



Urban Tree Canopy Assessment

Knox County and City of Knoxville, Tennessee

2021

Prepared by:

Trees Knoxville
PO Box 26313
Knoxville, TN 37912
865-236-0639
treesknoxville@gmail.com

PlanIT Geo
7878 Wadsworth Blvd, Suite 340
Arvada, Colorado 80003
303-214-5067
info@planitgeo.com

Acknowledgments

Majority funding for this project was provided through a grant by the Tennessee Department of Agriculture Division of Forestry in cooperation with the USDA Forest Service.



Trees Knoxville would also like to thank and acknowledge additional funding from City of Knoxville, Knox County, Knoxville Utilities Board, Knoxville Garden Club, and Tennessee Valley Authority. Their funding and expert guidance were essential to the success and completion of this project.



Why is Tree Canopy Important?

There are currently 157,000 acres of urban tree canopy (UTC) in Knox County and 24,000 acres of UTC in the City of Knoxville. This acreage of tree canopy accounts for 49% of the area in the County and 38% of the area in the City. The following data includes estimated benefits that UTC provides the community when modeling the amount of UTC in the County and City using i-Tree Landscape (a modeling program developed by the US Forest Service and other partners that quantifies tree benefits for selected areas):

- UTC in Knox County stores 5.5 million tons of carbon, equating to \$946,000,000 of benefits, and sequesters another 100 thousand tons of carbon dioxide per year, for an estimated \$17,000,000 per year of annual benefits.
- UTC in the City of Knoxville stores 767 thousand tons of carbon, equating to \$130,000,000 of benefits, and sequesters another 4 thousand tons of carbon dioxide per year, for an estimated \$3,600,000 per year of annual benefits.
- UTC in Knox County removes 9.2 million pounds of pollutants each year, estimating about \$18,000,000 of annual benefits for the community.
- UTC in the City of Knoxville removes about 1.4 million pounds of pollutants each year, estimating about \$4,800,000 of annual benefits for the community.
- Each year, UTC in Knox County transpires 20,610 million gallons of water, intercepts another 13,235 million gallons, and avoids 1,381 million gallons of runoff; providing the community with about \$12,300,000 in annual benefits.
- Each year, UTC in the City of Knoxville transpires 3,031 million gallons of water, intercepts another 1,904 million gallons, and avoids 355 million gallons of runoff; providing the community with about \$3,100,000 in annual benefits.

Key Terms

Census Block is a small section within a census tract used to measure census statistics. Census blocks in this report were taken from 2008 and 2018 census data.

Census Tract is a section of a county used to measure census statistics. These sections are larger than census blocks. Census tracts in this report were taken from 2010 Knox County census data.

City of Knoxville Neighborhoods are residential districts within the city. For this study, the neighborhood boundaries were used from previous urban tree canopy studies. Geographic features such as streets, railroads, highways, and ridges were used to delineate neighborhoods into similar sized boundaries. Not every official City of Knoxville neighborhood was assessed independently for this report.

City of Knoxville Public Service Zones are areas of Knoxville which are sectioned into zones for Public Service Department maintenance purposes such as tree maintenance, mowing, and brush pick-up.

Elementary School Districts identify the administrative boundaries for elementary schools in Knox County. Boundaries in this study were based on 2018 Knox County School districts and were used to subdivide Knox County into smaller geographies.

Impervious surfaces do not contain vegetation, such as pavement, buildings, trails and other hardscape.

Other (non-canopy) Vegetation is vegetation cover that includes shrubs, turf grass, and open green spaces. This green space could be recreational, residential, or agricultural.

Possible Planting Area (PPA) is land that is suitable for planting.

Raw Change (UTC) is the percentage of change in UTC from 2008 to 2018. This report mostly uses raw change to report on UTC.

Relative Change (UTC) is the percentage of change in the difference in UTC between 2008 and 2018 compared to the UTC in 2008. Relative change is shown in some parts of this report, but Raw Change is used for most of this study.

Rights-of-Way (ROW) is an area within Knox County where there is legal right for a government agency to utilize property owned by others for public improvements. For this study, typically the area adjacent to improved roads, highways, trails, and other public corridors.

Soil and Dry Vegetation is land surface with bare soil, gravel, rock, or sand. These could be most commonly found in undeveloped land or construction sites.

Urban Tree Canopy (UTC) is the amount of leaves, twigs, branches, and trunks of trees that cover an area when looking from above.

Watersheds are areas of land that catch and drain precipitation runoff from one common point. This study used Hydrologic Unit Code (HUC) 12 watershed geographies for Knox County.

Process and Methods

This Urban Tree Canopy Assessment of Knox County and the City of Knoxville was conducted by PlanIT Geo, LLC (PlanIT Geo) for Trees Knoxville and partnering organizations.

This Urban Tree Canopy (UTC) Assessment in the City of Knoxville and Knox County represents an important step in better understanding baseline conditions of the tree canopy, its distribution and value, and the importance of urban forestry during planning processes. The study encompasses approximately 526 square miles. It involves the use of high-resolution aerial imagery, LiDAR data, and GIS remote sensing technology.

Land Cover Mapping

PlanIT Geo used spectral and spatial remote sensing analysis, particularly using object-based image analysis (OBIA) for various urban land cover classifications. PlanIT Geo utilized Feature Analyst software v5.2 for the OBIA classification, which uses spectral and texture analysis and pattern recognition through an iterative machine-learning approach. High resolution (1-meter), multi-spectral (4-band) NAIP imagery (U.S. Department of Agriculture National Agriculture Imagery Program) from 2008 and 2018, and LiDAR data (Tennessee LiDAR) collected in 2016 were used for this study. Through this process, there were 5 different land cover classes that were mapped for this study:

Urban tree canopy (UTC) mapping included all vegetation generally greater than 10-15 feet. Generally speaking, UTC is the amount of leaves, twigs, branches, and trunks of trees that cover an area when looking from above.

Other (non-canopy) vegetation was mapped as shrub/scrub vegetation, turf grass, and other open green space. Following the remote sensing classification of the tree canopy layer, PlanIT Geo was able to extract all other types of vegetation using a Normalized Difference Vegetation Index (NDVI) analysis. The results of this extraction represents all areas of other green space throughout Knox County.

Impervious surfaces includes all paved surfaces and hardscapes using existing GIS data that the City or County provided. These subcategories include buildings, streets, parking lots, sidewalks, and “other impervious areas” such as patios, driveways, trails, and other miscellaneous hardscape surfaces.

Bare soil includes all barren soil, gravel pits, exposed dirt/open construction, rock, and sand as well as dry (non-photosynthetic) vegetation.

Water was mapped from the base imagery and available hydrologic, surface water features provided by the City or County such as lakes, rivers, ponds, and streams.

Through the process of mapping land cover, the following GIS raster layers were produced in this study:

1. Five Land Classes (tree canopy, other vegetation, impervious, bare soil, and water);
2. Five Land Classes, with impervious areas subdivided into buildings, roads, and “other” impervious areas;
3. Urban Tree Canopy Classes subdivided into existing tree canopy, areas suitable for planting trees, and unsuitable areas for planting trees.

Urban Tree Canopy Analysis and Mapping

After the different land covers were mapped, PlanIT GEO used GIS-based modeling processes to calculate the acreage and percent of each land cover type, as well as possible planting area (PPA), and impervious areas for 15 desired geographic scales. These scales included 1) Knox County, 2) City of Knoxville, 3) Knox County commission districts, 4) City of Knoxville council districts, 5) census tracts, 6) City of Knoxville zoning, 7) Knox County zoning, 8) City of Knoxville maintenance zones, 9) City of Knoxville neighborhoods, 10) Knox County watersheds, 11) 100 ft. stream buffer, 12) Knox County elementary school districts, 13) street ROW by census blocks, 14) City and County parks and public spaces, and 15) census blocks.

Potential Planting Areas (PPA)

After mapping “Other (non-canopy) Vegetation” throughout the study area, PlanIT Geo was able to digitize and extract areas unsuitable for tree planting. These unsuitable areas include, but are not limited to, airports, above-ground utility corridors, golf course playing areas, utility corridors, and recreation fields. All remaining vegetation was classified as “Possible Planting Area.” Parking lots, sidewalks, and driveways mapped as impervious were also mapped “Possible Planting Area – Impervious,” where slight modifications of the landscape could result in plantable space with enhanced ecosystem benefits. PPA and PPA-Impervious were mapped and calculated for each of the 15 geographic scales.

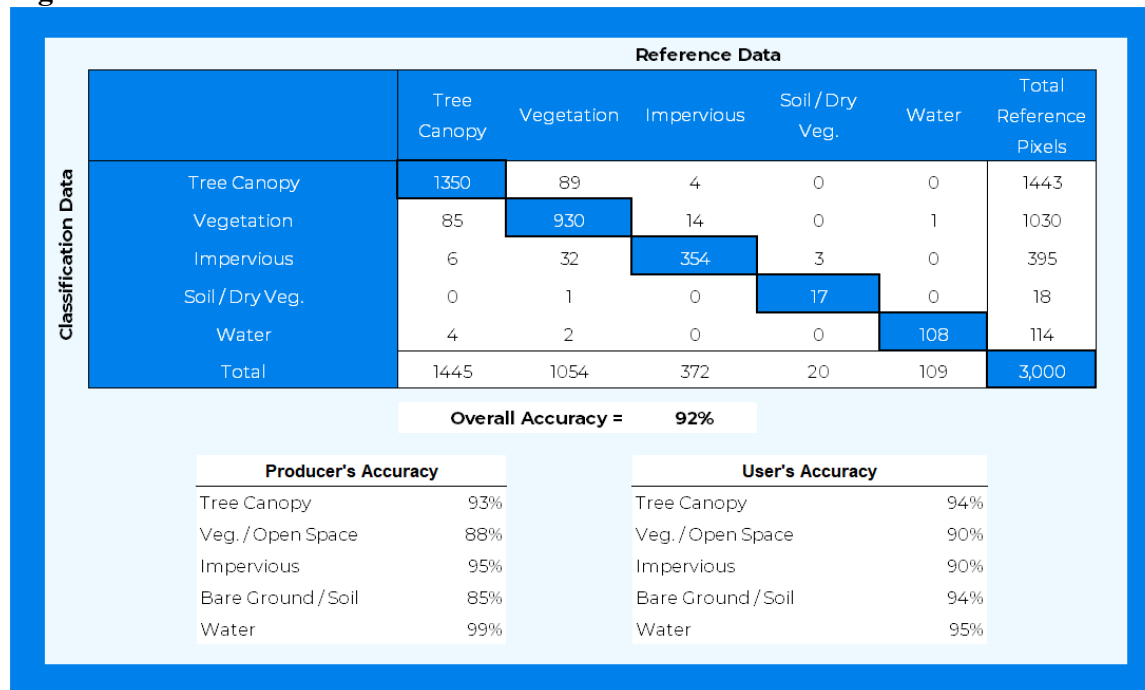
Tree Canopy Change

Similar mapping methods used to map UTC in 2018 were used to map tree canopy using NAIP imagery from 2008. PlanIT Geo calculated the change in quantity and distribution of UTC within a 10 year period (2008-2018). Changes in UTC were assessed within each of the 15 geographic scales to locate specific areas of change and measure the amount of change that has occurred in the last decade.

Accuracy Standards

After remote sensing mapping of all land cover classes, PlanIT Geo conducted a point-based assessment of the County to determine the accuracy of the study for quality control. 3,000 points were measured to see if the areas mapped by computer recognition were consistent when looking at the points manually. The result of the point-based assessment provided a standard error matrix (Figure A) for the 5 land covers mapped and assessed in the study. Quality control showed that the mapping process was 92% accurate for this study.

Figure A



How Much Urban Tree Canopy Exists?

Chart 1 summarizes the land cover statistics of Knox County and the two major municipalities within the County. The higher percentage of tree canopy in the County is a result of having more rural and agricultural areas that contribute to the percentage of UTC. Chart 2 shows the changes of UTC within the County. Appendix A shows maps of UTC for different geographies across Knox County and the City of Knoxville.

Chart 1: Knox County 2018 Land Cover Statistics

Location	Total Acres	Tree Canopy (Acres)	Tree Canopy %	Non-Canopy Vegetation (Acres)	Non-Canopy Vegetation %	Impervious (Acres)	Impervious %	Soil & Dry Vegetation (Acres)	Soil & Dry Vegetation %	Water (Acres)	Water %
Knox County	336,867	157,567	47%	117,194	35%	47,474	14%	2,577	1%	12,055	4%
City of Knoxville	66,722	24,252	36%	18,514	28%	20,025	30%	335	1%	3,597	5%
Farragut	10,343	3,864	37%	3,867	37%	2,264	22%	212	2%	136	1%

Chart 2: Urban Tree Canopy Change Metrics

Location	Total Area (Acres)	Land Area (Acres)	UTC 2008 (Acres)	UTC 2008 (%)	UTC 2018 (Acres)	UTC 2018 (%)	UTC Change 2008-2018 (Acres)	Raw Change (%)	Relative Change (%)
Knox County	336,867	324,812	157,030	48%	157,567	49%	538	0%	0%
City of Knoxville	66,722	63,125	24,984	40%	24,252	38%	-732	-1%	-3%
Farragut	10,343	10,207	3,512	34%	3,864	38%	352	3%	10%

Key findings on land cover statistics for Knox County and City of Knoxville:

- The City of Knoxville lost 732 acres (1%) of UTC in a 10 year period
- 1% loss of UTC in the City of Knoxville equates to an estimated loss of about \$115,000 of annual benefits to the community
- Knox County increased the amount of tree canopy by 532 acres
- The City of Knoxville makes up about 20% of the acreage within Knox County but contributes 15% of the UTC in the County
- The City of Farragut makes up 3% of the acreage within the County and contributes 2.5% of the UTC in the County
- The City of Knoxville makes up 42% of the impervious area in Knox County.

Chart 3: Urban Tree Canopy Change by County Commission District Metrics

	Commission District	Total Area	Land Area	UTC 2008	UTC 2008	UTC 2018	UTC 2018	UTC Change	Raw
		(Acres)	(Acres)	(Acres)	(%)	(Acres)	(%)	2008-2018 (Acres)	Change (%)
Knox County	Commission 1	15,488	15,149	5,750	38%	5,207	34%	-543	-4%
	Commission 2	14,855	14,845	5,622	38%	5,909	40%	287	2%
	Commission 3	15,320	15,272	5,697	37%	6,118	40%	421	3%
	Commission 4	24,061	20,323	10,545	52%	10,009	49%	-536	-3%
	Commission 5	25,832	22,955	9,564	42%	9,786	43%	222	1%
	Commission 6	40,790	39,263	16,655	42%	17,766	45%	1,111	3%
	Commission 7	36,870	36,774	16,991	46%	17,924	49%	934	3%
	Commission 8	114,041	112,348	55,887	50%	55,612	49%	-275	0%
	Commission 9	48,768	47,494	30,102	63%	29,013	61%	-1,089	-2%
	Totals		336,025	324,423	156,813	48%	157,345	48%	532

Chart 4: Urban Tree Canopy Change by City Council District Metrics

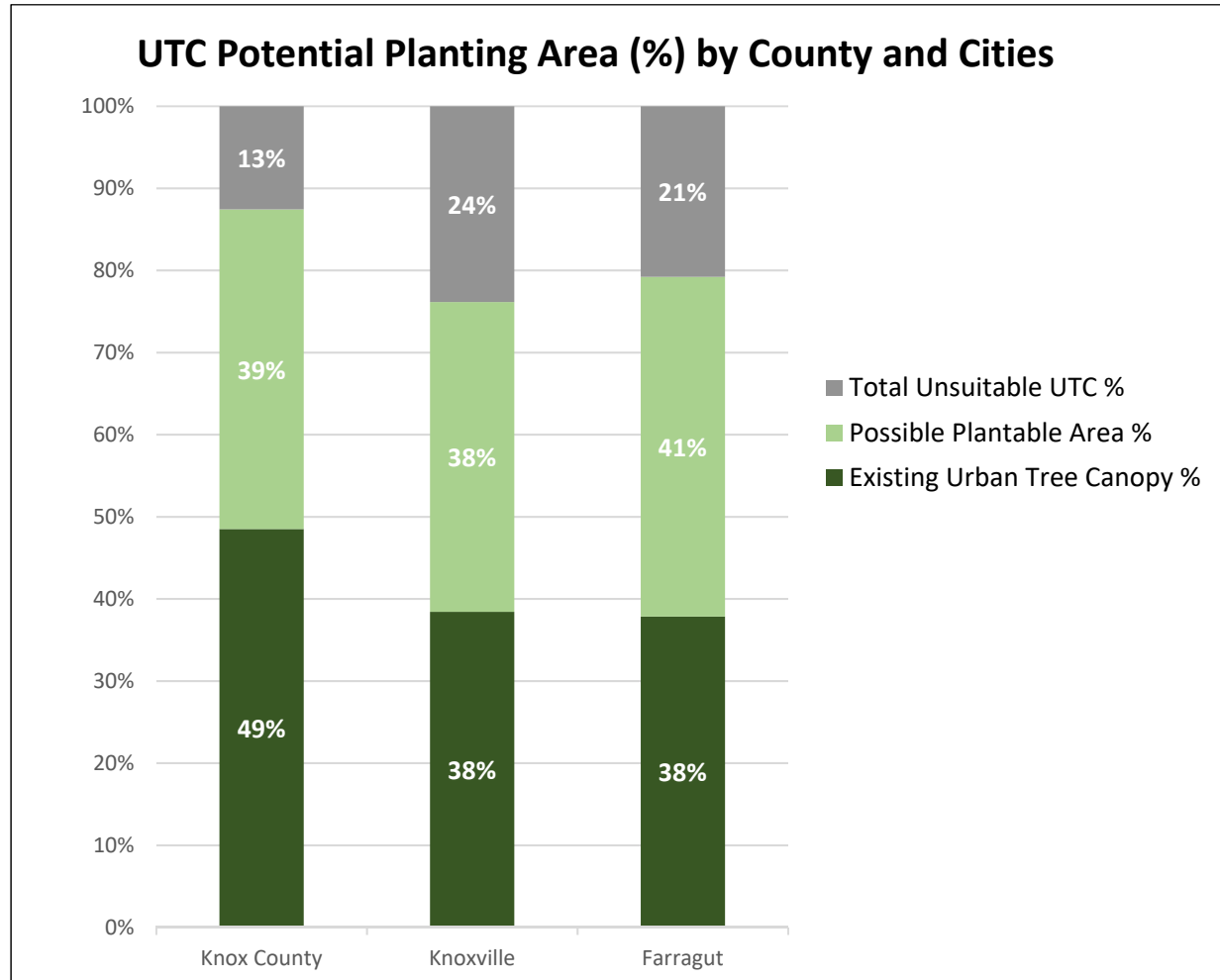
	City Council District	Total Area	Land Area	UTC 2008	UTC 2008	UTC 2018	UTC 2018	UTC Change	Raw
		(Acres)	(Acres)	(Acres)	(%)	(Acres)	(%)	2008-2018 (Acres)	Change (%)
Knoxville	CITY COUNCIL - 1	10,634	9,926	5,388	54%	4,944	50%	-444	-4%
	CITY COUNCIL - 2	17,987	15,491	4,786	31%	4,500	29%	-286	-2%
	CITY COUNCIL - 3	9,378	9,370	3,257	35%	3,501	37%	244	3%
	CITY COUNCIL - 5	8,227	8,223	2,897	35%	3,097	38%	200	2%
	CITY COUNCIL - 4	13,606	13,360	5,628	42%	5,498	41%	-130	-1%
	CITY COUNCIL - 6	9,250	8,909	3,036	34%	2,717	31%	-319	-4%
	Totals		69,081	65,279	24,992	38%	24,257	37%	-735

How Much Urban Tree Canopy Could Exist?

This study looked at the existing pervious and vegetated areas throughout the County and looked at what percentage of that area could potentially accommodate UTC or Potential Planting Area (PPA). Areas such as sports fields, airports, and other spaces not suitable for tree cover were not included as PPA. Figure B shows the percentage of land area (excluding water), that could be planted or revert back to UTC. Planting trees alone will not typically allow a community to increase or maintain UTC. There are several important factors that promote UTC which include:

- Properly selecting and planting trees in specific targeted areas in need
- Implementing policies that promote trees being properly selected, planted, and maintained, and identifying any barriers such as lack of enforcement
- Establishing policy or incentives to preserve existing trees and routinely measure the success of tree related policy
- Targeting preservation measures that protect stands of trees and not just individual trees
- Increasing education on the proper care and maintenance of trees
- Identifying and addressing threats to UTC such as invasive species, unsustainable development practices, and improper maintenance
- Communicating the importance of UTC throughout the community

Figure B



Planning

The following criteria are important when targeting a geographic area for planting and/or prioritizing efforts of increasing or maintaining UTC:

- Percentage of existing UTC in a geographic area
- Percentage of potential planting area (PPA) in a geographic area
- Historical trends in a geographic area (UTC increasing or decreasing)
- Percentage of impervious surfaces in a geographic area
- Community goals and expectations of UTC
- UTC impacts on social and economic entities
- Ecosystem services and tree benefits provided by UTC

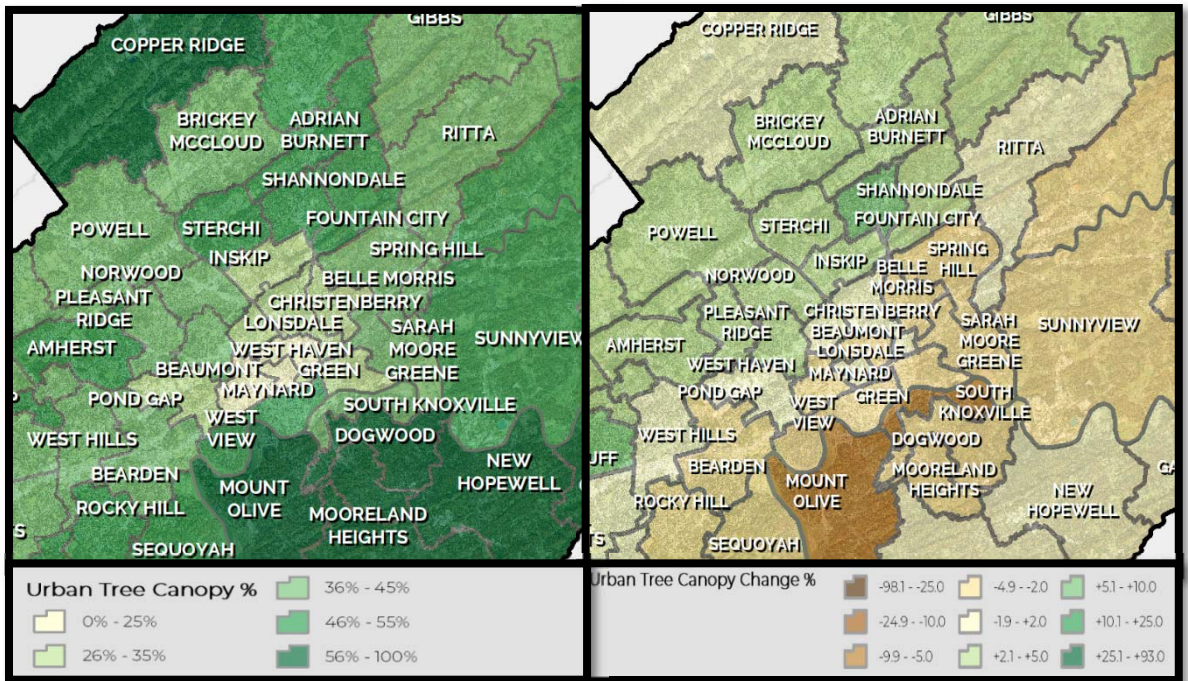
All of these criteria are important when planning how to allocate resources towards maintaining or increasing UTC within a geography. The following are some considerations when planning UTC goals:

- Most of the UTC in an area is on private property and impacted by the land use of that property (see zoning).
- It is not realistic to expect that all PPA within a geography could be planted or revert to UTC; however, communities could set specific UTC goals for a certain geography based on the existing PPA.
- Certain geographic and environmentally sensitive areas such as riparian buffers along streams, hilltops and slopes, areas with high impervious surfaces, and areas with high population density (downtown Knoxville) may require specific UTC goals.
- Many benefits of UTC are intangible but can be measured and areas prioritized using software programs such as i-Tree.
- Many intangible benefits of trees (such as carbon reduction) can be compared to other sustainability efforts within a community and resources weighted accordingly, but it is important to weigh all benefits of trees (trees can reduce carbon while also improving water quality, improving human health, etc.)
- It is vital to consider maintenance and follow-up care of trees when considering planting efforts and projects.

