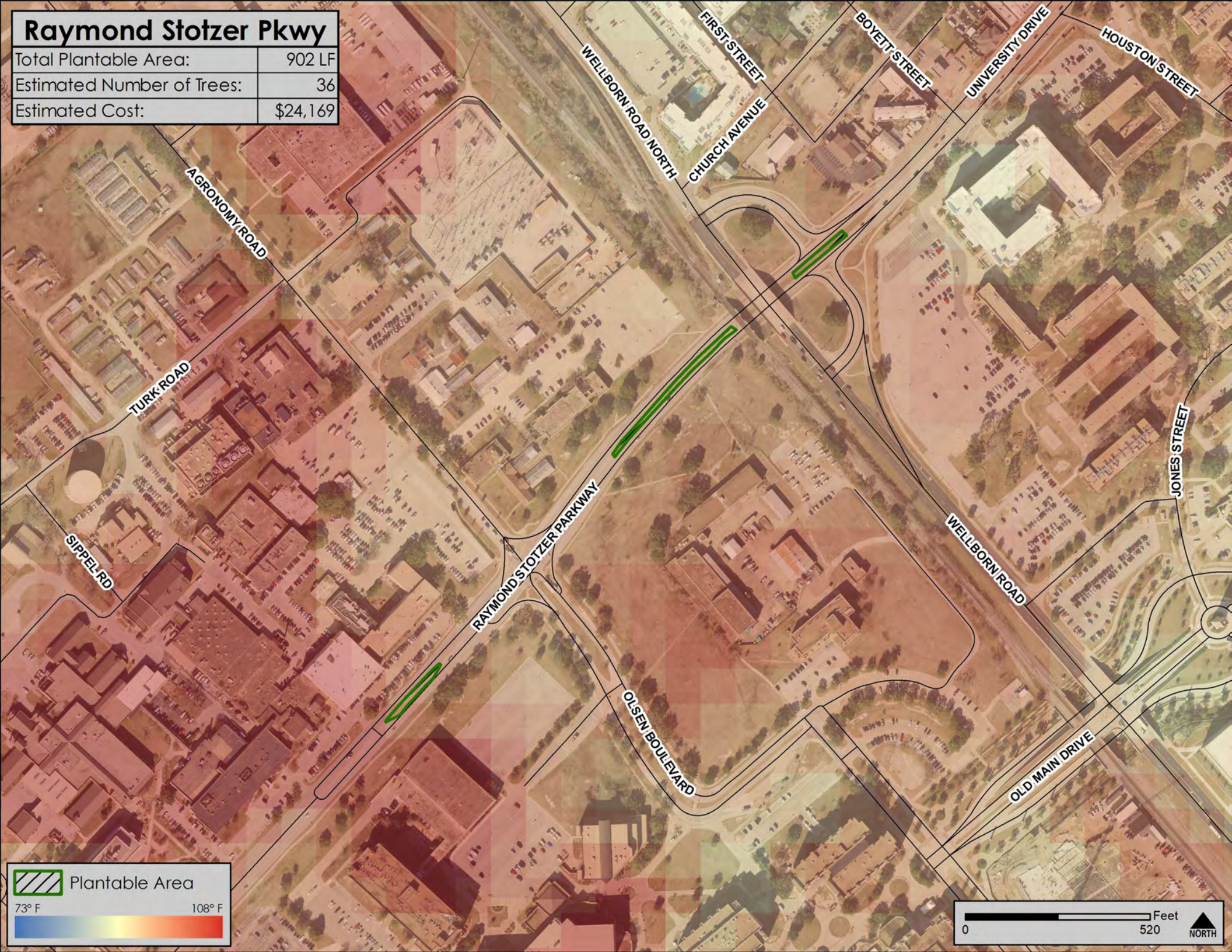
Municipal Court & Utility Customer Service