Many communities will set an overarching UTC goal and then target smaller geographic areas for specific UTC projects. Smaller geographic canopy goals (such as elementary school districts or neighborhoods) can also be valuable. Smaller geographic goals can be more measureable and attainable with specific projects. Local level support and input are also likely to be more impactful when making smaller localized UTC goals.

Figure C is an example of how to consider goals and objectives for a geographic area. Figure C shows UTC and the percentage of UTC change over a 10 year period for elementary school districts in central Knox County. Although the “Mount Olive” school district shows a high percentage of UTC that was lost over the course of ten years, it shows a relatively high percentage of UTC still exists in that district. This school district would not be a great location to target large amounts of resources towards tree planting, but rather to look at ways to preserve trees and look at what is contributing to the tree loss in that area.

Figure C



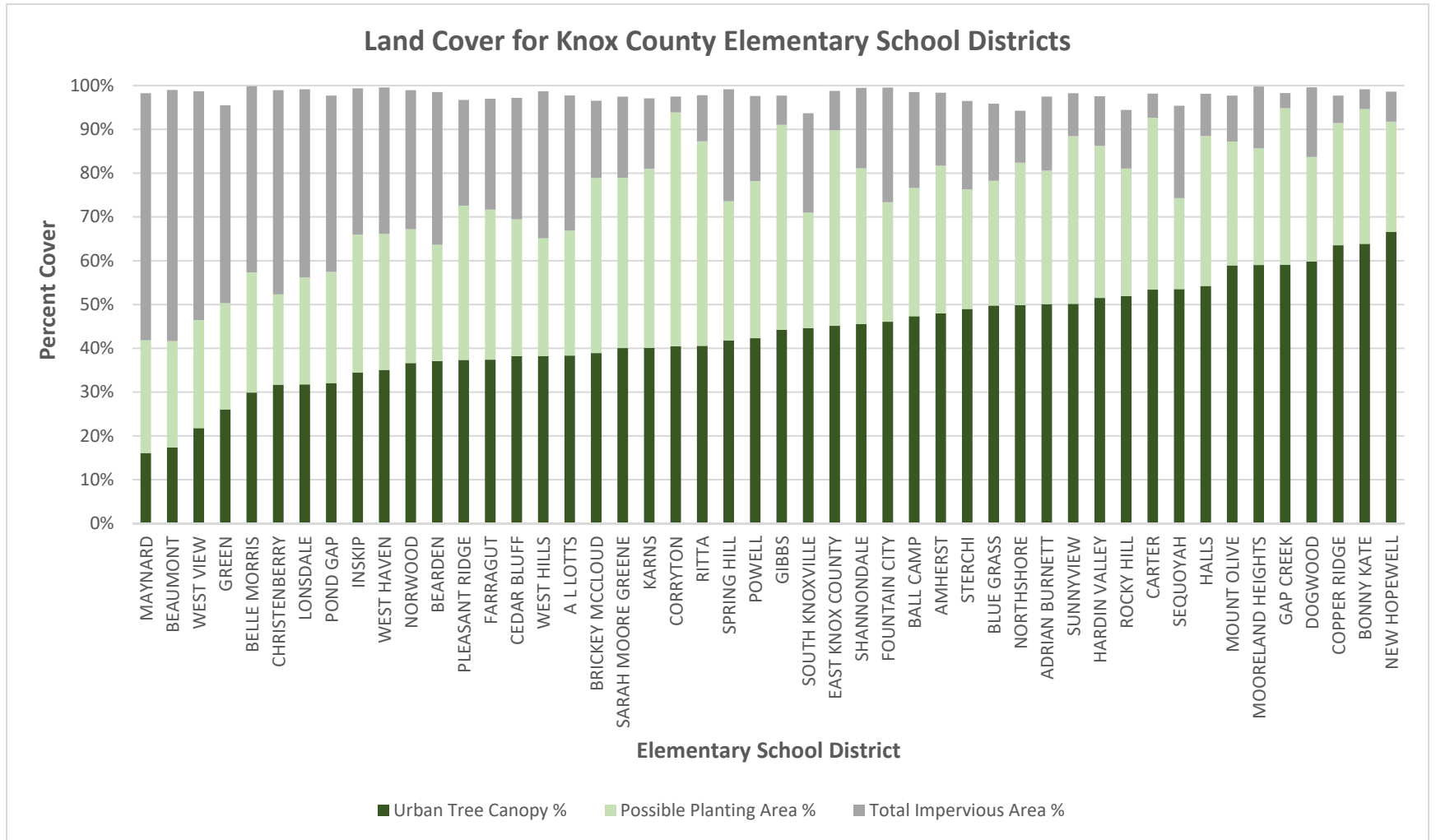
Urban Tree Canopy by Elementary School District

In order to subdivide Knox County into smaller geographic scales and look at trends, this study assessed UTC in each of the current 48 elementary school districts. Elementary school districts offered an easy way to subdivide the entire County to encompass smaller communities. Tables 1 and 2 in Appendix B show the data for each of the Knox County elementary school districts.

Existing UTC within a geography and the direction a geography is trending will impact the level of amenities that trees provide and how to address tree related issues in that community.

- The school districts in the southern part of the County tend to be trending in a declining direction
- South Knoxville, Mount Olive, Belle Morris, Dogwood, and Mooreland Heights elementary school districts have the greatest decrease in UTC over a 10 year period (all over 5% in UTC lost)
- Fountain City, Cedar Bluff, Inskip, Ball Camp, and Karns elementary school districts all had the greatest increase in UTC over a 10 year period (all over 4% increase in UTC)
- The school districts that overlay the City of Knoxville and urban communities tend to have a lower percent urban tree canopy (see Appendix A, Maps 1 and 2)
- Maynard, Beaumont, West View, Green, and Belle Morris elementary school districts all have the lowest percentage of UTC in the County, while New Hopewell, Bonny Kate, Copper Ridge, Dogwood, and Gap Creek all have the highest percentage of UTC (Figure D)

Figure D



Trees and Schools

There is research that suggests that the presence of trees and green space in the environment in which students learn can greatly impact their performance.

Several studies suggest:

- Access to greenspace increases attention, interest, and motivation
- Presence of trees and greenspace decreases stress
- Being able to view trees on school grounds increases academic achievements and graduation rates
- Standardized math and reading scores positively correlate with canopy cover

2018 rankings were found for Knox County Schools. The top five performing schools in Knox County are Sequoyah Hills Elementary, Rocky Hill Elementary, Farragut Middle School, A L Lotts Elementary, and Northshore Elementary. Two of these five schools, Sequoyah Hills Elementary and A L Lotts Elementary are also found in the list of schools with the greatest percentage of canopy cover (found in bullet lists below). While trees can increase the academic success of students, there are many other factors that contribute to academic success. This explains why the top five schools for performance and the top five schools for canopy cover aren't identical.

UTC was measured for school grounds to know how much canopy cover exists and much PPA there is. To gain greater access to these benefits, it is essential to know the PPA. The results from the UTC assessment show that there is much room for increasing canopy cover on school grounds across the County, from those with the highest percentages of canopy cover to those with the lowest.

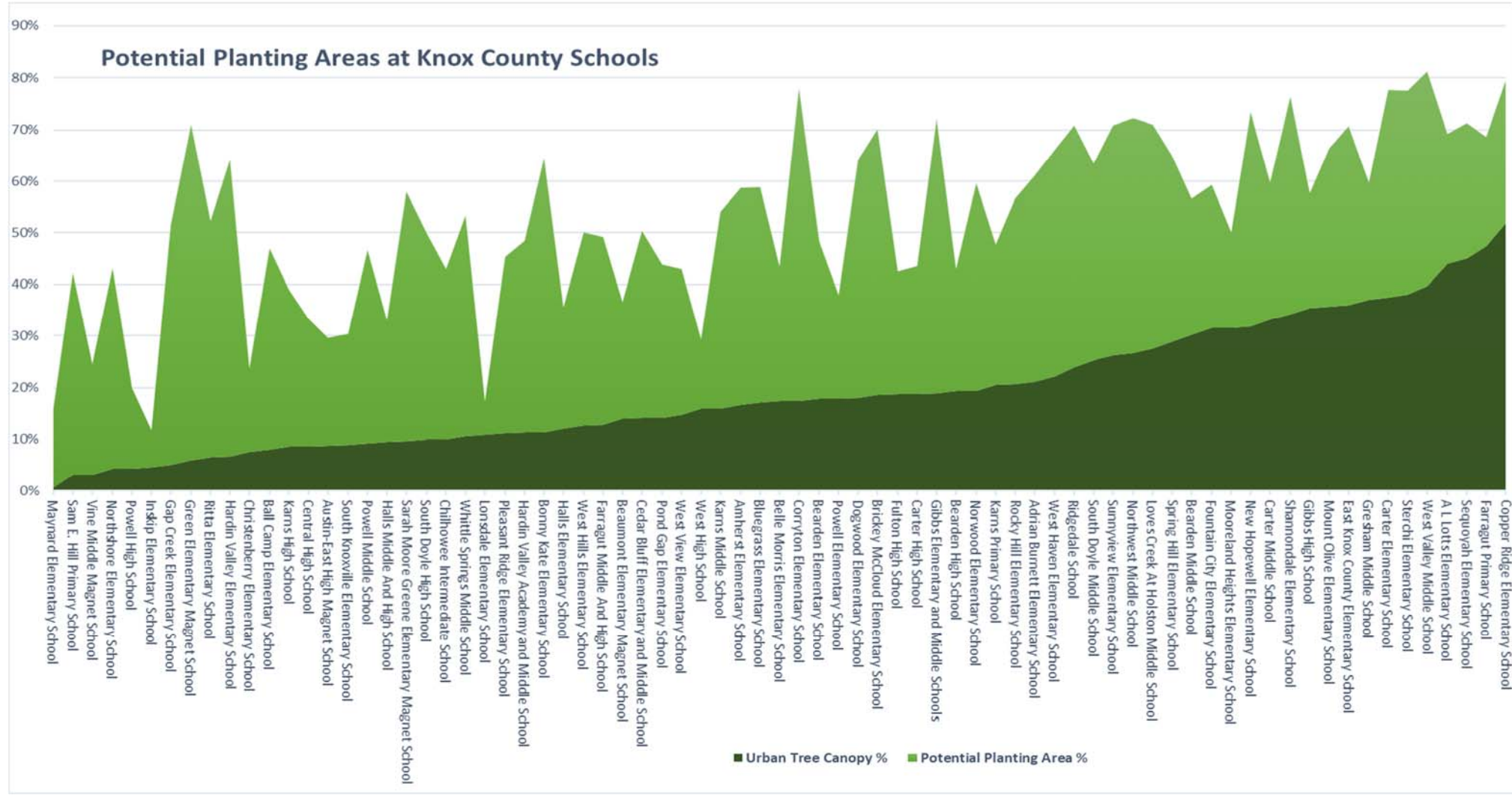
These five school grounds have the top 5 percentages of existing UTC, yet still a significant percentage of PPA:

- Copper Ridge Elementary has a canopy cover of 52% and a PPA of 28%
- Farragut Primary School has a canopy cover of 47% and a PPA of 21%
- Sequoyah Elementary has a canopy cover of 45% and a PPA of 26%
- A L Lotts Elementary has a canopy cover of 44% and a PPA of 25%
- West Valley Middle School has a canopy cover of 40% and a PPA of 41%

These five school grounds have the lowest 5 percentages of existing UTC and have significant percentages of PPA:

- Maynard Elementary has a canopy cover of 1% and a PPA of 15%
- Sam E Hill Primary School has a canopy cover of 3% and a PPA of 39%
- Vine Middle Magnet School has a canopy cover of 3% and a PPA of 21 %
- Northshore Elementary has a canopy cover of 4% and a PPA of 39%
- Powell High School has a canopy cover of 4% and a PPA of 16%

Figure E



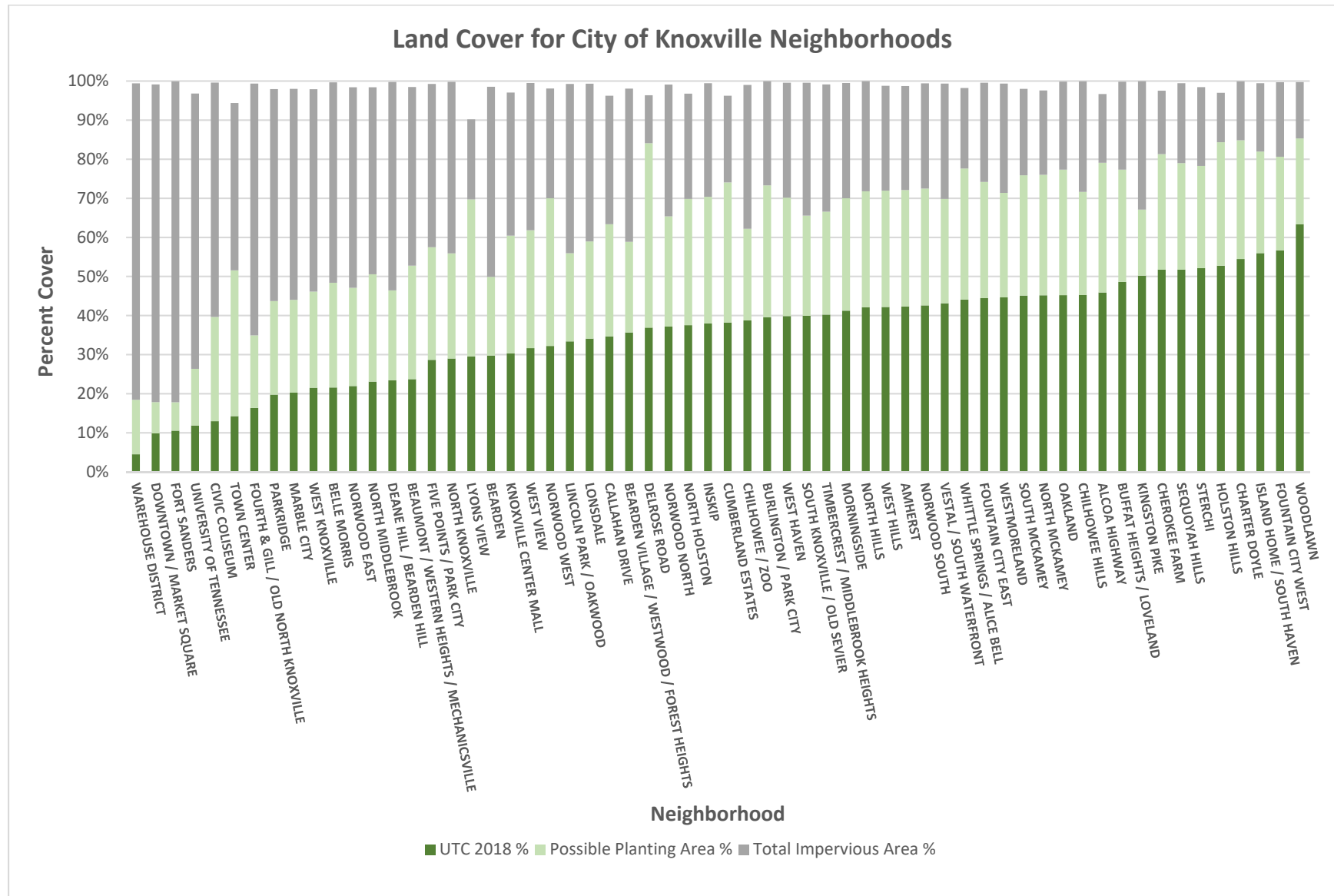
Urban Tree Canopy by City of Knoxville Neighborhood

In order to subdivide the City of Knoxville into smaller geographic scales and look at trends, this study assessed UTC in 60 different neighborhood zones. Since the City of Knoxville does not have neighborhood boundaries similar in size that cover every part of the City, neighborhoods were delineated by using geographic features such as highways, railroads, ridges, and other features to develop boundaries similar in size. Tables 3, 4, and 5 in Appendix B show the data for each of the City of Knoxville neighborhoods.

Existing UTC within a geography and the direction a geography is trending will impact the level of amenities that trees provide and how to address tree related issues in that community.

- There are 15 neighborhoods, mostly concentrated in the central urban part of Knoxville, which have a UTC under 25% (see Appendix A, Map 4).
- The Warehouse District, Downtown, Fort Sanders, University of Tennessee, and the Civic Coliseum have the lowest UTC in the City. The Warehouse District and Downtown are gaining canopy, therefore trending in the right direction.
- The average UTC in each neighborhood is 36%; 25 of the 60 neighborhoods fall below the City average.
- Of the 25 neighborhoods below 36% UTC, 7 are trending in the right direction.
- 19 of the 60 (33%) of neighborhoods are trending in the right direction and have increased the amount of UTC within their boundaries.
- Holston Hills, Sequoyah Hills, Morningside, Alcoa Highway, and Island Home/South Haven have lost the greatest amount of UTC between 2008 and 2018 respectively, all over 5% UTC (see Appendix A, Map 5).
- Most of the neighborhoods trending in the right direction tend to be located on the north side of the City.

Figure F



Urban Tree Canopy by Watershed and Stream Buffer

The amount of UTC within a defined watershed impacts the overall quality of water resources by intercepting rainfall, transpiring water back into the atmosphere, and avoiding runoff into waterways. This runoff could contain pollutants harmful to stream health and increase erosion along streams. Erosion can be eliminated or avoided by the stabilization tree roots provide. Trees along banks act as stream buffers, reducing the harmful effects of runoff into waterways. UTC also works to reduce air pollution and carbon through sequestration and storage. Aquatic ecosystems are also benefitted by providing a habitat. Chart 5 shows UTC across HUC 12 watersheds within Knox County and the change in UTC from 2008 to 2018.

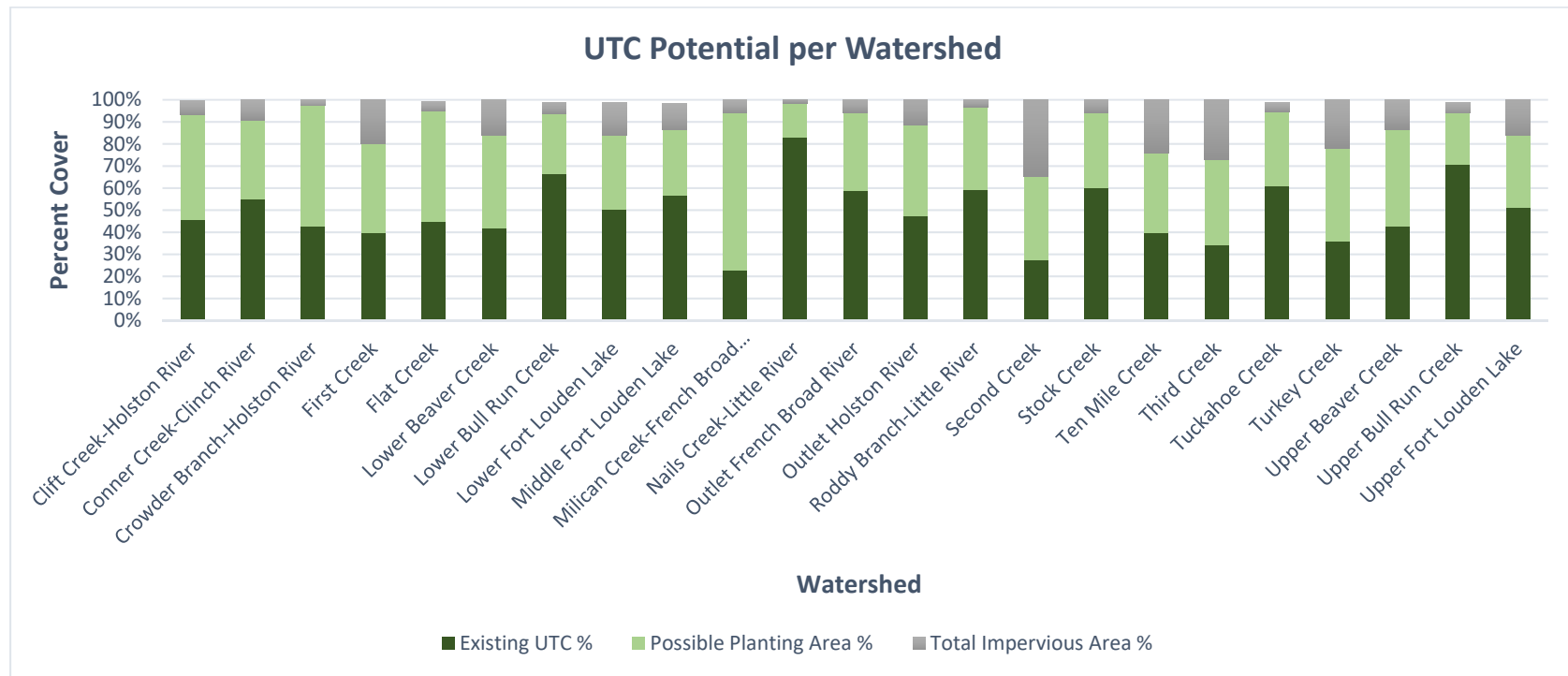
Chart 5

	Watershed	Total Area (Acres)	Land Area (Acres)	UTC 2008	UTC 2008	UTC 2018	UTC 2018	UTC Change	Raw
				(Acres)	(%)	(Acres)	(%)	2008-2018 (Acres)	Change (%)
Knox County	Clift Creek-Holston River	26,916	26,493	12,470	47%	12,075	46%	-396	-1%
	Conner Creek-Clinch River	15,817	14,271	7,642	54%	7,846	55%	204	1%
	Crowder Branch-Holston River	3,707	3,543	1,556	44%	1,515	43%	-41	-1%
	First Creek	13,854	13,842	5,148	37%	5,476	40%	328	2%
	Flat Creek	20,317	20,192	8,767	43%	9,008	45%	241	1%
	Lower Beaver Creek	26,118	25,983	9,966	38%	10,824	42%	859	3%
	Lower Bull Run Creek	22,686	22,614	14,686	65%	15,030	66%	344	2%
	Lower Fort Loudon Lake	13,543	10,304	5,397	52%	5,201	50%	-196	-2%
	Middle Fort Loudon Lake	9,415	7,823	4,555	58%	4,429	57%	-126	-2%
	Milican Creek-French Broad River	623	616	144	23%	141	23%	-2	0%
	Nails Creek-Little River	1,141	1,140	952	83%	944	83%	-7	-1%
	Outlet French Broad River	26,559	25,464	15,226	60%	14,975	59%	-252	-1%
	Outlet Holston River	25,883	25,411	13,023	51%	12,040	47%	-984	-4%
	Roddy Branch-Little River	1,435	1,280	763	60%	757	59%	-6	-1%
	Second Creek	4,275	4,273	1,102	26%	1,167	27%	65	2%
	Stock Creek	13,292	13,181	8,044	61%	7,917	60%	-127	-1%
	Ten Mile Creek	10,923	10,906	4,104	38%	4,322	40%	218	2%
	Third Creek	11,085	11,075	3,740	34%	3,792	34%	53	0%
	Tuckahoe Creek	6,183	6,153	3,891	63%	3,759	61%	-132	-2%
	Turkey Creek	16,733	16,217	5,240	32%	5,791	36%	551	3%
Upper Beaver Creek	31,493	31,435	12,259	39%	13,339	42%	1,079	3%	
Upper Bull Run Creek	3,329	3,323	2,255	68%	2,351	71%	96	3%	
Upper Fort Loudon Lake	31,086	28,820	15,928	55%	14,691	51%	-1,237	-4%	
Totals	336,412	324,359	156,858	48%	157,391	49%	533	0%	

Key findings from UTC in Knox County watersheds:

- Knox County had a UTC decrease in 12 watersheds, totaling a loss of 3,506 acres
- Knox County had a UTC increase in 11 watersheds, totaling a gain of 4,038 acres
- Upper and Lower Beaver Creek watersheds comprised almost half (48%) the UTC gain in the County
- Upper Fort Loudon Lake and Outlet to the Holston River watersheds comprised 63% of the lost UTC in the County
- Milcan Creek-French Broad River and Second Creek watersheds have the lowest UTC at 23% and 27% respectively
- 31,617.3 million gallons of water are being transpired/year (see Appendix B, Table 6)
- 20,492.6 million gallons of rainfall are being intercepted/year (see Appendix B, Table 6)
- 1,390.5 millions gallons of runoff are being avoided/year, providing an economic benefit of \$12,421,823/year (see Appendix B, Table 6)

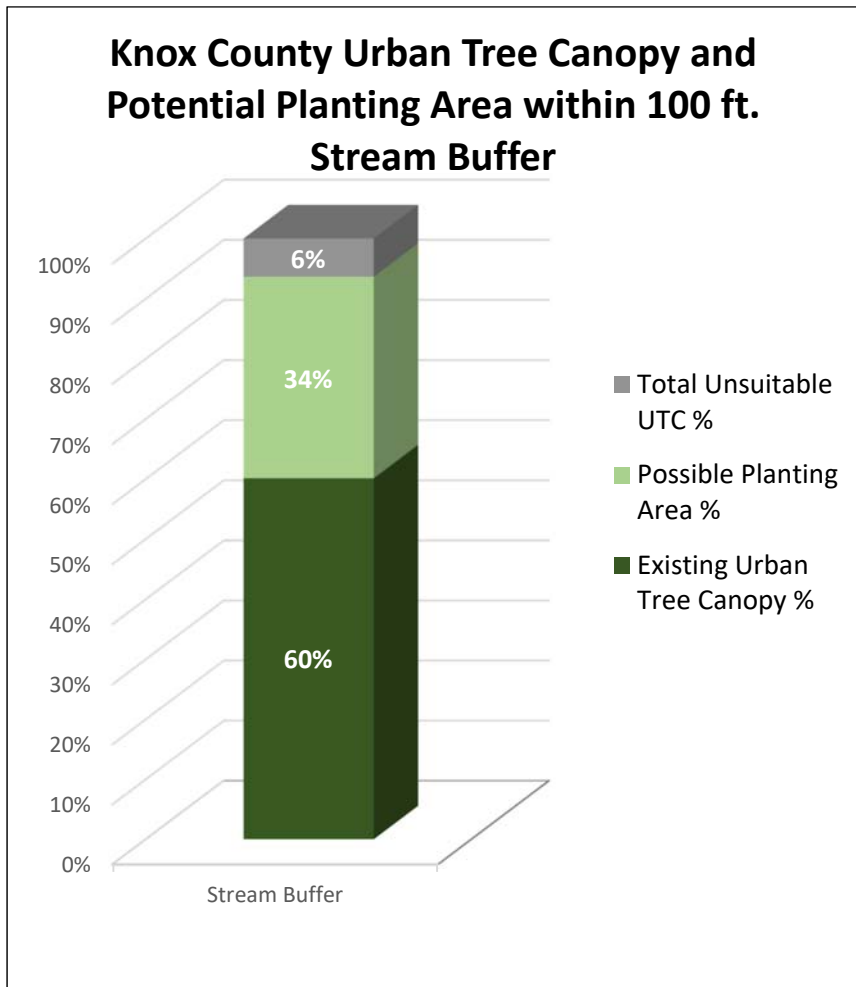
Figure G



Key findings of UTC and stream buffers:

- 34% of 100 ft. stream buffer space in Knox County does not have trees, but could be planted with trees
- 6% of the 100 ft. stream buffer space in Knox County is not suitable for trees

Figure H



Urban Tree Canopy by City of Knoxville Zoning

The City of Knoxville has different codes and ordinances that impact the allocation of trees across the City but most notably will influence the abundance of trees and the occurrence of trees on private property. This study looked at landcover, including UTC, at different zoning scales across the City. Historically, most UTC is found within parcels of land zoned for park use and residential property. UTC studies can help provide paths forwards for addressing UTC related questions, problems, and trends as it relates to zoning and regulations. The following are some of the key finding from the UTC study in relation to City of Knoxville Zoning:

- Residential zoned property comprises the largest amount of UTC in the City of Knoxville with 14,472 acres, followed by Natural Areas and Open Space (2,862 acres), ROW (2,515 acres), Commercial property (1,508 acres), and Industrial property (1,243) (See Chart 6).
- Residential zoned property accounts for over 14,000 acres (60%) of the 24,000 acres of trees in the City of Knoxville. Approximately 22% of the UTC within the City of Knoxville fall in ROW, Open Space, or Natural Areas.
- Commercial, Industrial, Downtown, South Waterfront, and Cumberland Avenue zoned property make up about 12% of the UTC in the City of Knoxville.
- Over a 10-year period, 756 acres of trees were lost in the City of Knoxville. Residential zoned property accounts for 515 acres (68%) of the UTC loss. Open Space and Natural Areas account for 8% of the land area within the City of Knoxville, but account for 16% of the UTC lost in the last 10 years.
- ROW within the City of Knoxville account for 6,050 acres (30%) of the impervious areas followed by Residential zoned property at 5,490 acres (27%), Commercial zoned property at 3,997 acres (20%), and Industrial zoned property at 2,679 acres (13%).
- Downtown and Cumberland Avenue zoned property has 8% and 6% UTC, and 86% and 91% impervious area respectively.
- Residential zoning types RN-1 and RN-2 account for 23,311 Acres (36%) of land, 12,025 Acres (50%) of UTC, and 7,298 acres (40%) of the potential planting areas within the City of Knoxville.
- Misc. (ROW) and Open Space (OS) make up 2,813 acres (16%) and 1,237 acres (7%) of potential planting area within the City of Knoxville, respectively.
- Commercial and Industrial zoned property accounts for 20% of the area within the City and 33% of the impervious area.

Figures I through K show land cover data and changes in UTC for individual Zoning type throughout the City of Knoxville. Appendix B, Tables 9 and 10 have detailed information for each individual Zoning type.

Chart 6

Zoning Type	Total Area (Acres)	UTC 2008 (Acres)	UTC 2018 (Acres)	UTC Change (Acres)	% UTC	% UTC Change	Impervious Area (Acres)	% Impervious	PPA (Acres)	% PPA
Agricultural	2,504	1,197	1,162	-35	46%	-1%	147	6%	1,042	42%
Commercial	7,146	1,504	1,508	4	21%	0%	3,967	56%	1,603	22%
Cumberland	32	3	2	-1	6%	-2%	29	91%	1	3%
Downtown	245	17	19	2	8%	1%	211	86%	15	6%
Industrial	5,313	1,289	1,243	-46	23%	-1%	2,679	50%	1,299	24%
Institutional	2,074	411	411	0	20%	0%	963	46%	573	28%
Open Space/ Natural Area	5,022	2,983	2,862	-121	57%	-2%	370	7%	1,499	30%
Residential	29,114	14,987	14,472	-515	50%	-2%	5,490	19%	8,984	31%
ROW	11,434	2,544	2,515	-29	22%	0%	6,050	53%	2,813	25%
South Waterfront	229	67	52	-14	23%	-6%	118	51%	59	26%
Citywide	63,114	25,002	24,246	-756	38%	-1%	20,023	32%	17,887	28%

Figure I

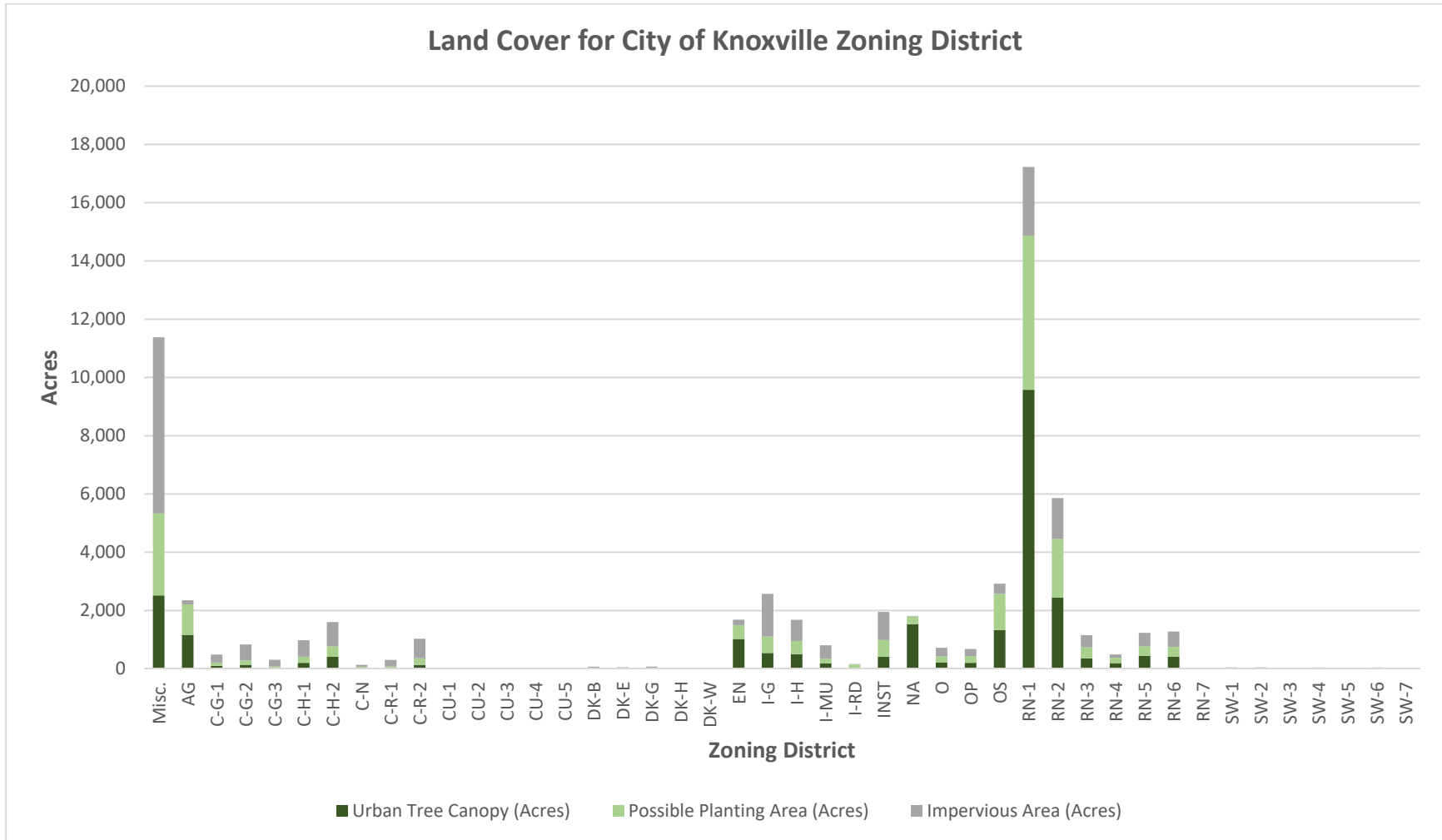


Figure J

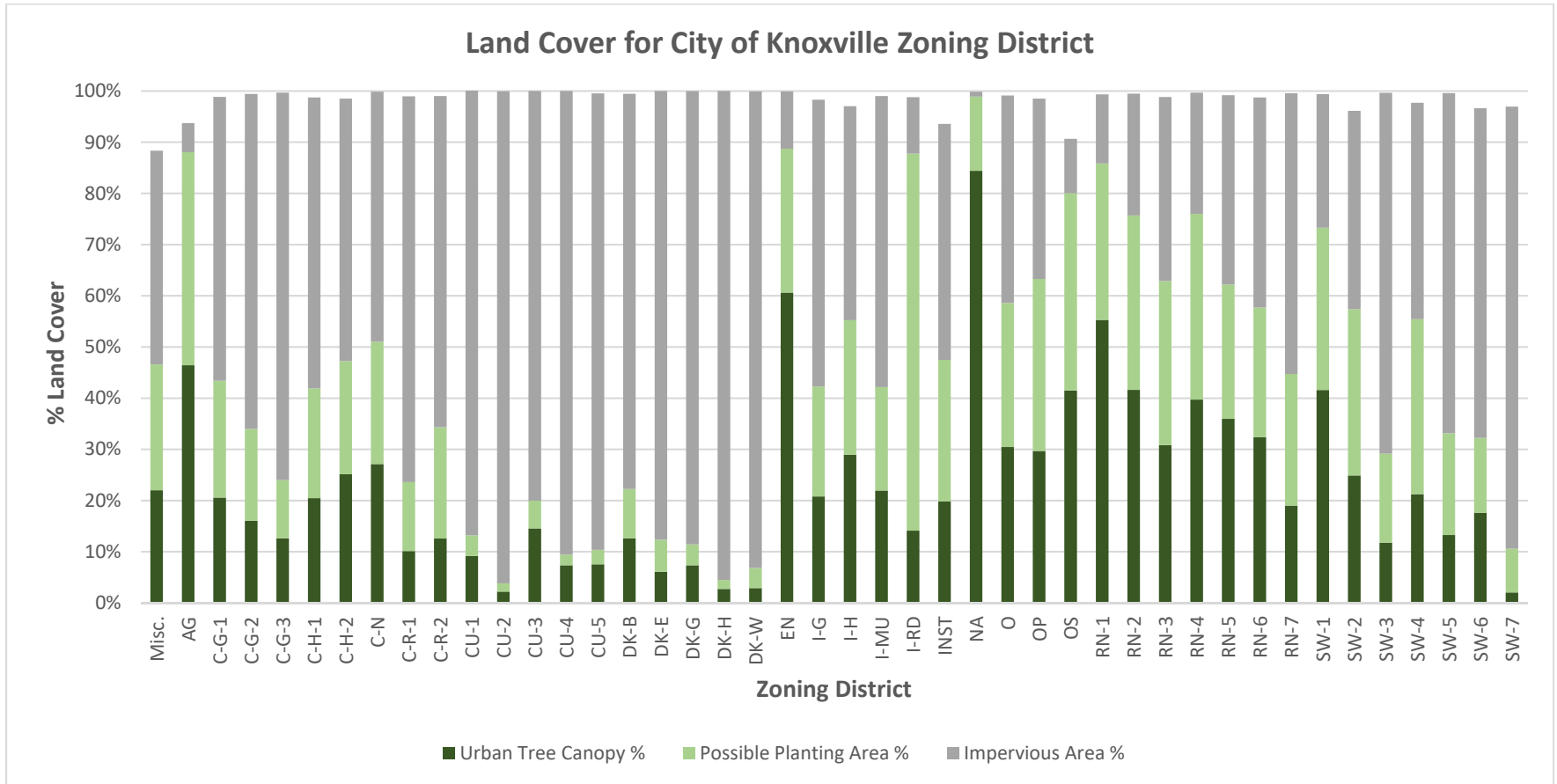
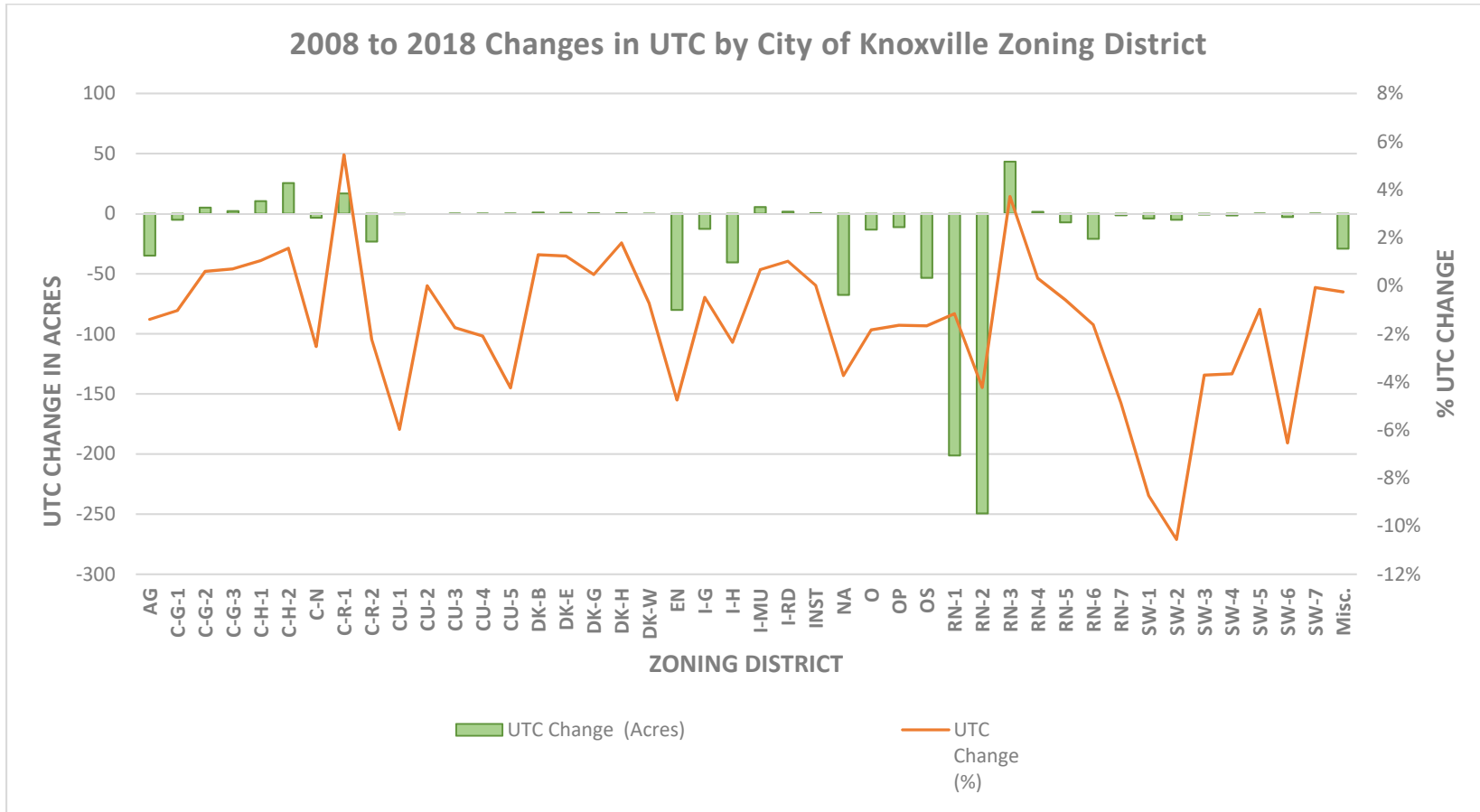


Figure K



Urban Tree Canopy by Knox County Zoning

The County Zones with the top 5 percent of UTC are:

- General Residential/Technology at 75%
- Floodway/Technology Overlay at 72%
- General Residential/ Floodway at 67%
- Office, Medical and Related Services/Technology Overlay (k) and Estate at 64%
- Agricultural/Historical Overlay at 63%

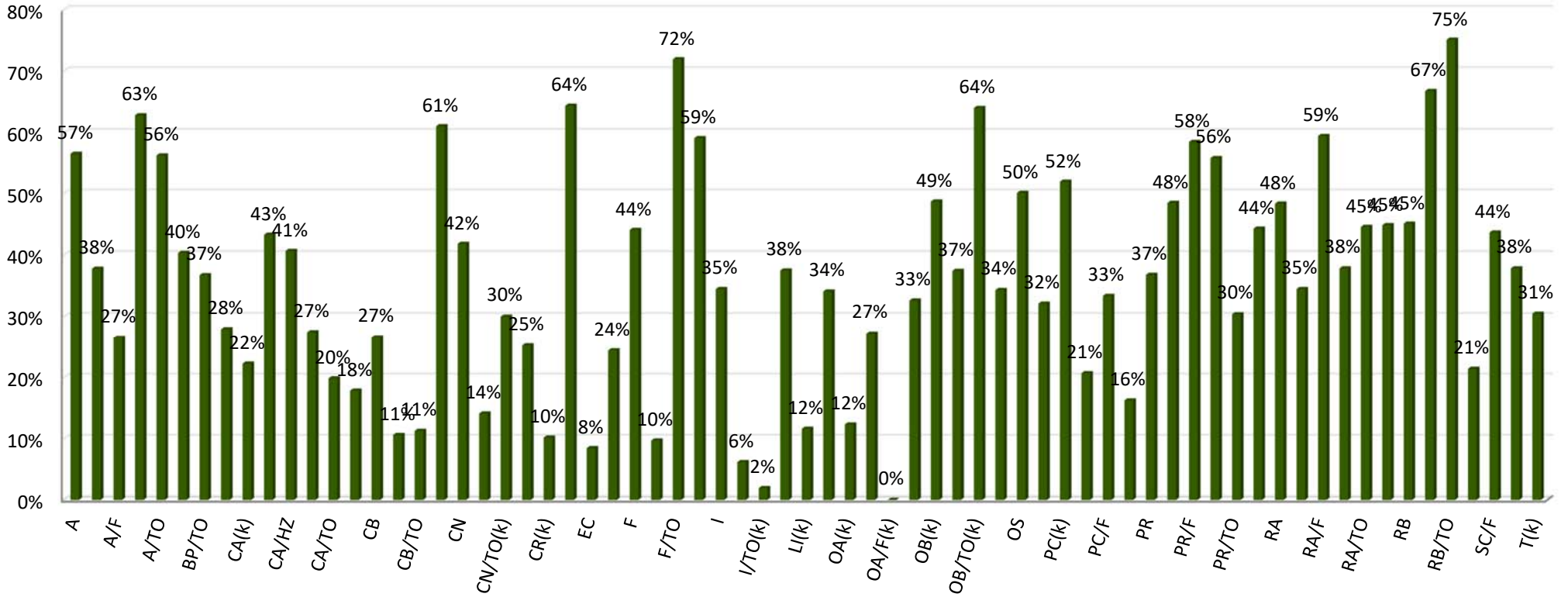
The County zones with the 5 smallest percentages of UTC are:

- Office Park/Floodway (k) at 0%
- Industrial/Technology Overlay (k) at 2%
- Industrial/Technology Overlay at 6%
- Employment Center at 8%
- Floodway/Historical Overlay and Regional Commercial (k) at 10%

Appendix B, Tables 11, 12, and 13 have information on Knox County Zoning Codes and their definition. In these tables, it is found that the General Business and Technology Overlay (k) zone saw the greatest decrease in canopy coverage at -29%. The zone with the greatest increase in canopy coverage is the Planned Commercial/Technology at +17%. Overall, Knox County saw a decrease in UTC of 1% between 2008 and 2018. Although the County saw an overall increase in UTC, most of that increase came from agricultural land that is no longer being used for agriculture and has reverted back to UTC. The area with the fifth most canopy cover is the Agricultural/Historical Overlay. There has been a decrease in canopy coverage in populated urban areas, such as Neighborhood/Commercial and General Business/Technology Overlay, which means efforts to increase and maintain canopy coverage need to take place in these urban areas in order for the public to take advantage of the benefits trees provide.