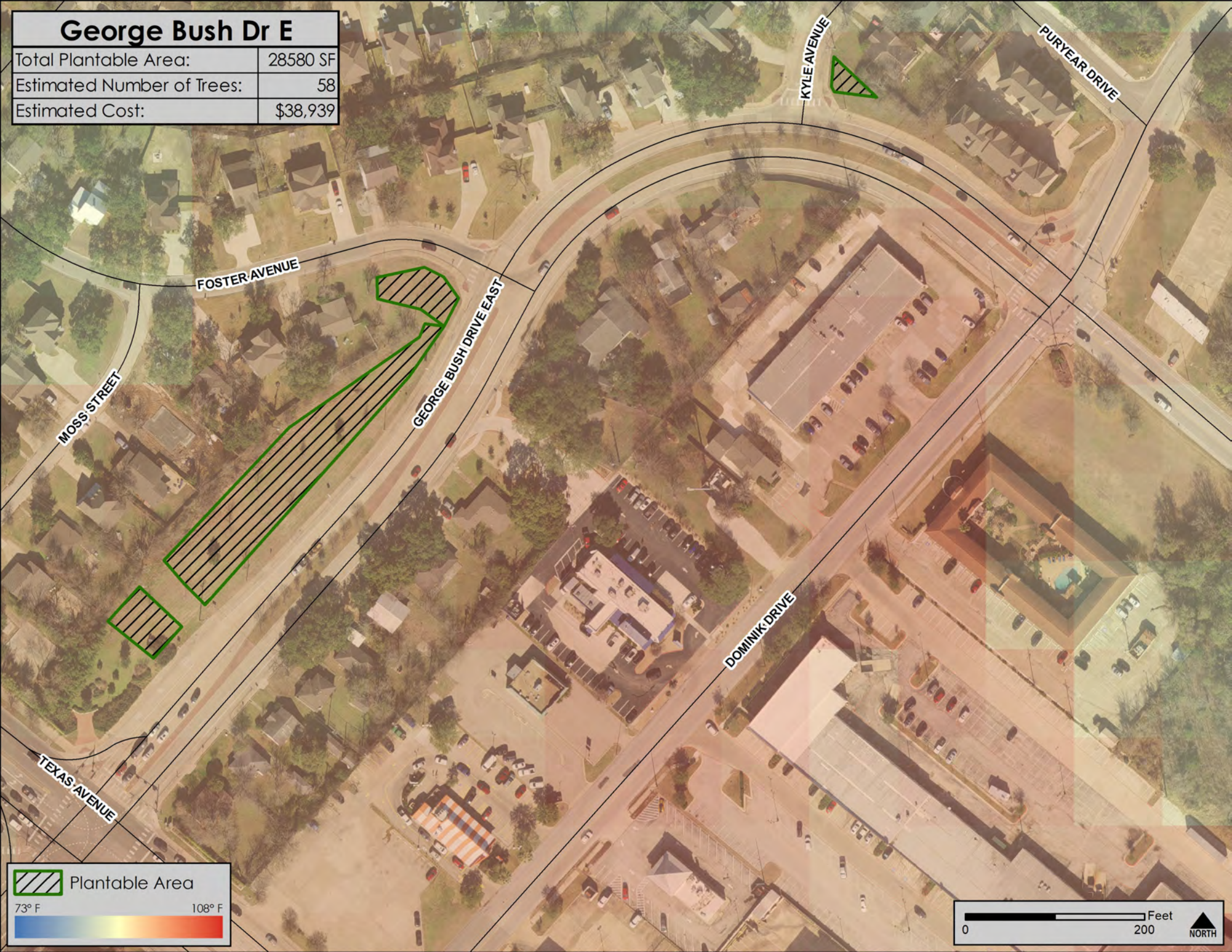
Total Plantable Area:	66,753 SF & 166 LF
Estimated Number of Trees:	143
Estimated Cost:	$96,006