Figure L

Existing UTC (%) by Knox County Zoning



Urban Tree Canopy by 2010 Census Data

Tree equity is important to ensure that all neighborhoods have adequate UTC and that all members of that community can obtain all the health, economic, and environmental benefits that trees provide. In order to look at the equability of UTC throughout Knox County and the City of Knoxville, UTC was researched at each US Census Tract. Census Tract information, such as population density, race and ethnicity, income, and poverty, was compared to UTC data and trends from this study to measure tree equity. The following are some of the findings from the study:

- Both Knox County and the City of Knoxville showed that household income does correlate to the amount of UTC in a community (see Figures M and N).
- If looking at the average UTC within the County at 49% and the City at 38% UTC, average household income would be around \$70,000 and \$45,000 respectively.
- Both Knox County and the City of Knoxville showed that as poverty rates increased, it was more likely the community lost UTC between 2008 and 2018 (see Figures O through R).
- Minorities living in Knox County tend to live in areas with lower UTC, and mostly live within the City of Knoxville, where UTC is lower (see Figures S and T).
- Minority communities in the City of Knoxville were not likely to see lower or higher UTC when compared to other communities across the City (Figure T).
- Lower UTC and higher impervious areas tend to exacerbate the urban heat island effect. Figure V shows that people living in poverty are more likely to be living in neighborhoods with high impervious areas while minorities are slightly less likely.

Figure M

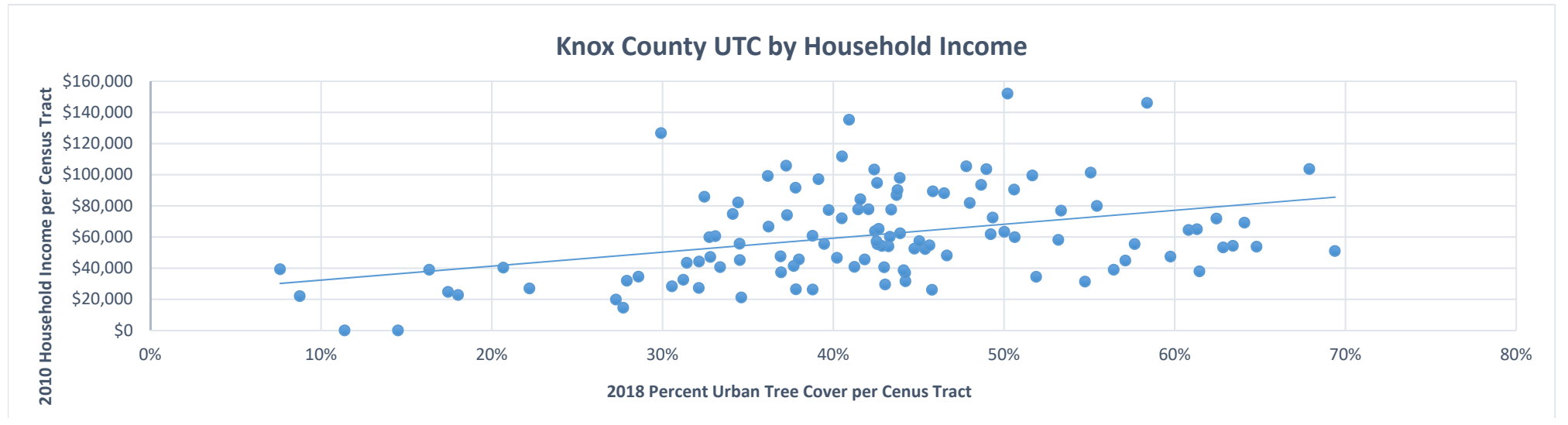


Figure N

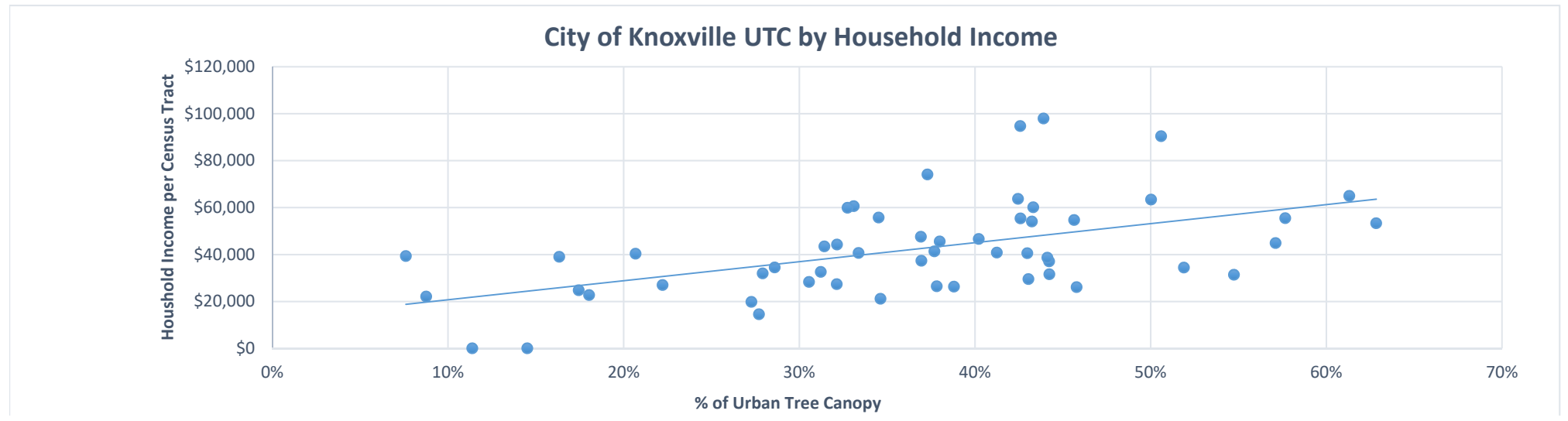


Figure O

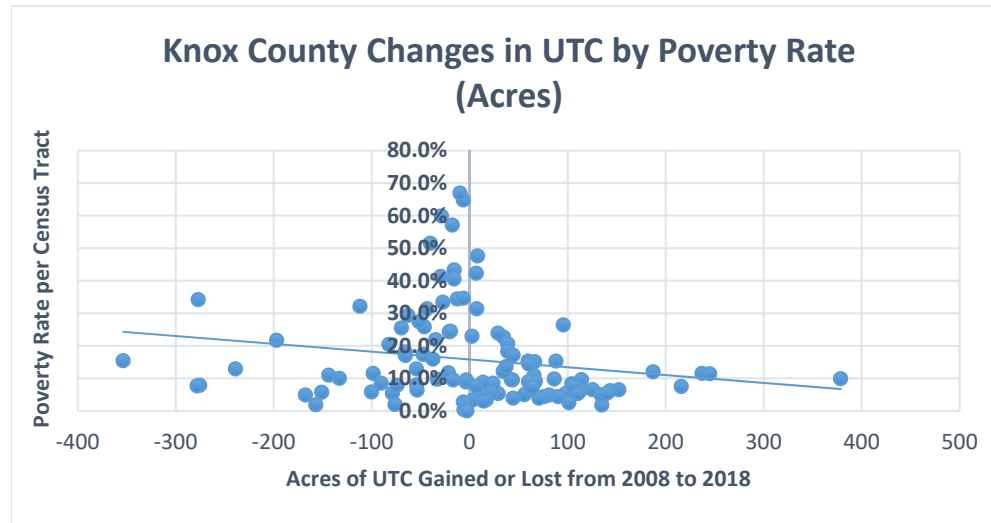


Figure P

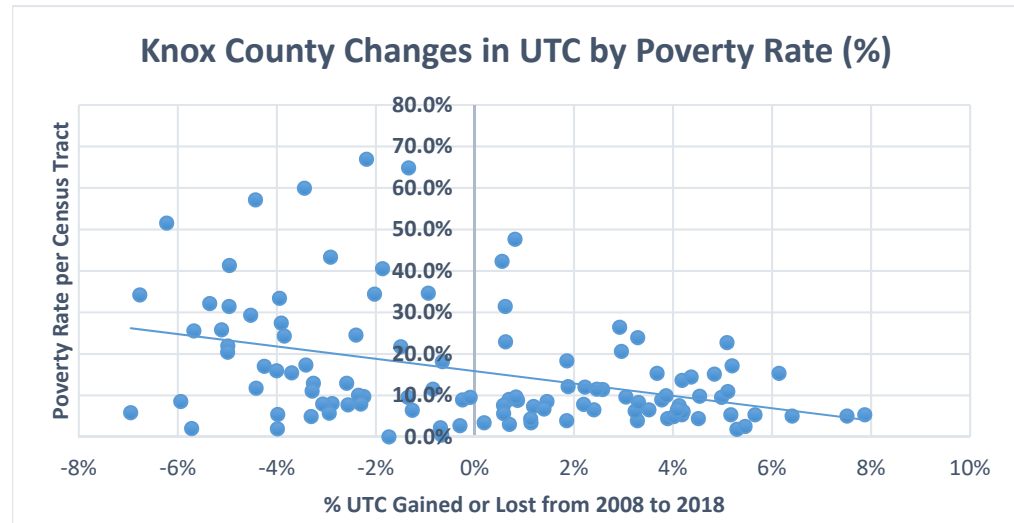


Figure Q

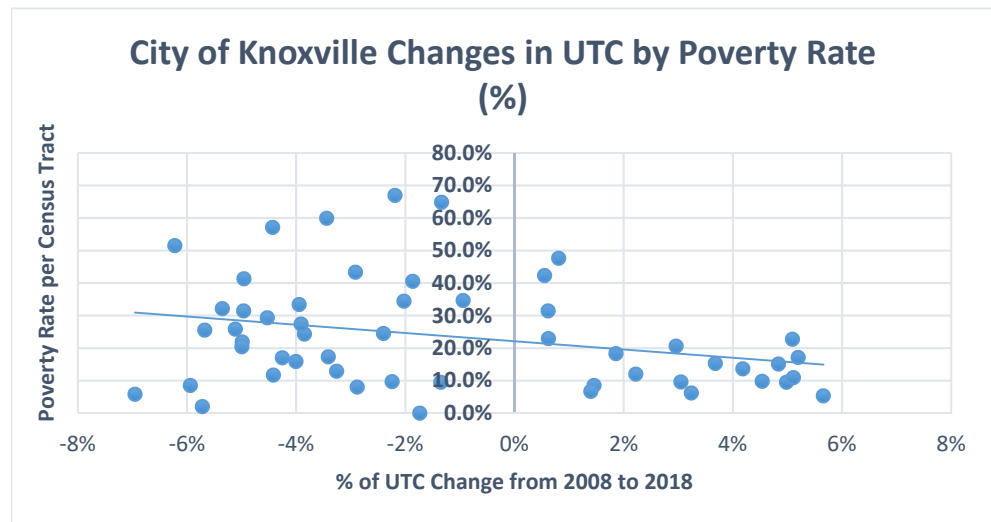


Figure R

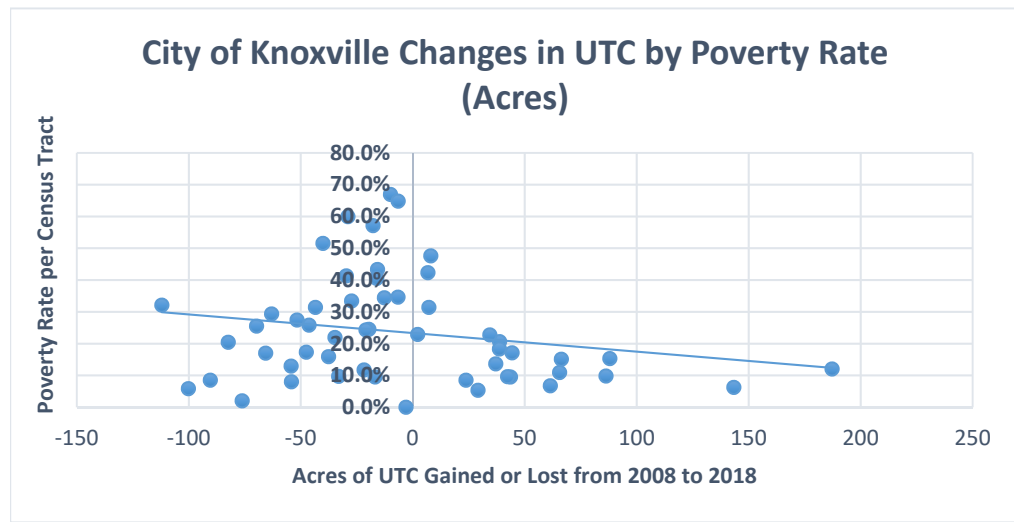


Figure S

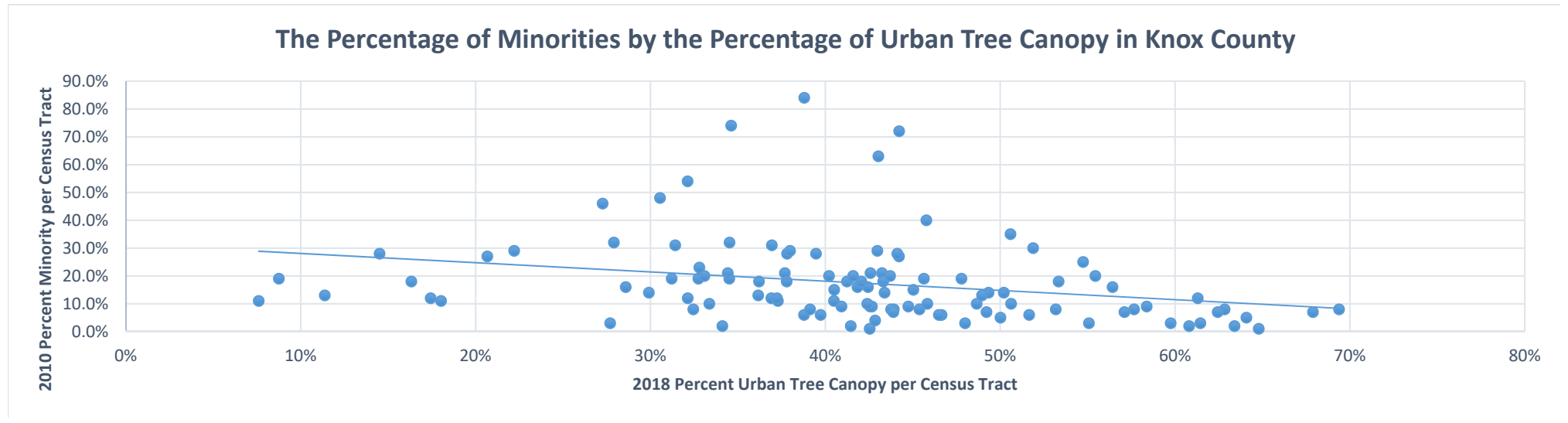


Figure T

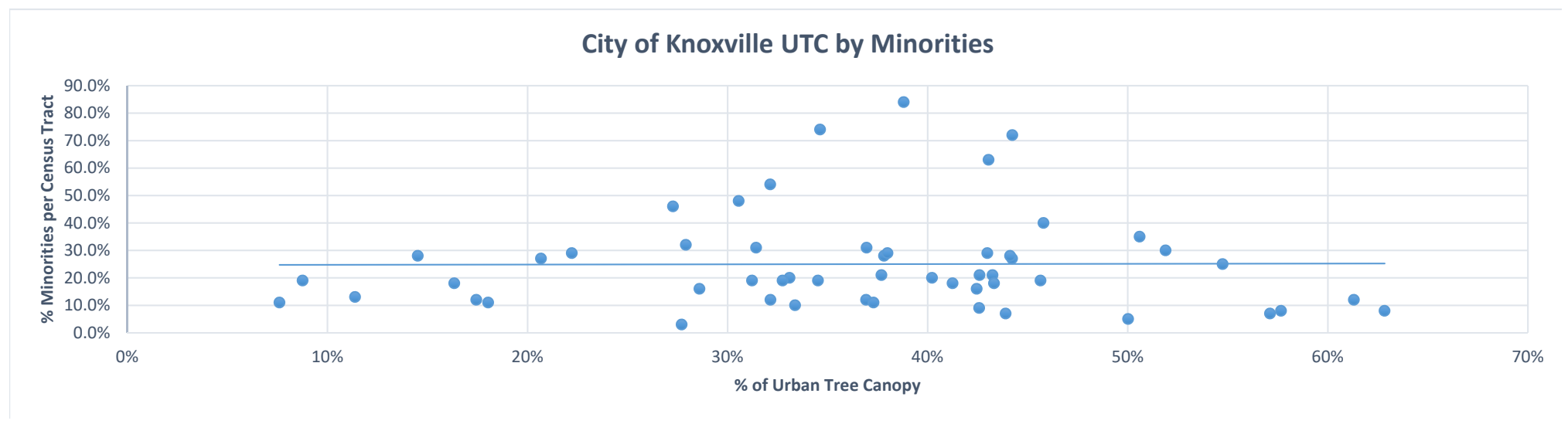


Figure U

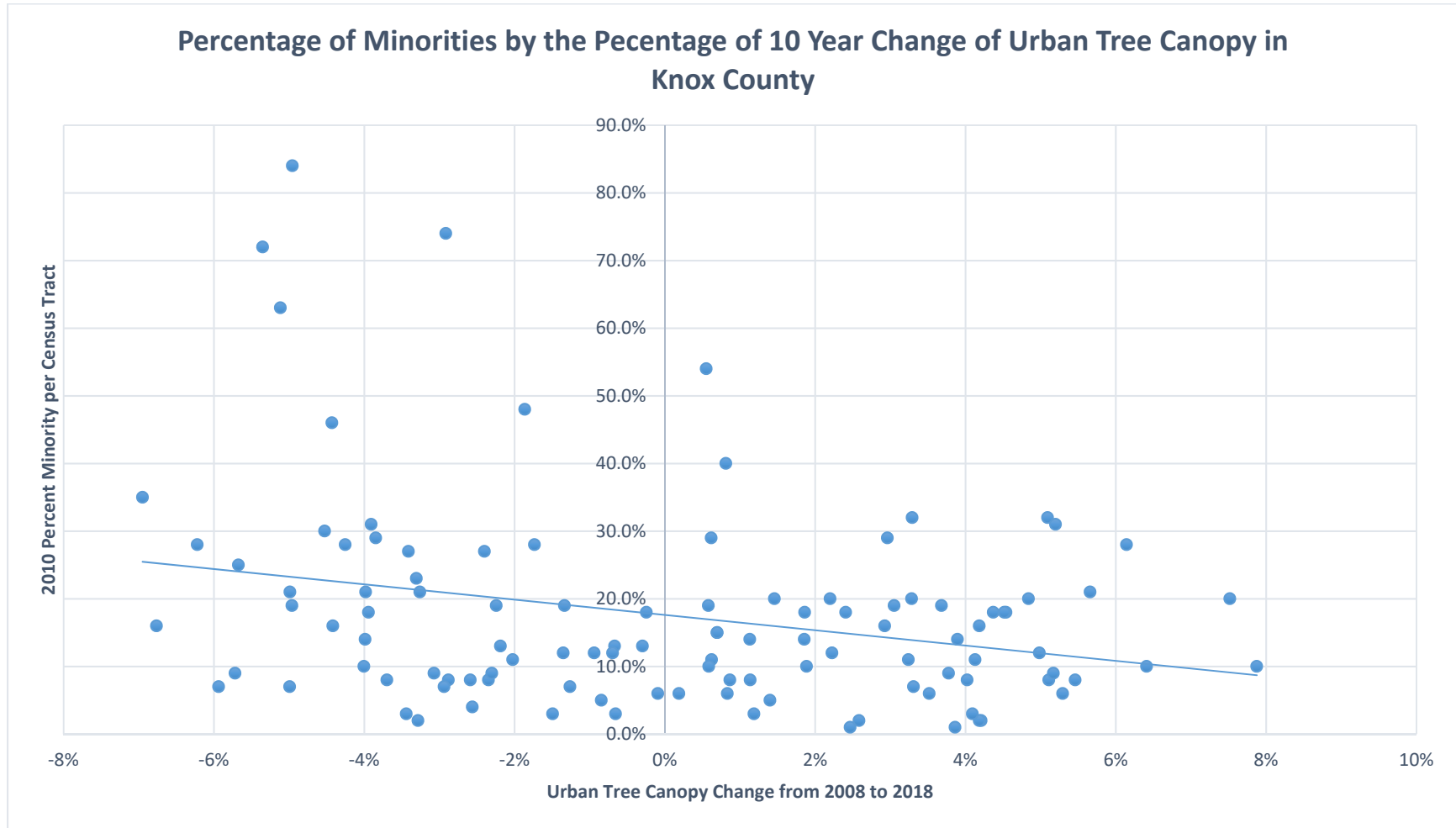
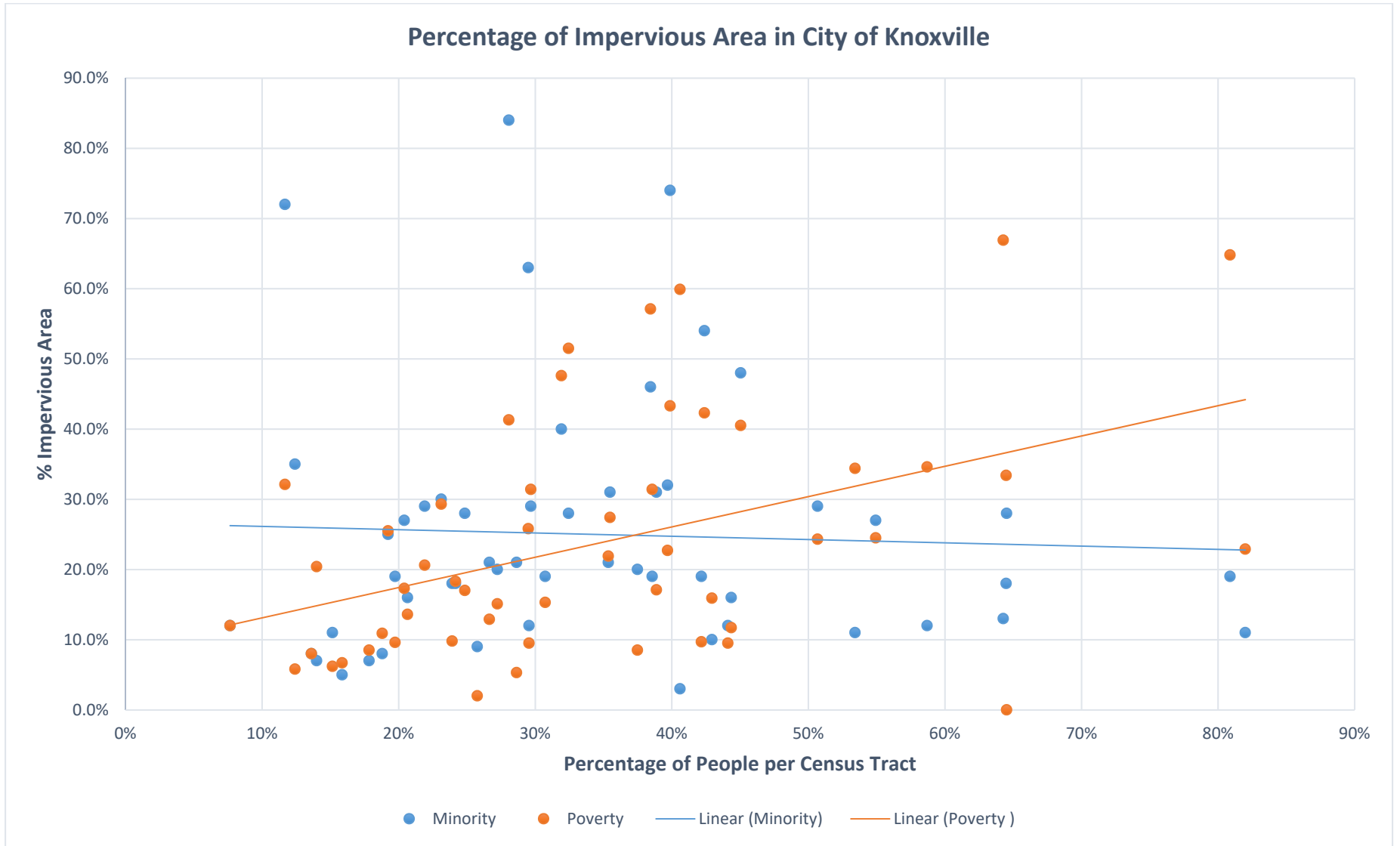


Figure V



Recommendations

The Urban Tree Canopy Assessment provides extensive information for the City of Knoxville and Knox County about the distribution of tree resources and the urban forest. The findings from this study can be used to:

- Develop urban tree canopy goals for different geographies including the City of Knoxville, Knox County, or smaller scales such as neighborhoods or elementary school districts
- Establish baseline urban tree canopy cover information to track and monitor progress on tree decisions and goals
- Develop or refine policies to ensure that the right measures are in place to maintain and increase UTC
- Integrate trees and the information from the study into other sustainability goals such as stormwater and water quality programs, air quality initiatives, climate preparedness and mitigation practices, and watershed protection programs
- Ensure tree equity across all communities in the City of Knoxville and Knox County
- Inform the public about the findings and develop community driven recommendations on how to proceed with urban forestry goals
- Educate the public about the importance of urban tree canopy and the social, economic, and environmental benefits that are impacted by trees
- Create an urban forestry master plan for the community to determine how to best manage its tree resource in order to maximize the benefits trees provide its residents
- Build protections and expand UTC in critical areas such as riparian corridors, slopes and hilltops, urban centers (such as downtown Knoxville), school and medical campuses, and along street ROW and other areas with high impervious land cover

Conclusions

The Urban Tree Canopy Assessment provides baseline information on urban tree canopy across Knox County and the City of Knoxville. The social, economic, and environmental benefits that trees provide a community are impacted by the amount of UTC in an area. Many communities have realized the importance of trees and have made strong efforts to increase and/or maintain UTC. What one community does may not work or be feasible for another, and there is not one specific number or percentage that a community must obtain. Rather, a community should look at how UTC will be addressed and balanced with other community needs. For example, the City of Knoxville has lost about 1% tree cover in the last ten years, but that does not mean tree programs and planting efforts are not working. The City may need to rethink what role trees play in the community and look at areas where UTC changes have been more dramatic or could easily be improved in time. The County had a small increase in the amount of UTC, but should look at where gains are being made and where losses are occurring. For example, the County has a large amount of agricultural land that may have been removed from agricultural programming and be reverting back to trees, while UTC may be lost in urban or populated areas, where it makes the most impact.

When looking at the total area (including water) of Knox County, 47% of the County is covered with trees and another 35 to 39% could be potential planting area that could accommodate trees. However, it is not realistic to expect that all parking lots and all other non-canopy vegetation could revert to UTC (Figure W). The City of Knoxville has 36% UTC with a potential planting area of 28 to 38% (Figure X) when including water. Both the City and the County have room to expand UTC, but must weigh those efforts with others needs in the community. By breaking the County and City into smaller geographic areas such as watersheds, neighborhoods, school districts, or census tracts, both communities could get more specific and targeted UTC goals that work. Preservation may be a priority for one geographic area, while planting efforts is better suited in another. Engaging the public is essential for future planning efforts. This report and study are key for that public process.

Figure W

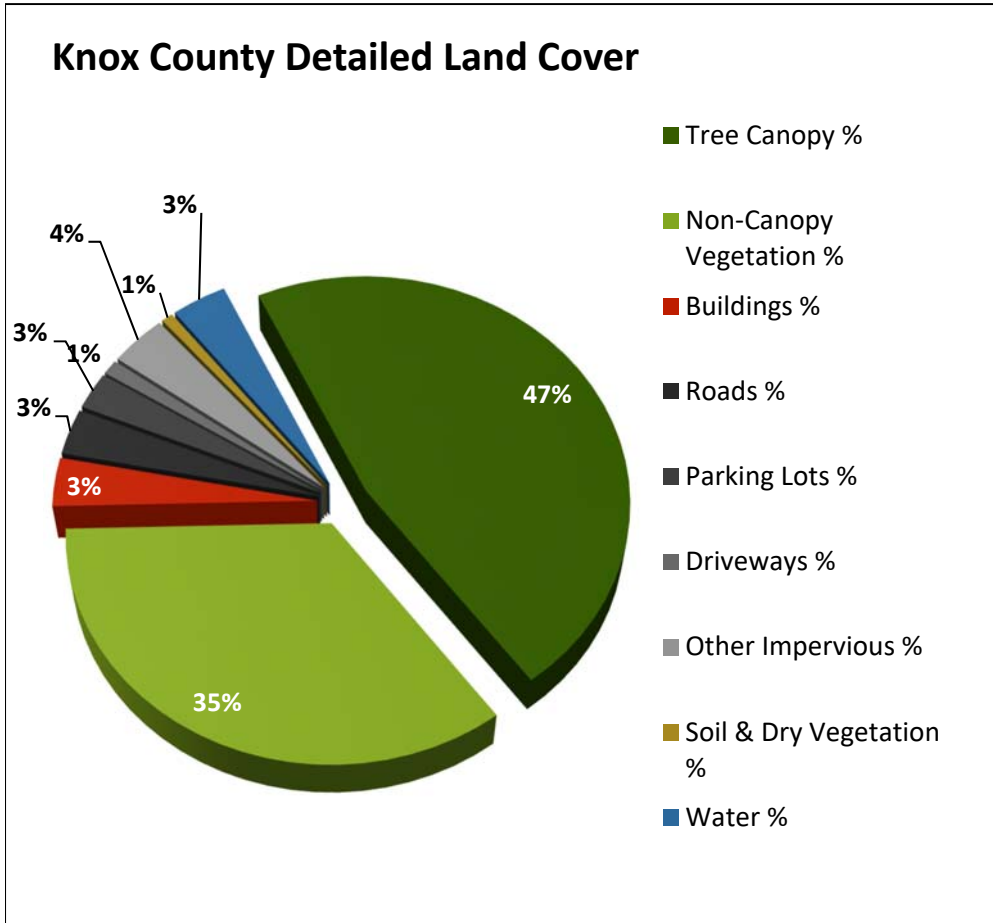
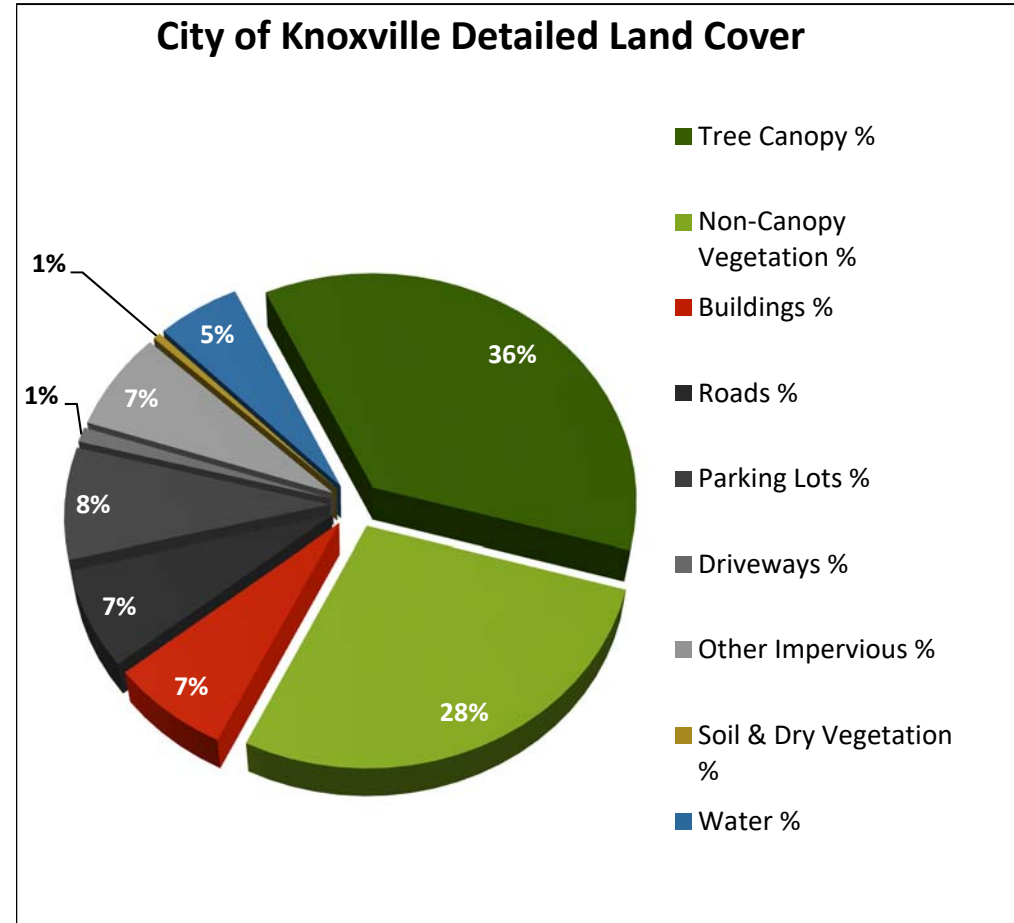