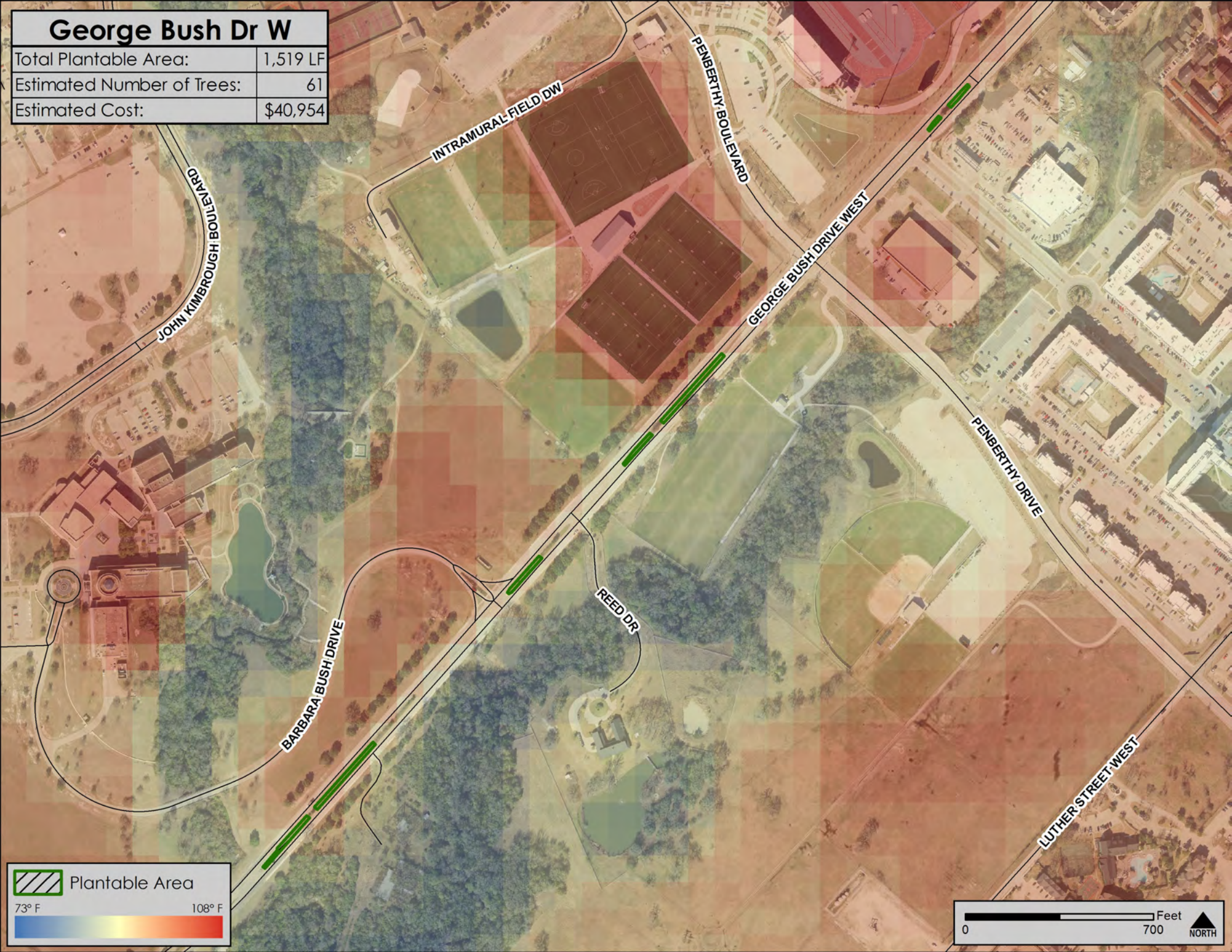



Police Department
Total Plantable Area: 51,001 SF
Estimated Number of Trees: 104
Estimated Cost: $69,822
KRENEK TAP ROAD
DARTMOUTH STREET
Plantable Area
73° F
108° F
0
260
Feet
NORTH

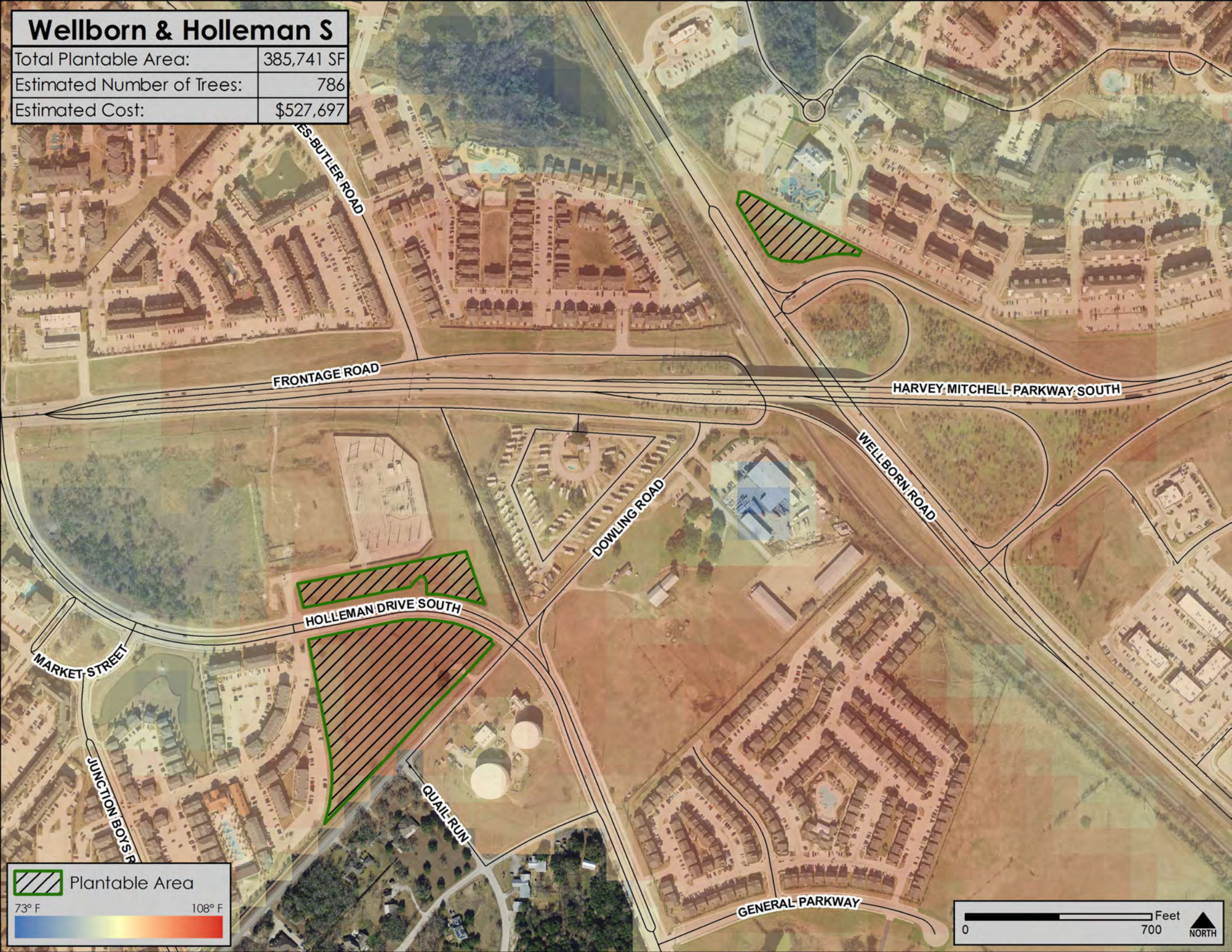

University Dr E
Total Plantable Area: 3,221 LF
Estimated Number of Trees: 129
Estimated Cost: $86,607
Plantable Area
73° F
108° F
Feet
0
1,000
NORTH