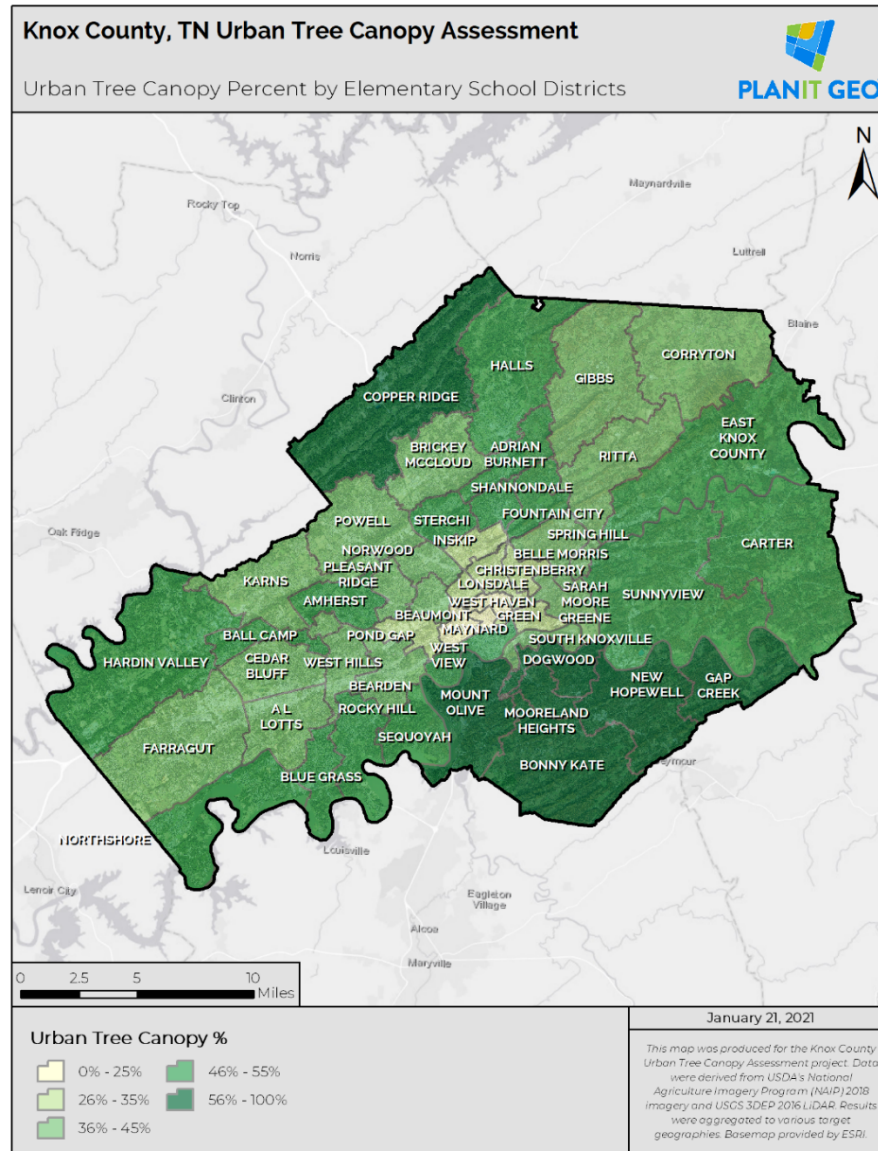
Figure X



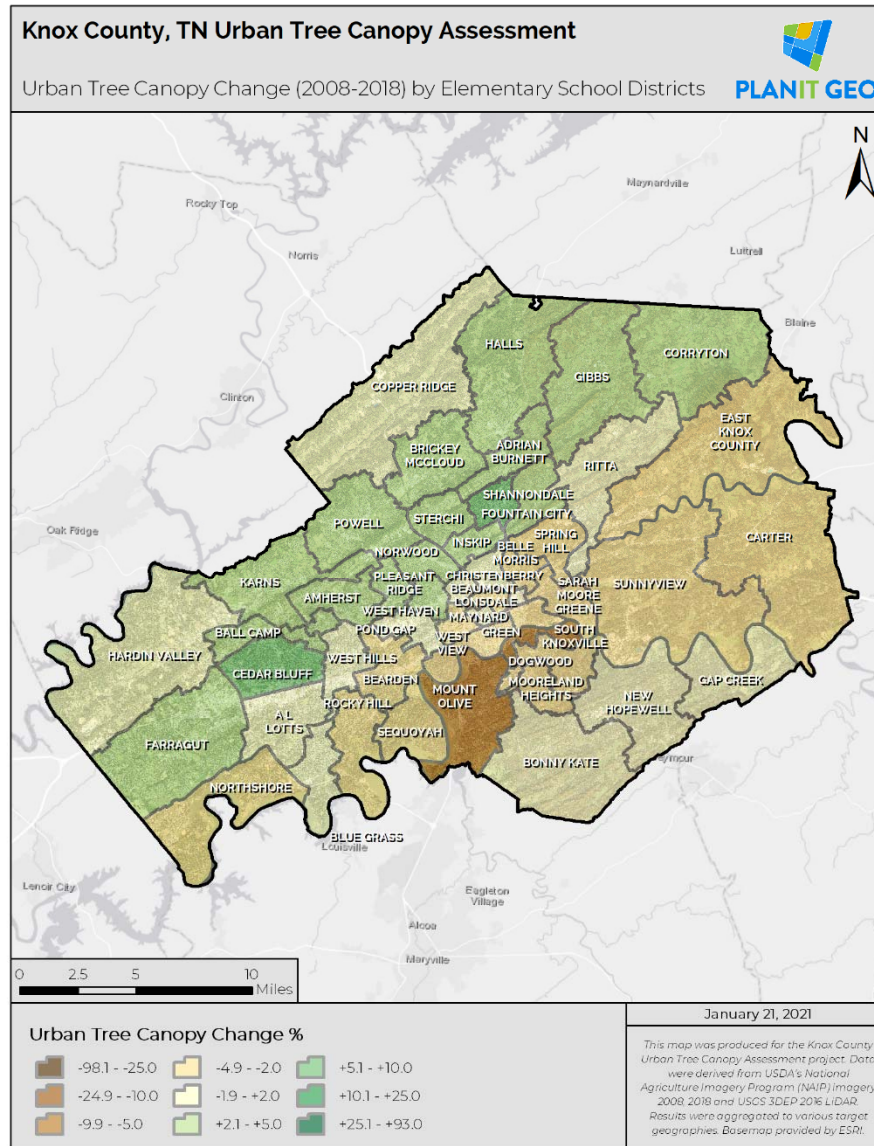
Appendix A

Maps

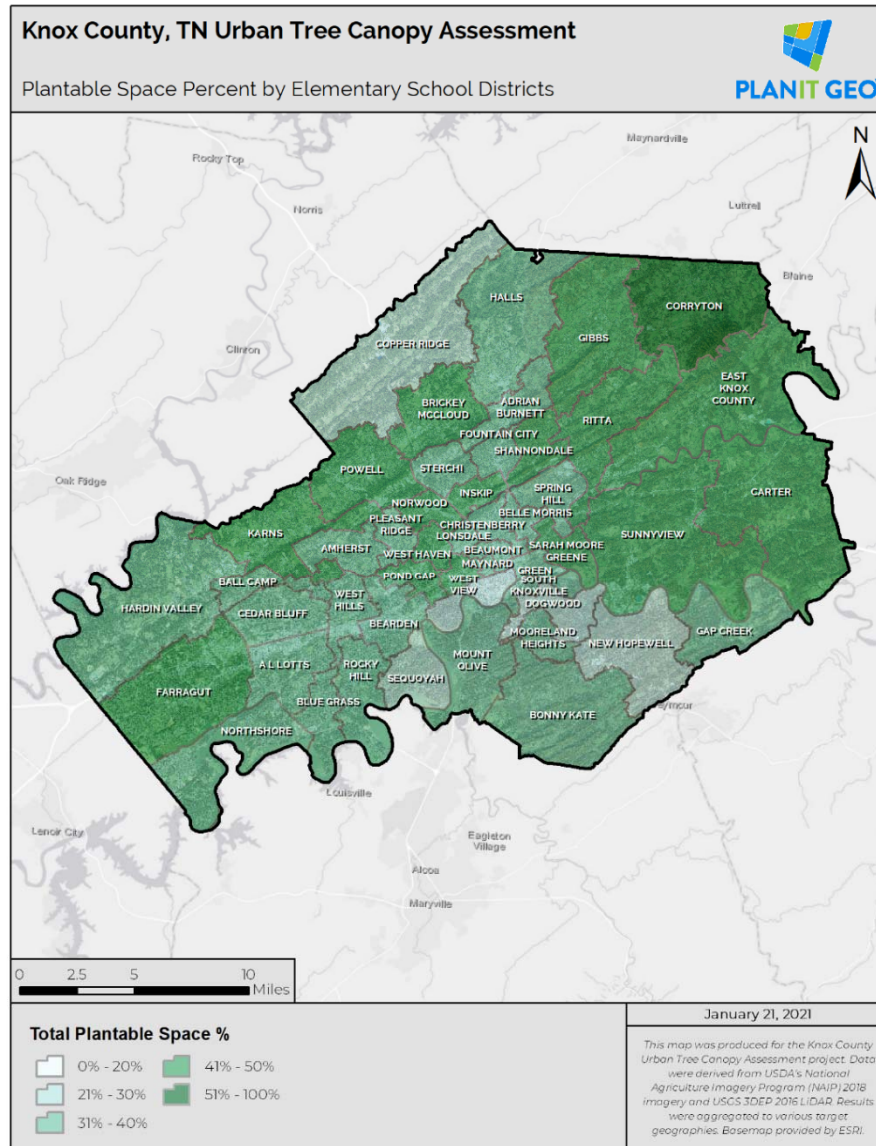
Map 1



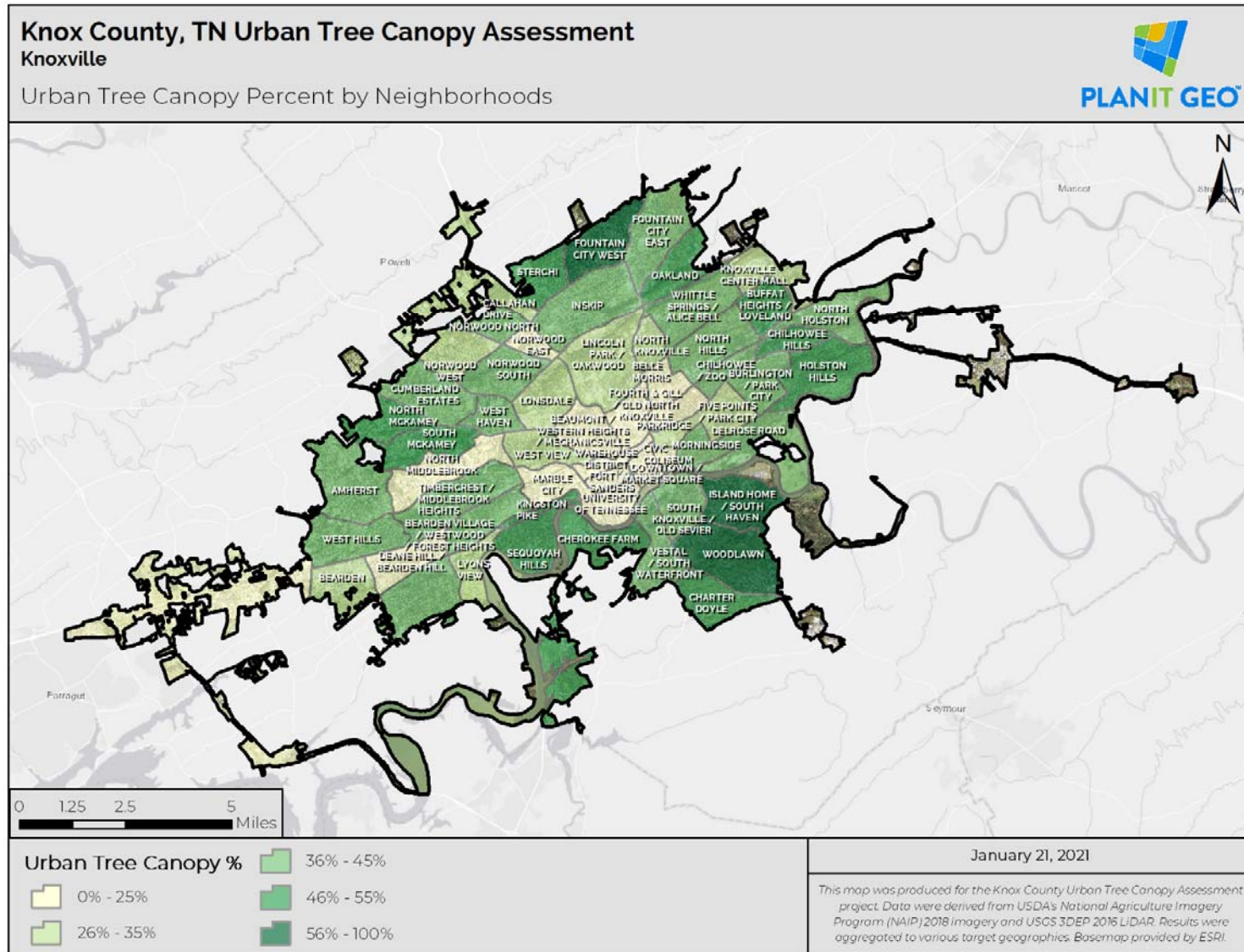
Map 2



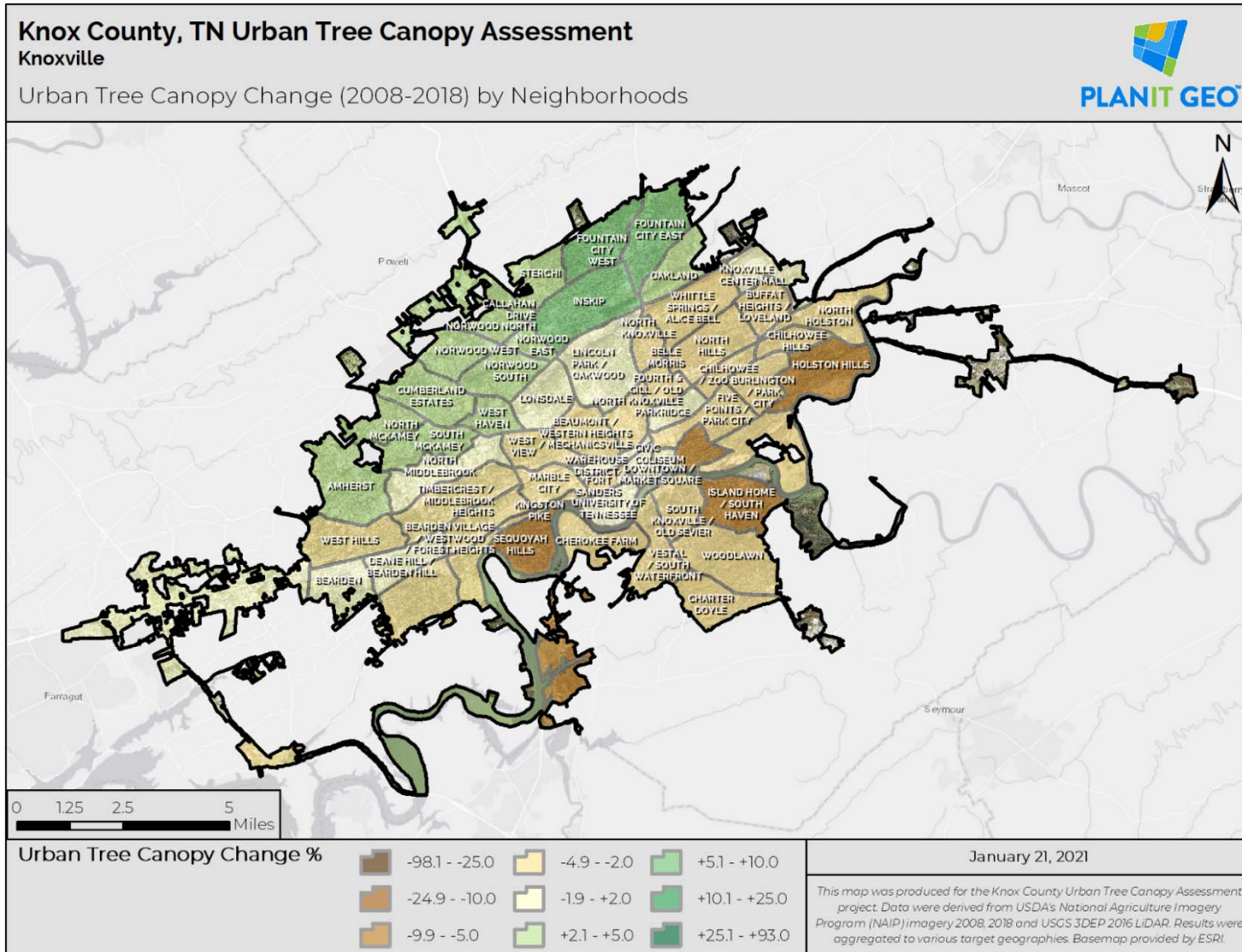
Map 3



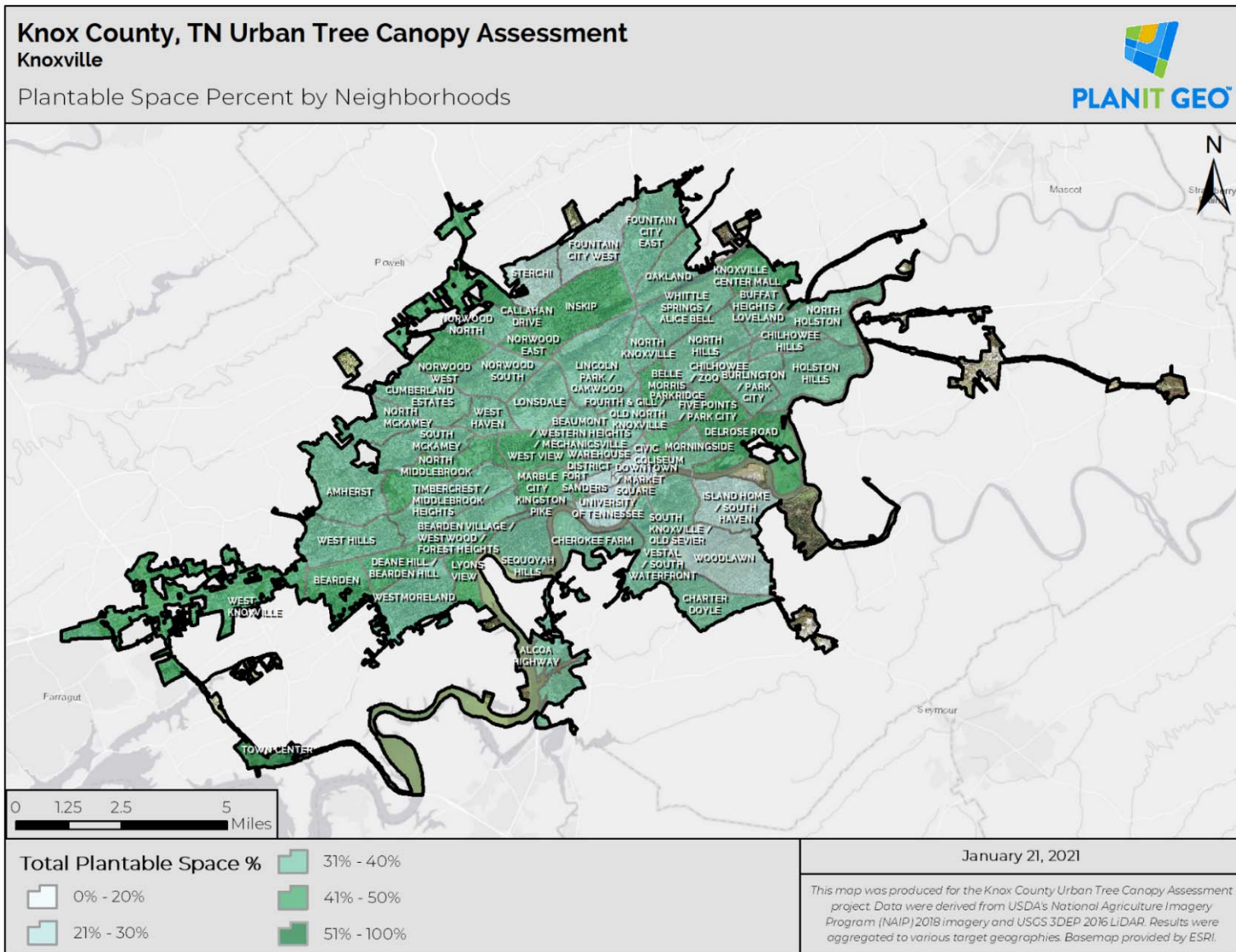
Map 4



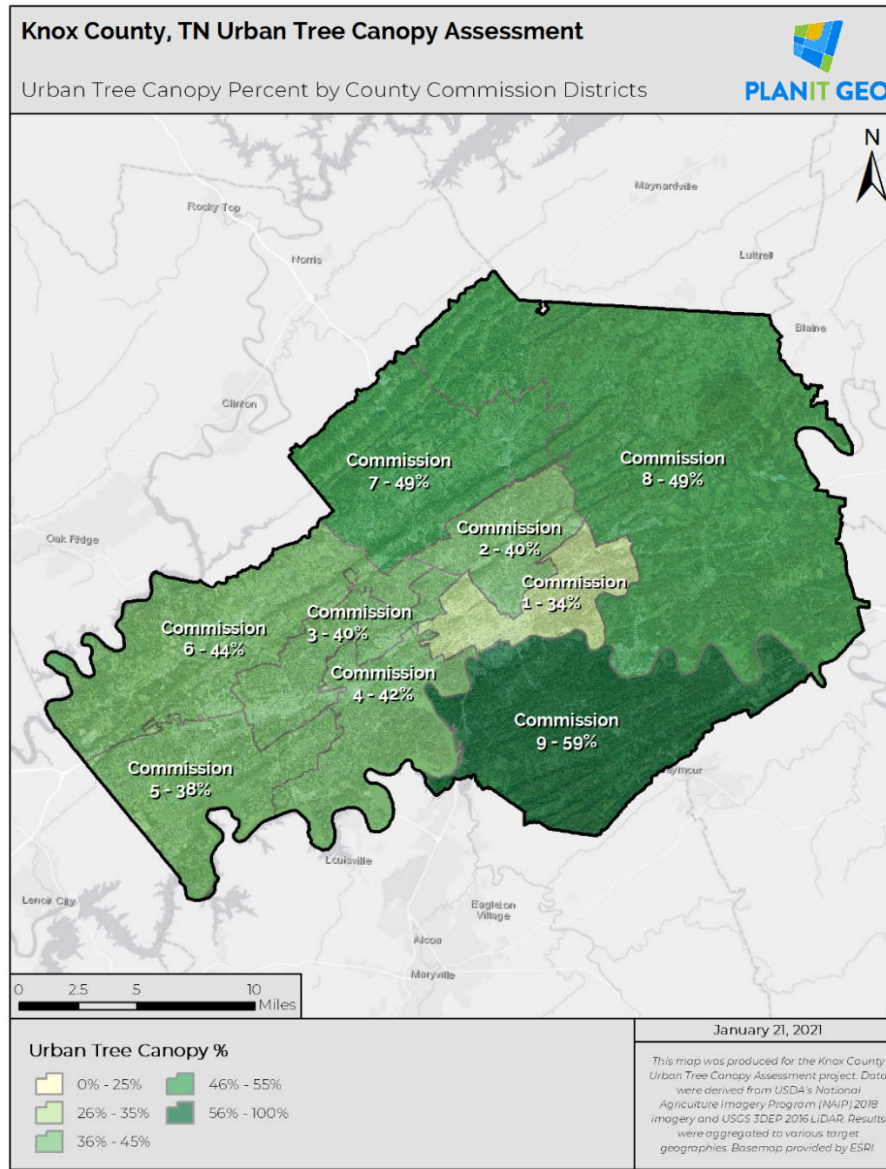
Map 5



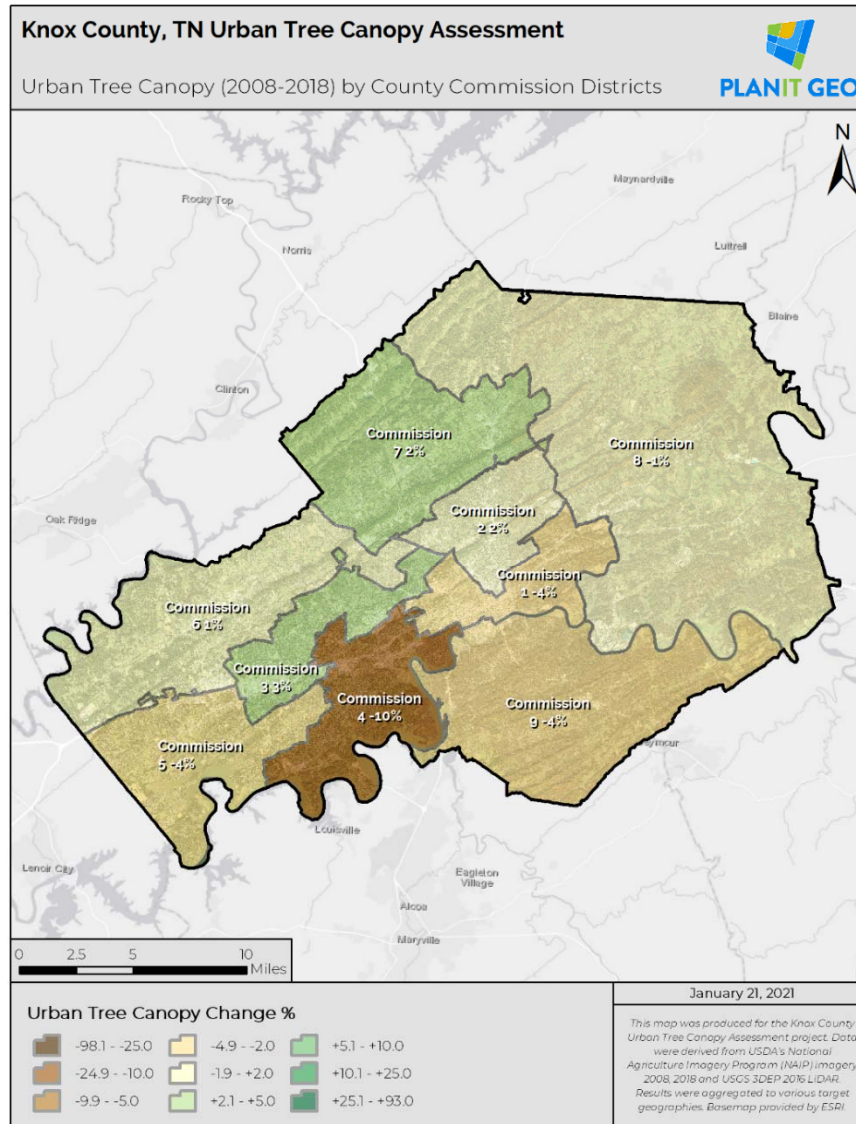
Map 6



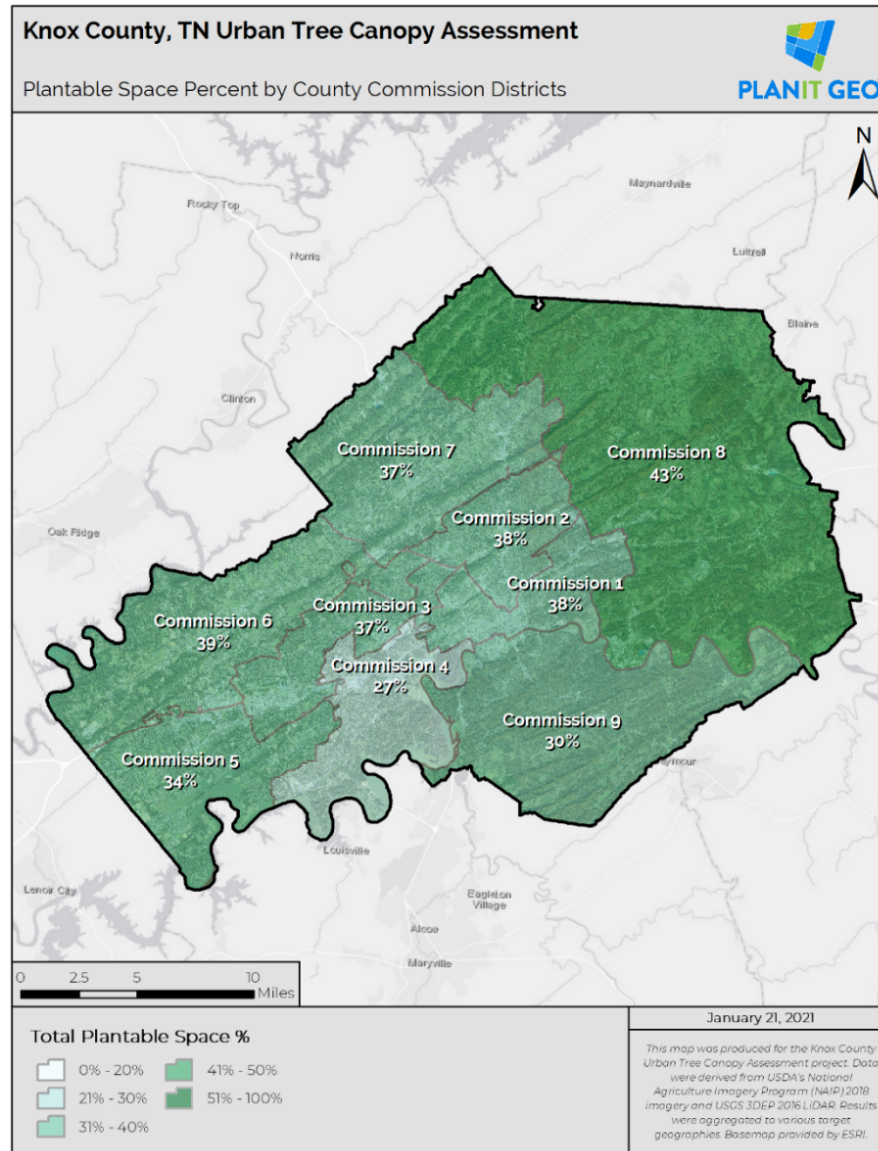
Map 7



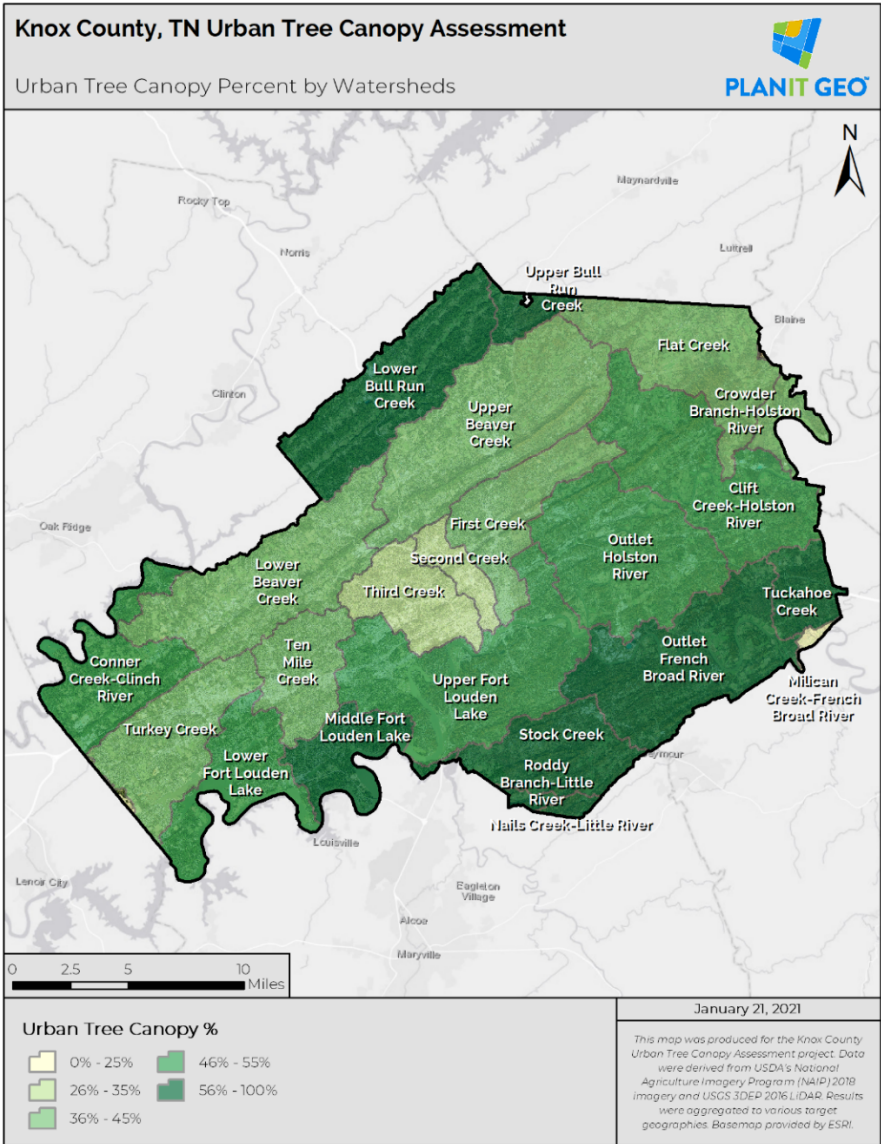
Map 8



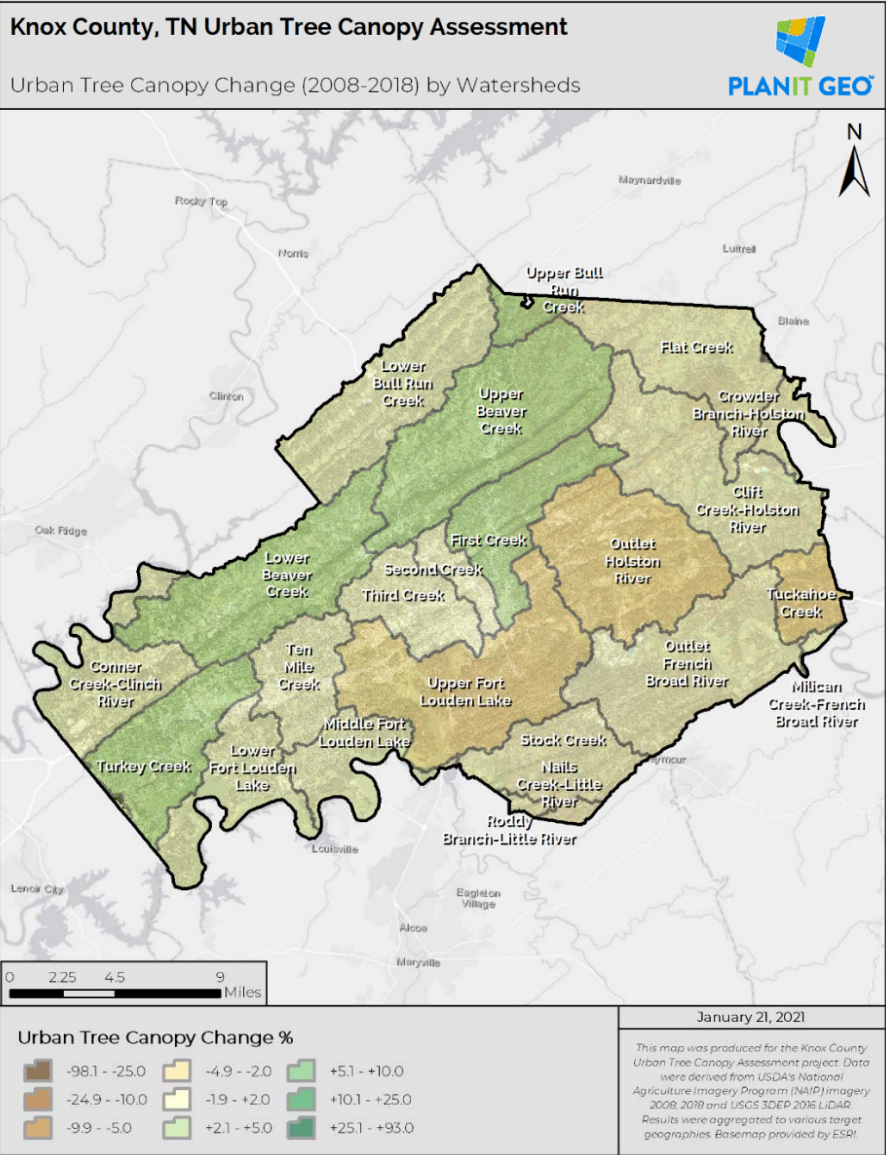
Map 9



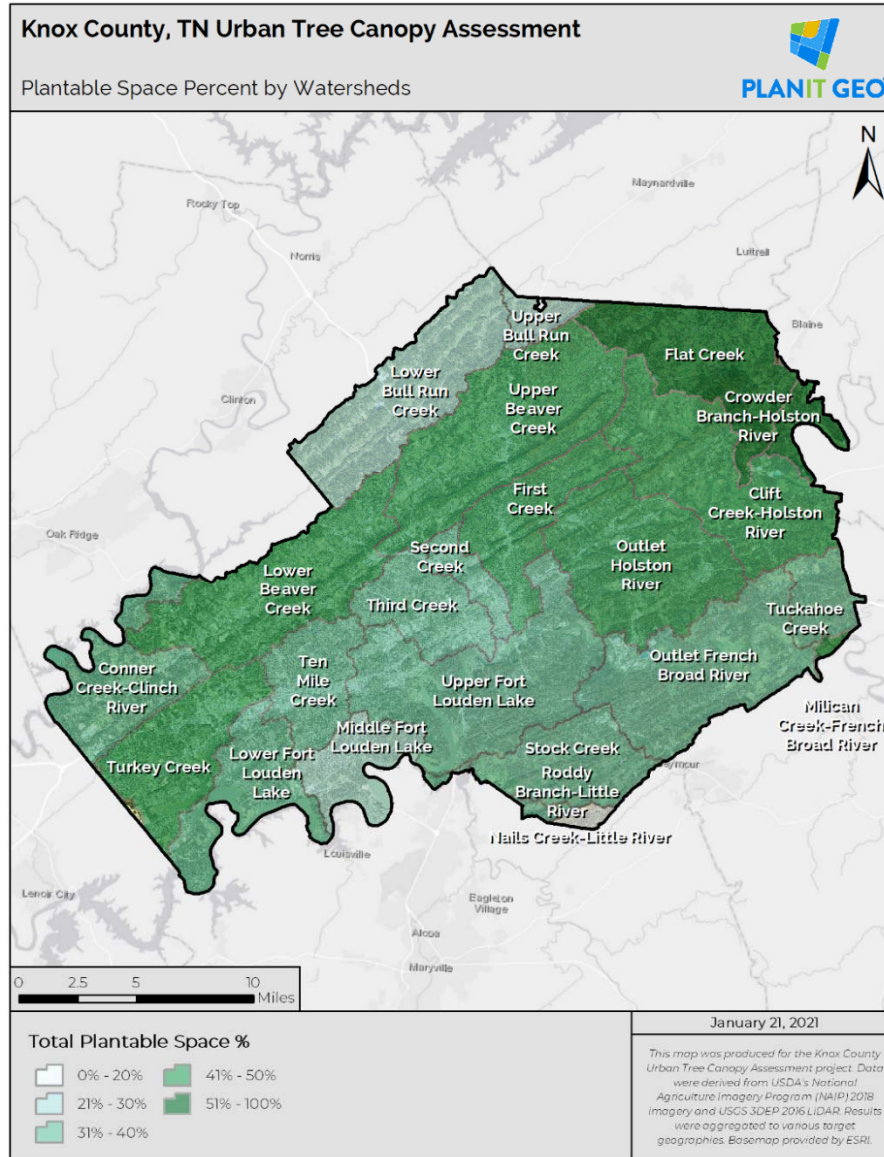
Map 10



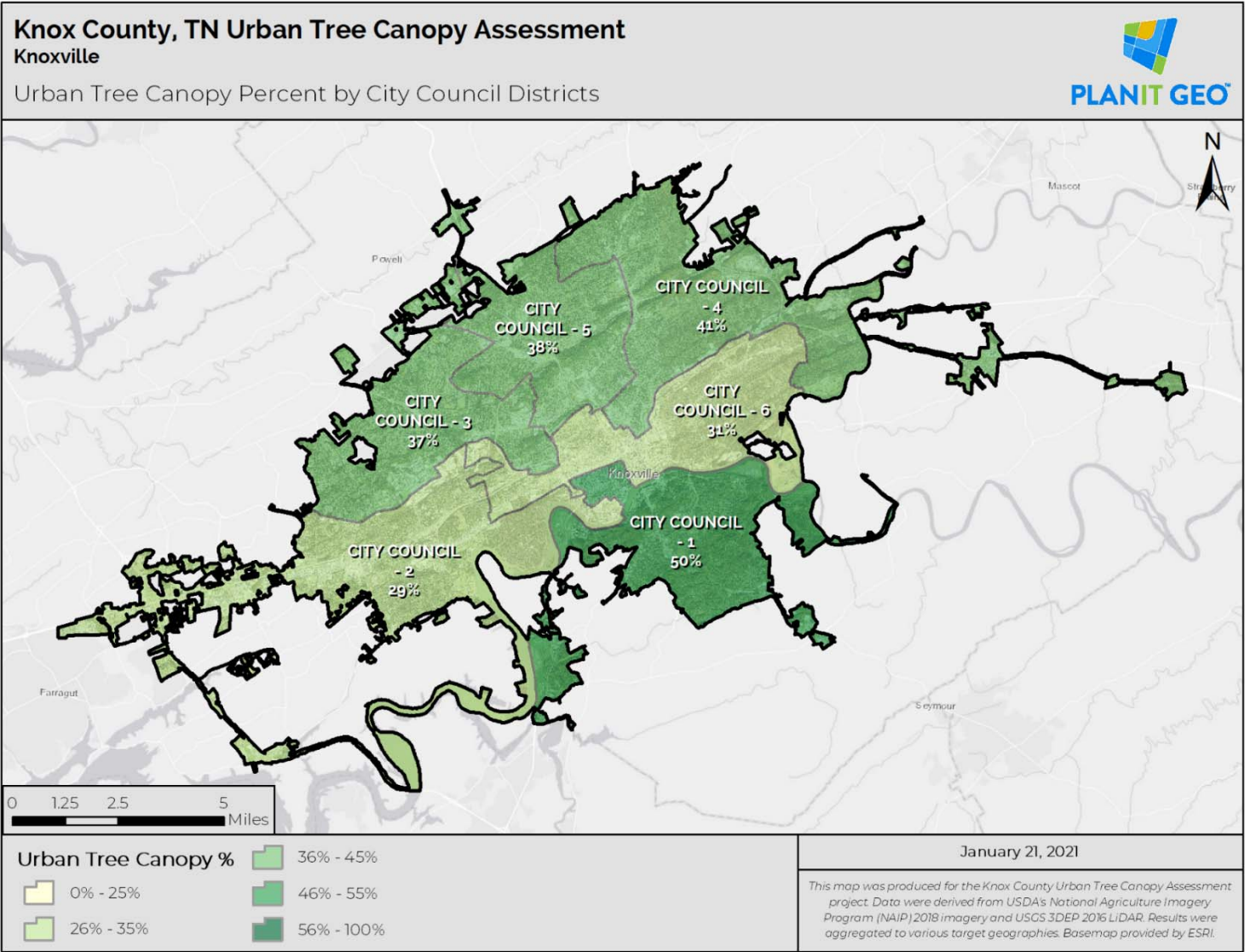
Map 11



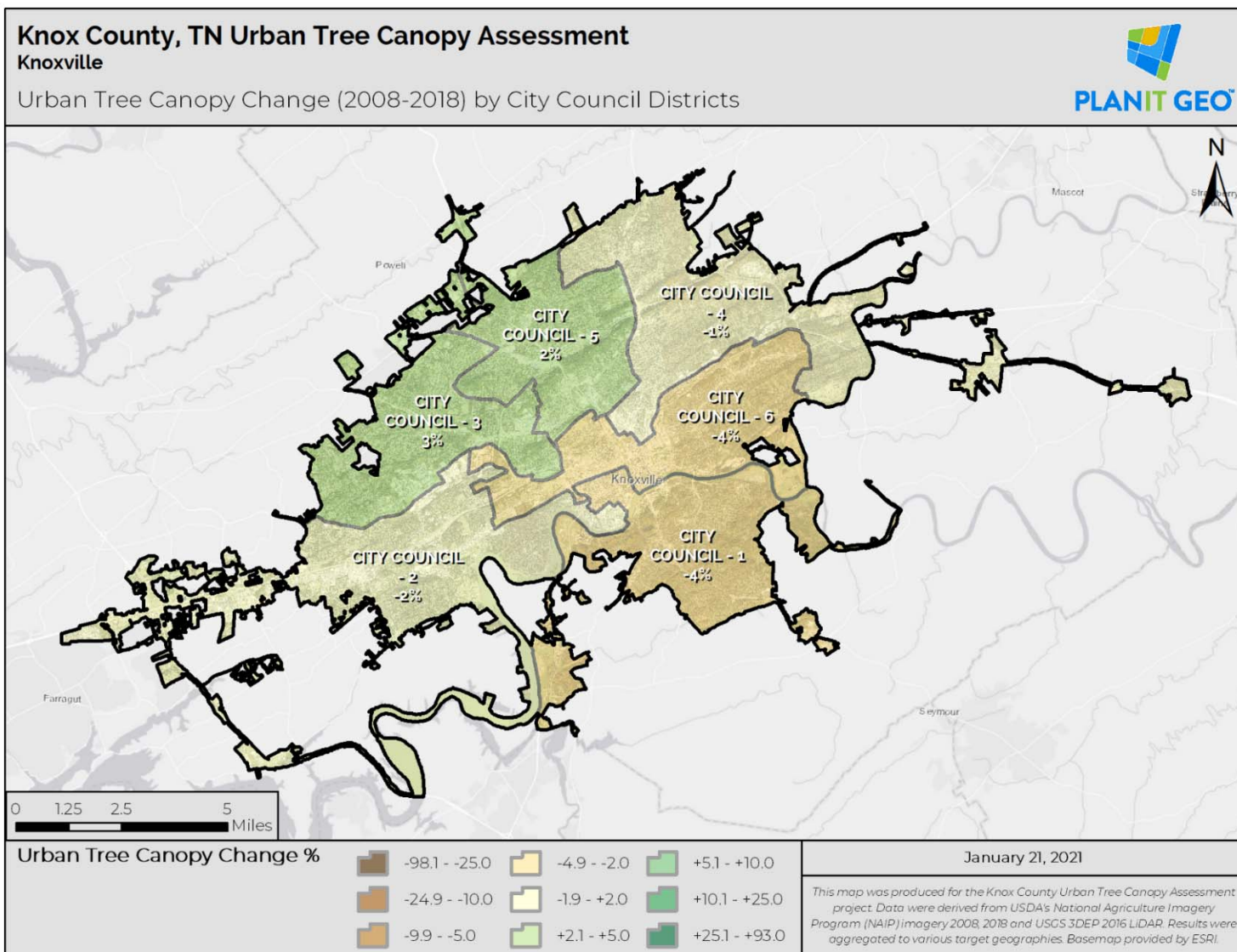
Map 12



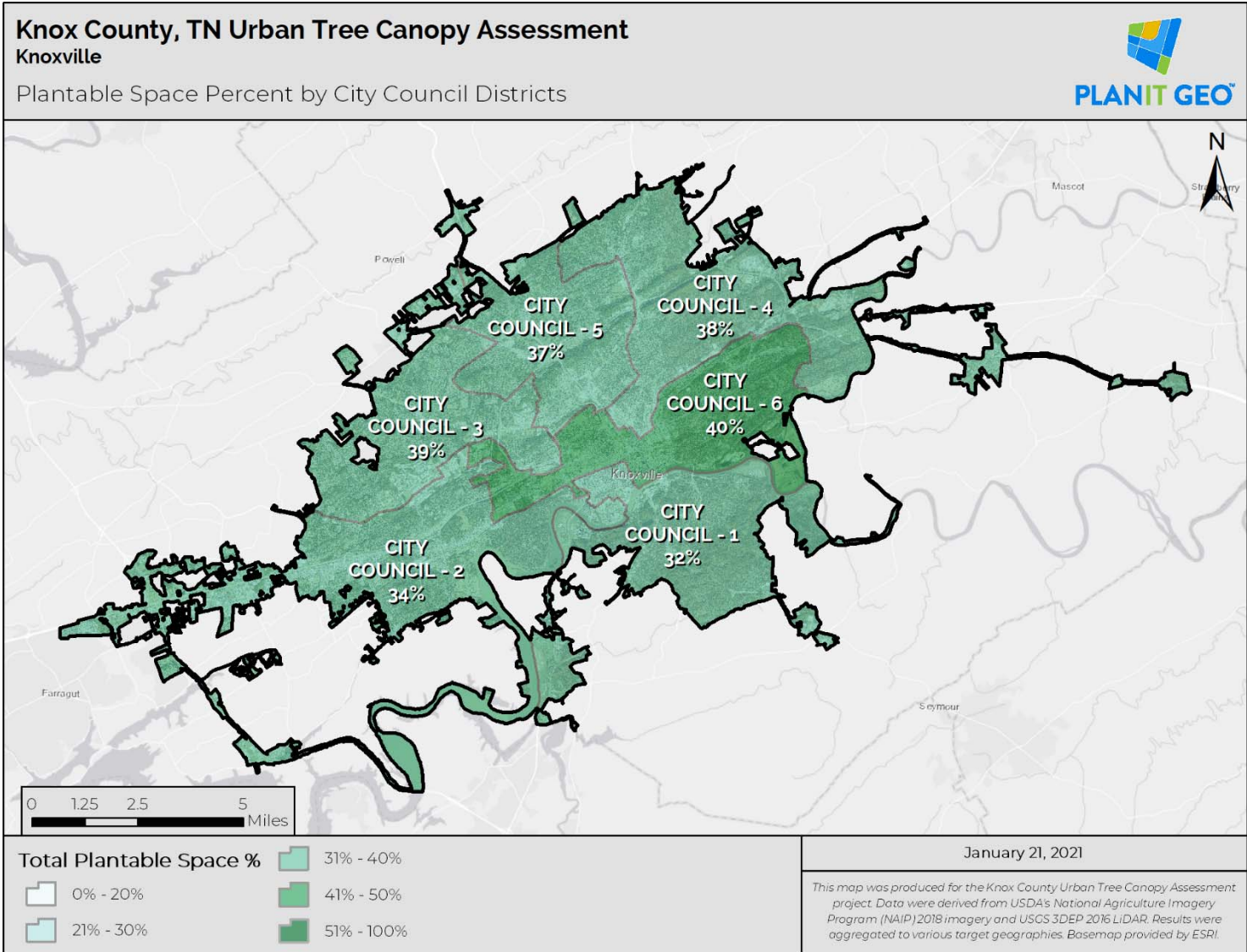
Map 13



Map 14



Map 15



Appendix B

Tables

Table 1

UTC Metrics by Elementary School District A-G									
	Elementary School District	Total Area (Acres)	UTC %	PPA %	Total Impervious Area %	UTC 2008 (%)	UTC 2018 (%)	UTC Change 2008-2018 (Acres)	Raw Change (%)
Knox County	A L Lotts	5,921	38%	29%	31%	40%	38%	-81	-1%
	ADRIAN BURNETT	3,898	50%	30%	17%	46%	50%	143	4%
	AMHERST	3,913	48%	34%	17%	45%	48%	125	3%
	BALL CAMP	2,766	47%	29%	22%	43%	47%	131	5%
	BEARDEN	4,278	37%	27%	35%	41%	37%	-149	-4%
	BEAUMONT	893	17%	24%	57%	21%	17%	-30	-3%
	BELLE MORRIS	1,487	30%	27%	43%	35%	30%	-70	-5%
	BLUE GRASS	3,926	50%	28%	18%	50%	50%	-12	0%
	BONNY KATE	14,765	64%	31%	5%	65%	64%	-162	-1%
	BRICKEY MCCLLOUD	7,187	39%	40%	18%	36%	39%	234	3%
	CARTER	21,299	53%	39%	6%	56%	53%	-469	-2%
	CEDAR BLUFF	5,383	38%	31%	28%	33%	38%	273	5%
	CHRISTENBERRY	1,975	32%	21%	47%	34%	32%	-39	-2%
	COPPER RIDGE	20,358	64%	28%	6%	62%	64%	362	2%
	CORRYTON	14,276	40%	53%	4%	38%	40%	325	2%
	DOGWOOD	3,958	60%	24%	16%	64%	60%	-177	-5%
	EAST KNOX COUNTY	20,106	45%	45%	9%	48%	45%	-523	-3%
	FARRAGUT	15,390	37%	34%	25%	34%	37%	495	3%
	FOUNTAIN CITY	2,106	46%	27%	26%	41%	46%	116	6%
	GAP CREEK	6,920	59%	36%	3%	60%	59%	-42	-1%
GIBBS	13,340	44%	47%	7%	40%	44%	496	4%	
GREEN	1,447	26%	24%	45%	29%	26%	-43	-3%	

Table 2

UTC Metrics by Elementary School District H-Z									
	Elementary School District	Total Area (Acres)	UTC %	PPA %	Total Impervious Area %	UTC 2008 (%)	UTC 2018 (%)	UTC Change 2008-2018 (Acres)	Raw Change (%)
Knox County	HALLS	13,827	54%	34%	10%	51%	54%	400	3%
	HARDIN VALLEY	20,986	52%	35%	11%	50%	52%	350	2%
	INSKIP	1,878	34%	31%	33%	30%	34%	91	5%
	KARNS	9,743	40%	41%	16%	36%	40%	412	4%
	LONSDALE	933	32%	24%	43%	34%	32%	-16	-2%
	MAYNARD	487	16%	26%	56%	17%	16%	-5	-1%
	MOORELAND HEIGHTS	2,324	59%	27%	14%	64%	59%	-105	-5%
	MOUNT OLIVE	8,754	59%	28%	10%	64%	59%	-408	-5%
	NEW HOPEWELL	10,282	67%	25%	7%	68%	67%	-98	-1%
	NORTHSHORE	9,703	50%	33%	12%	52%	50%	-184	-3%
	NORWOOD	2,208	37%	31%	32%	33%	37%	80	4%
	PLEASANT RIDGE	2,044	37%	35%	24%	34%	37%	78	4%
	POND GAP	2,253	32%	25%	40%	34%	32%	-35	-2%
	POWELL	8,308	42%	36%	19%	40%	42%	198	2%
	RITTA	9,963	41%	47%	11%	40%	41%	57	1%
	ROCKY HILL	5,941	52%	29%	13%	54%	52%	-114	-2%
	SARAH MOORE GREENE	2,990	40%	39%	19%	44%	40%	-115	-4%
	SEQUOYAH	7,296	53%	21%	21%	57%	53%	-228	-4%
	SHANNONDALE	3,437	46%	36%	18%	42%	46%	136	4%
	SOUTH KNOXVILLE	1,706	45%	26%	23%	50%	45%	-85	-6%
	SPRING HILL	3,535	42%	32%	26%	46%	42%	-137	-4%
	STERCHI	2,955	49%	27%	20%	45%	49%	115	4%
	SUNNYVIEW	22,859	50%	38%	10%	54%	50%	-752	-3%
	WEST HAVEN	1,613	35%	31%	33%	33%	35%	35	2%
WEST HILLS	3,291	38%	27%	34%	38%	38%	5	0%	
WEST VIEW	1,286	22%	25%	52%	25%	22%	-41	-3%	

Table 3

UTC Metrics by Neighborhoods A-D									