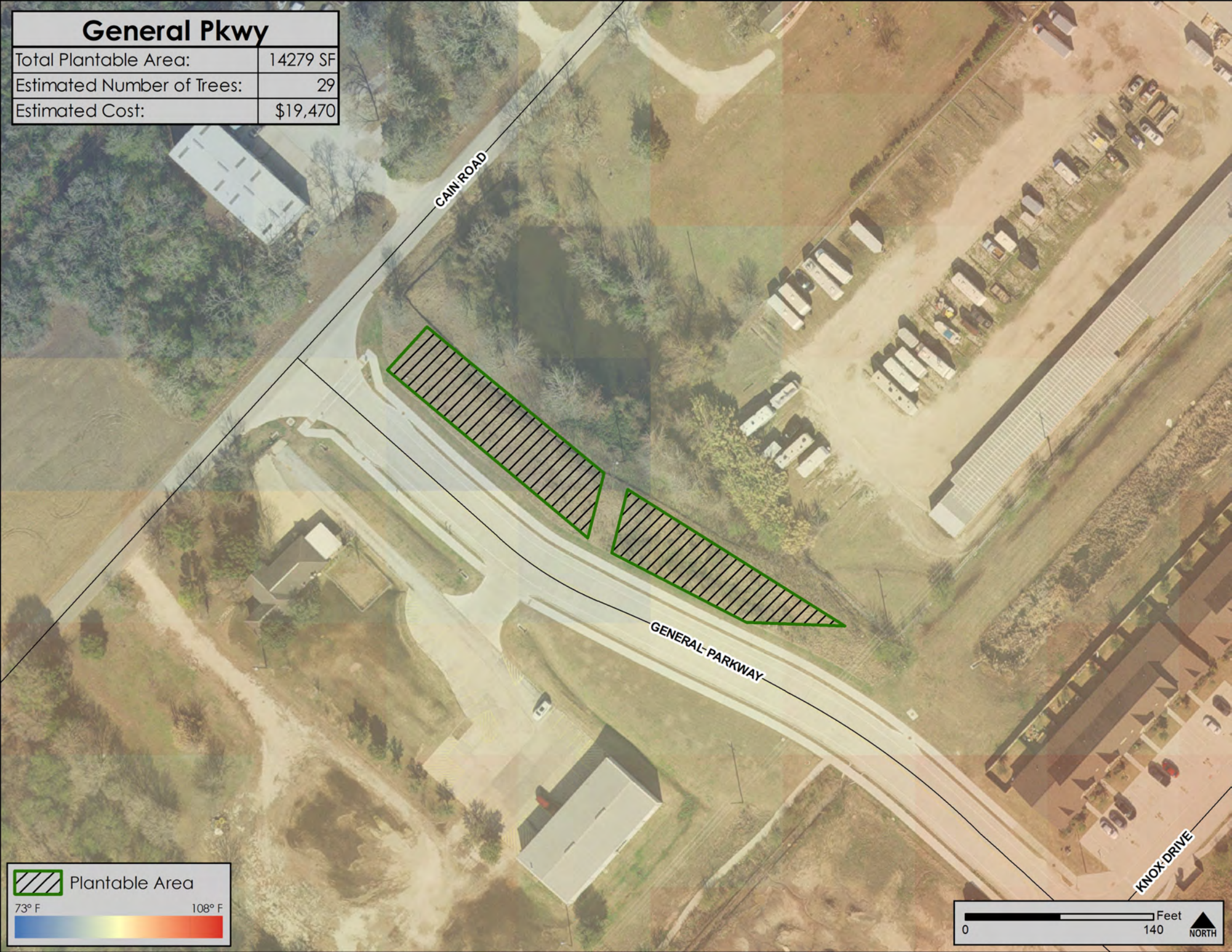

Raymond Stotzer Pkwy
Total Plantable Area: 902 LF
Estimated Number of Trees: 36
Estimated Cost: $24,169
AGRONOMY ROAD
TURK ROAD
SIPPEL RD
RAYMOND STOTZER PARKWAY
WELLBORN ROAD NORTH
FIRST STREET
CHURCH AVENUE
BOYETT STREET
UNIVERSITY DRIVE
HOUSTON STREET
WELLBORN ROAD
JONES STREET
OLSEN BOULEVARD
OLD MAIN DRIVE
Plantable Area
73° F
108° F
Feet
0
520
NORTH


George Bush Dr E
Total Plantable Area: 28580 SF
Estimated Number of Trees: 58
Estimated Cost: $38,939
FOSTER AVENUE
MOSS STREET
GEORGE BUSH DRIVE EAST
KYLE AVENUE
PURYEAR DRIVE
DOMINIK DRIVE
TEXAS AVENUE
Plantable Area
73° F
108° F
Feet
0
200
NORTH


George Bush Dr W
Total Plantable Area: 1,519 LF
Estimated Number of Trees: 61
Estimated Cost: $40,954
INTRAMURAL FIELD DW
PENBERTHY BOULEVARD
JOHN KIMBROUGH BOULEVARD
GEORGE BUSH DRIVE WEST
PENBERTHY DRIVE
REED DR
BARBARA BUSH DRIVE
LUTHER STREET WEST
Plantable Area
73° F
108° F
Feet
0
700
NORTH


Harvey Mitchell Pkwy
Total Plantable Area: 183,634 SF & 55 LF
Estimated Number of Trees: 377
Estimated Cost: $253,106
Plantable Area
73° F
108° F
Feet
0
400
NORTH

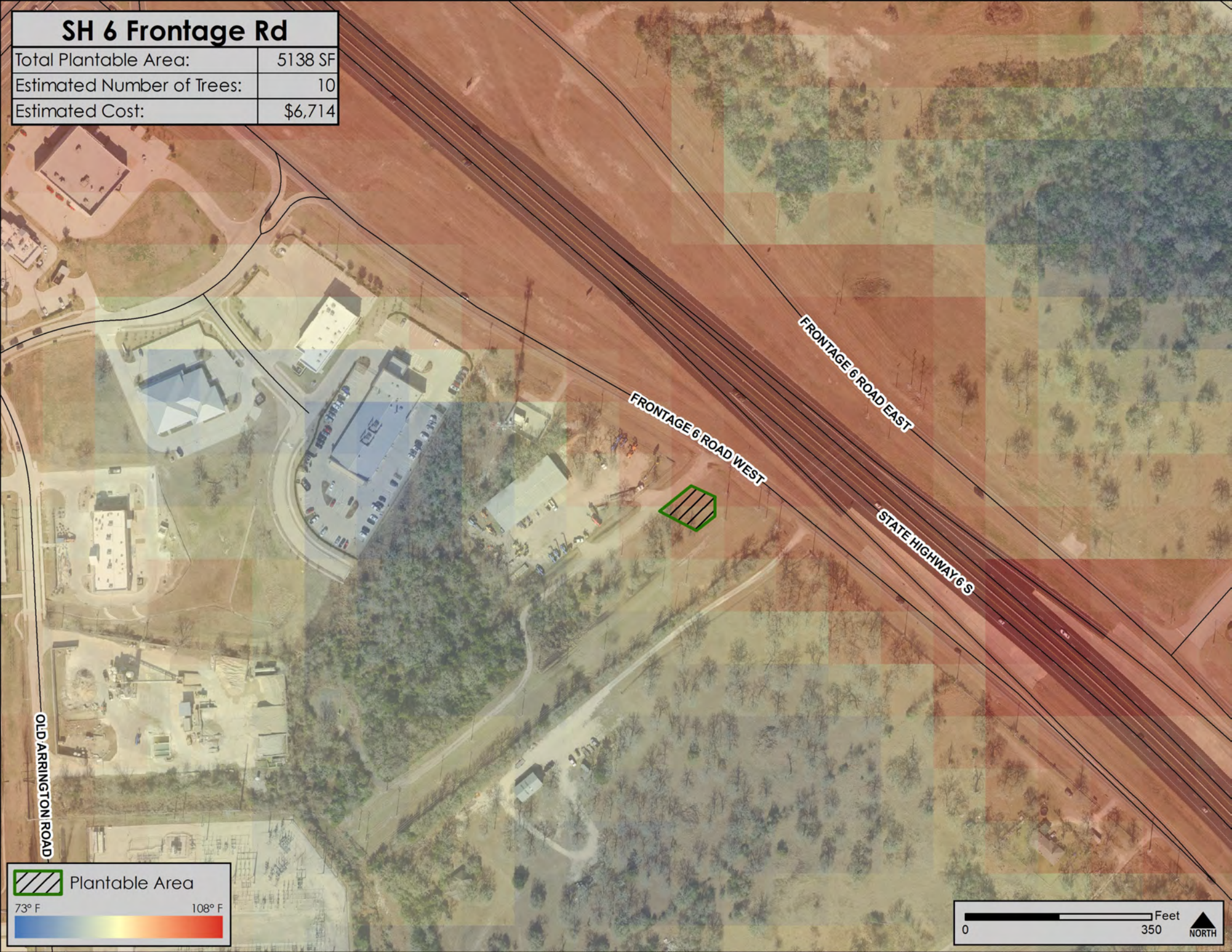

Wellborn & Holleman S
Total Plantable Area: 385,741 SF
Estimated Number of Trees: 786
Estimated Cost: $527,697
ES-BUTLER ROAD
FRONTAGE ROAD
HARVEY MITCHELL PARKWAY SOUTH
WELLBORN ROAD
DOWLING ROAD
HOLLEMAN DRIVE SOUTH
MARKET STREET
JUNCTION BOYS R
QUAIL RUN
GENERAL PARKWAY
Plantable Area
73° F
108° F
Feet
0
700
NORTH


General Pkwy
Total Plantable Area: 14279 SF
Estimated Number of Trees: 29
Estimated Cost: $19,470
CAIN ROAD
GENERAL PARKWAY
KNOX DRIVE
Plantable Area
73° F
108° F
0
140
Feet
NORTH


Wellborn & Graham
Total Plantable Area: 289 LF
Estimated Number of Trees: 12
Estimated Cost: $8,056
GRAHAM ROAD
WELLBORN ROAD
OLDENBURG LANE
Plantable Area
73° F
108° F
Feet
0
160
NORTH


W D Fitch Pkwy
Total Plantable Area: 437,082 SF
Estimated Number of Trees: 890
Estimated Cost: $597,519
Plantable Area
73° F
108° F
0
Feet
1,240
NORTH


W D Fitch & Rock Prairie
Total Plantable Area: 83,518 SF
Estimated Number of Trees: 170
Estimated Cost: $114,133
WISE DRIVE
WILLIAM D FITCH PARKWAY
WILLIAMS CREEK DRIVE
ROCK PRAIRIE ROAD
Plantable Area
73° F
108° F
0
350
Feet
NORTH


SH 6 Frontage Rd
Total Plantable Area: 5138 SF
Estimated Number of Trees: 10
Estimated Cost: $6,714
FRONTAGE 6 ROAD EAST
FRONTAGE 6 ROAD WEST
STATE HIGHWAY 6 S
OLD ARRINGTON ROAD
Plantable Area
73° F
108° F
Feet
0
350
NORTH