	Neighborhood	Total Area (Acres)	UTC %	PPA %	Total Impervious Area %	UTC 2008 (%)	UTC 2018 (%)	UTC Change 2008-2018 (Acres)	Raw Change (%)
Knox County	ALCOA HIGHWAY	1,122	46%	33%	18%	52%	46%	-63	-6%
	AMHERST	1,797	42%	30%	27%	38%	42%	83	5%
	BEARDEN	1,008	30%	20%	49%	31%	30%	-13	-1%
	BEARDEN VILLAGE / WESTWOOD / FOREST HEIGHTS	937	36%	23%	39%	39%	36%	-36	-4%
	BEAUMONT / WESTERN HEIGHTS / MECHANICSVILLE	918	24%	29%	46%	27%	24%	-32	-3%
	BELLE MORRIS	512	22%	27%	51%	25%	22%	-20	-4%
	BUFFAT HEIGHTS / LOVELAND	741	49%	29%	22%	53%	49%	-34	-5%
	BURLINGTON / PARK CITY	818	40%	34%	27%	44%	40%	-35	-4%
	CALLAHAN DRIVE	1,459	35%	29%	33%	32%	35%	39	3%
	CHARTER DOYLE	1,038	54%	30%	15%	58%	54%	-38	-4%
	CHEROKEE FARM	984	52%	30%	16%	55%	52%	-26	-3%
	CHILHOWEE / ZOO	435	39%	23%	37%	42%	39%	-15	-3%
	CHILHOWEE HILLS	502	45%	26%	28%	50%	45%	-22	-4%
	CIVIC COLISEUM	160	13%	27%	60%	15%	13%	-3	-2%
	CUMBERLAND ESTATES	1,291	38%	36%	22%	35%	38%	38	3%
	DEANE HILL / BEARDEN HILL	873	23%	23%	53%	25%	23%	-10	-1%
	DELROSE ROAD	1,372	37%	47%	12%	42%	37%	-66	-5%
DOWNTOWN / MARKET SQUARE	333	10%	8%	81%	9%	10%	4	1%	

Table 4

UTC Metrics by Neighborhood F-N									
Knox County	Neighborhood	Total Area (Acres)	UTC %	PPA %	Total Impervious Area %	UTC 2008 (%)	UTC 2018 (%)	UTC Change 2008-2018 (Acres)	Raw Change (%)
	FIVE POINTS / PARK CITY	1,016	29%	29%	42%	31%	29%	-27	-3%
	FORT SANDERS	279	11%	7%	82%	14%	11%	-10	-4%
	FOUNTAIN CITY EAST	1,509	44%	30%	25%	39%	44%	89	6%
	FOUNTAIN CITY WEST	1,172	57%	24%	19%	39%	57%	64	5%
	FOURTH & GILL / OLD NORTH KNOXVILLE	685	16%	19%	64%	39%	16%	-28	-4%
	HOLSTON HILLS	1,567	53%	32%	13%	39%	53%	-122	-8%
	INSKIP	1,895	38%	32%	29%	39%	38%	96	5%
	ISLAND HOME / SOUTH HAVEN	1,278	56%	26%	17%	39%	56%	-74	-6%
	KINGSTON PIKE	205	50%	17%	33%	39%	50%	-9	-4%
	KNOXVILLE CENTER MALL	822	30%	30%	37%	39%	30%	-3	0%
	LINCOLN PARK / OAKWOOD	1,925	33%	23%	43%	39%	33%	-7	0%
	LONSDALE	1,040	34%	25%	40%	39%	34%	6	1%
	LYONS VIEW	630	30%	40%	20%	39%	30%	-19	-3%
	MARBLE CITY	746	20%	24%	54%	39%	20%	-15	-2%
	MORNINGSIDE	486	41%	29%	29%	39%	41%	-27	-6%
	NORTH HILLS	1,291	42%	30%	28%	39%	42%	-64	-5%
	NORTH HOLSTON	1,123	38%	32%	27%	39%	38%	-26	-2%
	NORTH KNOXVILLE	476	29%	27%	44%	39%	29%	-22	-5%
	NORTH MCKAMEY	784	45%	31%	22%	39%	45%	19	2%
NORTH MIDDLEBROOK	1,292	23%	27%	48%	39%	23%	-17	-1%	
NORWOOD EAST	368	22%	25%	51%	39%	22%	15	4%	
NORWOOD NORTH	549	37%	28%	34%	39%	37%	26	5%	
NORWOOD SOUTH	1,060	43%	30%	27%	39%	43%	37	4%	
NORWOOD WEST	904	32%	38%	28%	39%	32%	40	4%	

Table 5

UTC Metrics by Neighborhood O-Z									
Knox County	Neighborhood	Total Area (Acres)	UTC %	PPA %	Total Impervious Area %	UTC 2008 (%)	UTC 2018 (%)	UTC Change 2008-2018 (Acres)	Raw Change (%)
	OAKLAND	942	45%	32%	23%	41%	45%	36	4%
	PARKRIDGE	480	20%	24%	54%	21%	20%	-6	-1%
	SEQUOYAH HILLS	1,071	52%	27%	20%	59%	52%	-77	-7%
	SOUTH KNOXVILLE / OLD SEVIER	875	40%	26%	34%	45%	40%	-42	-5%
	SOUTH MCKAMEY	1,054	45%	31%	22%	41%	45%	42	4%
	STERCHI	844	52%	26%	20%	48%	52%	34	4%
	TIMBERCREST / MIDDLEBROOK HEIGHTS	1,567	40%	26%	33%	44%	40%	-60	-4%
	TOWN CENTER	380	14%	37%	43%	17%	14%	-9	-3%
	UNIVERSITY OF TENNESSEE	634	12%	15%	70%	14%	12%	-12	-2%
	VESTAL / SOUTH WATERFRONT	1,096	43%	27%	30%	48%	43%	-48	-4%
	WAREHOUSE DISTRICT	333	4%	14%	81%	3%	4%	4	1%
	WEST HAVEN	591	40%	30%	29%	36%	40%	21	4%
	WEST HILLS	1,358	42%	30%	27%	45%	42%	-43	-3%
	WEST KNOXVILLE	3,194	22%	25%	52%	20%	22%	46	1%
	WEST VIEW	832	32%	30%	38%	36%	32%	-40	-5%
	WESTMORELAND	1,556	45%	27%	28%	48%	45%	-50	-3%
WHITTLE SPRINGS / ALICE BELL	1,400	44%	34%	21%	47%	44%	-47	-3%	
WOODLAWN	1,864	63%	22%	14%	68%	63%	-82	-4%	

Table 6

UTC Metrics by Watersheds: Hydrology Quality													
	Watershed	Total Area (Acres)	UTC %	PPA %	Total Impervious Area %	UTC 2008 (%)	UTC 2018 (%)	UTC Change 2008-2018 (Acres)	UTC Change (%)	Transpiration (Millions of Gallons/Year)	Rainfall Interception (Millions of Gallons/Year)	Avoided Runoff (Millions of Gallons/Year)	Avoided Runoff (\$/Year)
Knox County	Clift Creek-Holston River	26,916	46%	48%	6%	47%	46%	-396	-1%	1,704.9	1,117.1	25.8	\$230,536
	Conner Creek-Clinch River	15,817	55%	36%	9%	54%	55%	204	1%	3,047.6	1,902.2	37.0	\$330,300
	Crowder Branch-Holston River	3,707	43%	55%	3%	44%	43%	-41	-1%	787.5	512.0	7.0	\$62,637
	First Creek	13,854	40%	41%	25%	37%	40%	328	2%	693.6	435.7	81.3	\$726,136
	Flat Creek	20,317	45%	50%	4%	43%	45%	241	1%	2,785.0	1,903.2	34.7	\$309,780
	Lower Beaver Creek	26,118	42%	42%	17%	38%	42%	859	3%	1,357.4	852.7	159.0	\$1,420,893
	Lower Bull Run Creek	22,686	66%	27%	5%	65%	66%	344	2%	2,820.2	1,783.2	38.9	\$347,307
	Lower Fort Loudon Lake	13,543	50%	33%	15%	52%	50%	-196	-2%	1,036.3	677.5	58.2	\$519,776
	Middle Fort Loudon Lake	9,415	57%	30%	12%	58%	57%	-126	-2%	893.8	566.5	90.8	\$811,070
	Milican Creek-French Broad River	623	23%	71%	6%	23%	23%	-2	0%	760.1	481.9	3.8	\$33,617
	Nails Creek-Little River	1,141	83%	16%	2%	83%	83%	-7	-1%	825.2	574.5	3.6	\$32,316
	Outlet French Broad River	26,559	59%	35%	6%	60%	59%	-252	-1%	2,337.3	1,525.6	32.4	\$289,438
	Outlet Holston River	25,883	47%	41%	14%	51%	47%	-984	-4%	1,618.5	1,039.3	108.5	\$969,504
	Roddy Branch-Little River	1,435	59%	37%	4%	60%	59%	-6	-1%	743.9	498.6	30.5	\$272,272
	Second Creek	4,275	27%	38%	48%	26%	27%	65	2%	123.9	77.9	14.5	\$129,765
	Stock Creek	13,292	60%	34%	6%	61%	60%	-127	-1%	1,083.2	712.5	16.6	\$148,064
	Ten Mile Creek	10,923	40%	36%	31%	38%	40%	218	2%	492.4	309.3	57.7	\$515,504
	Third Creek	11,085	34%	39%	35%	34%	34%	53	0%	462.4	290.5	54.2	\$484,073
	Tuckahoe Creek	6,183	61%	34%	4%	63%	61%	-132	-2%	1,338.1	855.6	11.7	\$104,106
	Turkey Creek	16,733	36%	42%	26%	32%	36%	551	3%	604.5	379.6	70.4	\$629,189
Upper Beaver Creek	31,493	42%	44%	14%	39%	42%	1,079	3%	1,745.9	1,096.9	204.6	\$1,827,947	
Upper Bull Run Creek	3,329	71%	23%	5%	68%	71%	96	3%	2,405.6	1,675.3	20.8	\$186,116	
Upper Fort Loudon Lake	31,086	51%	33%	20%	55%	51%	-1,237	-4%	1,950.0	1,225.0	228.5	\$2,041,477	
	Totals	336,412	49%	39%	14%	48%	49%	533	0%	31,617.3	20,492.6	1,390.5	\$12,421,823

Table 7

UTC Metrics by Watersheds: Pollution											
Knox County	Watershed	Total Area (Acres)	UTC %	PPA %	Total Impervious Area %	UTC 2008 (%)	UTC 2018 (%)	UTC Change 2008-2018 (Acres)	UTC Change (%)	Air Pollution Removal \$/Year	Air Pollution Removal lb/Year
	Clift Creek-Holston River	26,916	46%	48%	6%	47%	46%	-396	-1%	\$258,610	757,696.4
	Conner Creek-Clinch River	15,817	55%	36%	9%	54%	55%	204	1%	\$37,110	1,462,462.2
	Crowder Branch-Holston River	3,707	43%	55%	3%	44%	43%	-41	-1%	\$99,852	373,887.7
	First Creek	13,854	40%	41%	25%	37%	40%	328	2%	\$1,090,311	315,315.6
	Flat Creek	20,317	45%	50%	4%	43%	45%	241	1%	\$299,469	1,366,552.9
	Lower Beaver Creek	26,118	42%	42%	17%	38%	42%	859	3%	\$2,133,534	617,033.5
	Lower Bull Run Creek	22,686	66%	27%	5%	65%	66%	344	2%	\$379,040	1,217,979.6
	Lower Fort Loudon Lake	13,543	50%	33%	15%	52%	50%	-196	-2%	\$879,430	504,901.6
	Middle Fort Loudon Lake	9,415	57%	30%	12%	58%	57%	-126	-2%	\$1,376,702	433,608.0
	Milican Creek-French Broad River	623	23%	71%	6%	23%	23%	-2	0%	\$71,930	411,315.1
	Nails Creek-Little River	1,141	83%	16%	2%	83%	83%	-7	-1%	\$94,037	454,783.8
	Outlet French Broad River	26,559	59%	35%	6%	60%	59%	-252	-1%	\$336,627	1,069,617.0
	Outlet Holston River	25,883	47%	41%	14%	51%	47%	-984	-4%	\$1,410,968	724,798.1
	Roddy Branch-Little River	1,435	59%	37%	4%	60%	59%	-6	-1%	\$608,436	403,014.7
	Second Creek	4,275	27%	38%	48%	26%	27%	65	2%	\$194,846	56,348.5
	Stock Creek	13,292	60%	34%	6%	61%	60%	-127	-1%	\$165,453	481,253.6
	Ten Mile Creek	10,923	40%	36%	31%	38%	40%	218	2%	\$774,042	223,851.2
	Third Creek	11,085	34%	39%	35%	34%	34%	53	0%	\$726,848	210,202.6
	Tuckahoe Creek	6,183	61%	34%	4%	63%	61%	-132	-2%	\$167,508	649,159.8
Turkey Creek	16,733	36%	42%	26%	32%	36%	551	3%	\$945,833	274,394.7	
Upper Beaver Creek	31,493	42%	44%	14%	39%	42%	1,079	3%	\$2,744,706	793,762.8	
Upper Bull Run Creek	3,329	71%	23%	5%	68%	71%	96	3%	\$150,467	1,254,253.3	
Upper Fort Loudon Lake	31,086	51%	33%	20%	55%	51%	-1,237	-4%	\$3,065,420	886,532.4	
Totals	336,412	49%	39%	14%	48%	49%	533	0%	\$18,011,179	14,942,725.1	

Table 8

UTC Metrics by Watersheds: Carbon													
	Watershed	Total Area (Acres)	UTC %	PPA %	Total Impervious Area %	UTC 2008 (%)	UTC 2018 (%)	UTC Change 2008-2018 (Acres)	UTC Change (%)	Carbon Storage (\$ and lbs)		Carbon Sequestration (\$ and lbs)	
Knox County	Clift Creek-Holston River	26,916	46%	48%	6%	47%	46%	-396	-1%	\$8,144,715	477,539.6	\$1,075,225	6,304.4
	Conner Creek-Clinch River	15,817	55%	36%	9%	54%	55%	204	1%	\$144,350,646	846,379.5	\$1,747,682	10,247.3
	Crowder Branch-Holston River	3,707	43%	55%	3%	44%	43%	-41	-1%	\$44,619,055	216,617.5	\$969,768	5,686.1
	First Creek	13,854	40%	41%	25%	37%	40%	328	2%	\$30,173,137	176,915.9	\$784,957	4,602.5
	Flat Creek	20,317	45%	50%	4%	43%	45%	241	1%	\$154,851,420	907,949.4	\$2,622,265	15,375.3
	Lower Beaver Creek	26,118	42%	42%	17%	38%	42%	859	3%	\$61,486,148	360,515.3	\$1,119,255	6,562.6
	Lower Bull Run Creek	22,686	66%	27%	5%	65%	66%	344	2%	\$171,982,980	1,008,397.8	\$1,688,689	9,901.4
	Lower Fort Loudon Lake	13,543	50%	33%	15%	52%	50%	-196	-2%	\$48,195,648	282,588.3	\$703,701	4,126.1
	Middle Fort Loudon Lake	9,415	57%	30%	12%	58%	57%	-126	-2%	\$41,651,359	244,216.9	\$528,283	3,097.5
	Milican Creek-French Broad River	623	23%	71%	6%	23%	23%	-2	0%	\$46,477,808	272,516.0	\$252,981	1,483.3
	Nails Creek-Little River	1,141	83%	16%	2%	83%	83%	-7	-1%	\$51,690,545	303,080.2	\$519,629	3,046.8
	Outlet French Broad River	26,559	59%	35%	6%	60%	59%	-252	-1%	\$114,226,847	669,752.9	\$1,152,858	6,759.6
	Outlet Holston River	25,883	47%	41%	14%	51%	47%	-984	-4%	\$75,438,798	442,324.7	\$1,142,196	6,697.1
	Roddy Branch-Little River	1,435	59%	37%	4%	60%	59%	-6	-1%	\$45,526,681	266,969.2	\$451,206	2,645.5
	Second Creek	4,275	27%	38%	48%	26%	27%	65	2%	\$5,246,161	30,760.1	\$165,298	969.2
	Stock Creek	13,292	60%	34%	6%	61%	60%	-127	-1%	\$52,647,385	308,690.5	\$518,155	3,038.1
	Ten Mile Creek	10,923	40%	36%	31%	38%	40%	218	2%	\$20,906,562	122,582.6	\$645,409	3,784.2
	Third Creek	11,085	34%	39%	35%	34%	34%	53	0%	\$19,569,592	114,434.6	\$616,731	3,616.1
	Tuckahoe Creek	6,183	61%	34%	4%	63%	61%	-132	-2%	\$74,630,775	437,586.9	\$1,505,452	8,827.0
	Turkey Creek	16,733	36%	42%	26%	32%	36%	551	3%	\$26,062,438	152,813.4	\$703,379	4,124.2
	Upper Beaver Creek	31,493	42%	44%	14%	39%	42%	1,079	3%	\$79,540,275	466,373.1	\$1,361,678	7,984.0
Upper Bull Run Creek	3,329	71%	23%	5%	68%	71%	96	3%	\$151,300,658	887,129.9	\$1,533,245	8,990.0	
Upper Fort Loudon Lake	31,086	51%	33%	20%	55%	51%	-1,237	-4%	\$89,109,925	522,483.4	\$1,473,631	8,640.5	
Totals	336,412	49%	39%	14%	48%	49%	533	0%	\$1,557,829,558	9,518,617.7	\$23,281,673	136,508.8	

Table 9

UTC Metrics by City of Knoxville Zoning A-E												
	Knoxville Zoning Type Code	Zoning Type	Total Area (Acres)	UTC %	PPA (Acres)	PPA %	Impervious Area (Acres)	Impervious Area %	UTC 2008 (%)	UTC 2018 (%)	UTC Change 2008-2018 (Acres)	Raw Change (%)
Knoxville	Misc.	ROW, Railroad	14,494	22%	2,813	25%	6,050	42%	48%	46%	-35	-1%
	AG	General Agricultural	2,584	46%	1,042	42%	147	6%	22%	21%	-5	-1%
	C-G-1	General Commercial	490	21%	112	23%	272	55%	15%	16%	5	1%
	C-G-2	General Commercial-more intense than 1	840	16%	151	18%	550	65%	12%	13%	2	1%
	C-G-3	General Commercial-more intense than 2	309	13%	35	11%	234	76%	19%	20%	10	1%
	C-H-1	Highway Commercial	996	20%	212	21%	566	57%	24%	25%	25	2%
	C-H-2	Highway Commercial-more intense than 1	1,626	25%	359	22%	834	51%	30%	27%	-3	-3%
	C-N	Neighborhood Commercial	134	27%	32	24%	65	49%	5%	10%	17	5%
	C-R-1	Regional Commercial	308	10%	42	13%	232	75%	15%	13%	-23	-2%
	C-R-2	Regional Commercial-more intense than 1	1,042	13%	226	22%	674	65%	15%	9%	0	-6%
	CU-1	Lake Avenue	7	9%	0	4%	6	87%	2%	2%	0	0%
	CU-2	Cumberland Avenue	16	2%	0	2%	15	96%	16%	15%	0	-2%
	CU-3	White Avenue/Hospital	5	15%	0	5%	4	80%	9%	7%	0	-2%
	CU-4	White Avenue/Neighborhood	2	7%	0	2%	2	91%	12%	8%	0	-4%
	CU-5	Seventeenth Street	2	8%	0	3%	2	89%	11%	13%	1	1%
	DK-B	Downtown Knoxville Boulevards Subdistrict	73	13%	7	10%	56	77%	5%	6%	1	1%
	DK-E	Downtown Knoxville Edge Subdistrict	50	6%	3	6%	44	88%	7%	7%	0	0%
	DK-G	Downtown Knoxville Grid Subdistrict	75	7%	3	4%	66	89%	1%	3%	0	2%
	DK-H	Downtown Knoxville Historic Core Subdistrict	14	3%	0	2%	13	96%	4%	3%	0	-1%
	DK-W	Downtown Knoxville Warehouse Subdistrict	34	3%	1	4%	31	93%	65%	61%	-80	-5%
EN	Established Neighborhood	1,688	61%	474	28%	189	11%	21%	21%	-13	0%	

Table 10

UTC Metrics by City of Knoxville Zoning I-S												
	Knoxville Zoning Type Code	Zoning Type	Total Area (Acres)	UTC %	PPA (Acres)	PPA %	Impervious Area (Acres)	Impervious Area %	UTC 2008 (%)	UTC 2018 (%)	UTC Change 2008-2018 (Acres)	Raw Change (%)
Knoxville	I-G	General Industrial	2,620	21%	561	21%	1,468	56%	31%	29%	-41	-2%
	I-H	Heavy Industrial	1,743	29%	453	26%	728	42%	21%	22%	5	1%
	I-MU	Industrial Mixed-Use	814	22%	164	20%	463	57%	13%	14%	2	1%
	I-RD	Research and Development	179	14%	119	74%	20	11%	20%	20%	0	0%
	INST	Institutional	2,088	20%	573	28%	963	46%	88%	84%	-68	-4%
	NA	Natural Areas	1,917	84%	262	14%	18	1%	32%	30%	-13	-2%
	O	Office	726	30%	204	28%	294	41%	31%	30%	-11	-2%
	OP	Office Park	698	30%	230	34%	246	35%	43%	42%	-53	-2%
	OS	Open Space	3,311	42%	1,237	39%	351	11%	56%	55%	-201	-1%
	RN-1	Single Family Residential Neighborhood-Low Density, Large Lots	17,470	55%	5,291	31%	2,358	13%	46%	42%	-249	-4%
	RN-2	Single Family Residential Neighborhood-Low Density, Small Lots, primarily single family dwellings	5,890	42%	2,007	34%	1,401	24%	27%	31%	43	4%
	RN-3	General Residential Neighborhood-Medium Density, primarily single and two family dwellings	1,172	31%	373	32%	421	36%	39%	40%	2	0%
	RN-4	General Residential Neighborhood-Mixed Medium Density, single family, two family, and townhouse dwellings	493	40%	179	36%	117	24%	37%	36%	-7	-1%
	RN-5	General Residential Neighborhood-Medium Density, mix of single family, two family, townhouse, and multifamily dwellings	1,240	36%	325	26%	459	37%	34%	32%	-21	-2%
	RN-6	Multifamily Residential Neighborhood-High Density, all housing types	1,295	32%	327	25%	531	41%	24%	19%	-1	-5%
	RN-7	Multifamily Residential Neighborhood-Most Intense High Density in townhouse and multifamily deveopments	27	19%	7	26%	15	55%	50%	42%	-4	-9%
	SW-1	South Waterfront-Old Sevier, Scottish Pike	47	42%	15	32%	12	26%	35%	25%	-5	-11%
	SW-2	South Waterfront-River Road, Goose Creek Row, Island Home Ave	52	25%	16	32%	20	39%	15%	12%	-1	-4%
	SW-3	South Waterfront-Sevier Ave	22	12%	4	17%	15	70%	25%	21%	-1	-4%
	SW-4	South Waterfront-Scottish Pike, Campus Cove, Quay Village	43	21%	14	34%	18	42%	14%	13%	0	-1%
	SW-5	South Waterfront-Bell Tower Walk	16	13%	3	20%	11	66%	24%	18%	-3	-7%
SW-6	South Waterfront-Henley Gateway	45	18%	6	15%	29	64%	2%	2%	0	0%	
SW-7	South Waterfront-Waterfront Marketplace	14	2%	1	9%	12	86%	22%	22%	-29	0%	
	Totals		66,710	38%	17,887	28%	20,023	30%	40%	38%	-756	-1%

Table 11

UTC Metrics by Knox County Zoning A-E												
	Zoning Type Code	Zoning Type	Total Area (Acres)	UTC %	PPA (Acres)	PPA %	Total Impervious Area (Acres)	Total Impervious Area %	UTC 2008 (%)	UTC 2018 (%)	UTC Change 2008-2018 (Acres)	Raw Change (%)
Knox County	A	Agricultural	176,438	57%	64,310	37%	8,702	5%	56%	57%	143	0%
	A(k)	Agricultural (k)	3	38%	2	55%	0	8%	58%	38%	-1	-20%
	A/F	Agricultural/Floodway	14	27%	10	73%	0	0%	21%	27%	1	6%
	A/HZ	Agricultural/Historical Overlay	110	63%	37	34%	3	3%	70%	63%	-8	-7%
	A/TO	Agricultural/Technology Overlay	710	56%	229	32%	70	10%	54%	56%	19	3%
	BP	Business and Technology Park	6	40%	2	27%	2	32%	34%	40%	0	6%
	BP/TO	Technology Overlay	1,081	37%	401	37%	252	23%	31%	37%	59	5%
	CA	General Business	3,905	28%	1,398	36%	1,316	34%	27%	28%	31	1%
	CA(k)	General Business (k)	90	22%	41	46%	22	25%	22%	22%	1	1%
	CA/F	General Business/Floodway	12	43%	5	45%	0	1%	42%	43%	0	1%
	CA/HZ	General Business/Historical Overlay	25	41%	8	33%	6	26%	45%	41%	-1	-5%
	CA/HZ(k)	General Business/Historical Overlay (k)	1	27%	0	37%	0	35%	24%	27%	0	4%
	CA/TO	General Business/Technology Overlay	87	20%	29	33%	38	44%	16%	20%	3	4%
	CA/TO(k)	General Business/Technology Overlay (k)	5	18%	2	33%	2	48%	46%	18%	-1	-29%
	CB	Business and Manufacturing	1,649	27%	472	29%	717	43%	25%	27%	29	2%
	CB(k)	Business Manufacturing (k)	15	11%	6	41%	7	47%	29%	11%	-3	-18%
	CB/TO	Business and Manufacturing/Technology Overlay	334	11%	120	36%	167	50%	7%	11%	14	4%
	CH	Highway Commercial	32	61%	4	12%	8	26%	54%	61%	2	7%
	CN	Neighborhood Commercial	41	42%	16	38%	8	18%	50%	42%	-3	-8%
	CN(k)	Neighborhood Commercial (k)	18	14%	8	42%	8	42%	36%	14%	-4	-22%
	CN/TO(k)	Neighborhood Commercial/Technology Overlay (k)	6	30%	3	57%	1	13%	21%	30%	1	9%
	CR	Regional Commercial	45	25%	19	44%	12	28%	25%	25%	0	1%
	CR(k)	Regional Commercial (k)	1	10%	0	25%	0	63%	5%	10%	0	5%
	E	Estate	449	64%	127	29%	29	6%	69%	64%	-18	-4%
EC	Employment Center	118	8%	82	69%	11	10%	8%	8%	1	1%	
EC(k)	Employment Center (k)	348	24%	203	58%	6	2%	29%	24%	-17	-5%	

Table 12

UTC Metrics by Knox County Zoning F-O												
	Zoning Type Code	Zoning Type	Total Area (Acres)	UTC %	PPA (Acres)	PPA %	Total Impervious Area (Acres)	Total Impervious Area %	UTC 2008 (%)	UTC 2018 (%)	UTC Change 2008-2018 (Acres)	Raw Change (%)
Knox County	F	Floodway	8,928	44%	1,816	48%	107	1%	46%	44%	-56	-1%
	F/HZ	Floodway/Historical Overlay	0	10%	0	65%	0	22%	29%	10%	0	-19%
	F/TO	Floodway/Technology Overlay	42	72%	9	22%	1	3%	64%	72%	3	8%
	HZ	Historical Overlay	113	59%	34	31%	10	9%	57%	59%	2	2%
	I	Industrial	8,778	35%	3,273	38%	2,257	26%	35%	35%	-54	-1%
	I/TO	Industrial/Technology Overlay	3	6%	0	14%	3	80%	2%	6%	0	4%
	I/TO(k)	Industrial/Technology Overlay (k)	5	2%	0	1%	5	97%	3%	2%	0	-1%
	LI	Light Industrial	236	38%	106	45%	29	12%	37%	38%	1	0%
	LI(k)	Light Industrial (k)	97	12%	37	38%	40	41%	6%	12%	5	6%
	OA	Office Park	103	34%	33	32%	32	31%	32%	34%	2	2%
	OA(k)	Office Park (k)	3	12%	1	25%	2	62%	5%	12%	0	8%
	OA/F	Office Park/Floodway	7	27%	3	44%	2	22%	41%	27%	-1	-14%
	OA/F(k)	Office Park/Floodway (k)	1	0%	0	13%	0	21%	11%	0%	0	-11%
	OB	Office, Medical and Related Services	525	33%	198	38%	139	27%	33%	33%	-1	0%
	OB(k)	Office, Medical, and Related Services (k)	21	49%	7	32%	4	19%	41%	49%	2	7%
	OB/TO	Office, Medical and Related Services/Technology Overlay	255	37%	88	35%	70	27%	36%	37%	3	1%
OB/TO(k)	Office, Medical, and Related Services/Technology Overlay (k)	58	64%	12	20%	7	13%	69%	64%	-3	-5%	
OC	Civic and Institutional Zone	18	34%	8	47%	2	14%	49%	34%	-3	-15%	
OS	Open Space	330	50%	84	26%	22	7%	51%	50%	-4	-1%	

Table 13

UTC Metrics by Knox County Zoning P-T												
	Zoning Type Code	Zoning Type	Total Area (Acres)	UTC %	PPA (Acres)	PPA %	Total Impervious Area (Acres)	Total Impervious Area %	UTC 2008 (%)	UTC 2018 (%)	UTC Change 2008-2018 (Acres)	Raw Change (%)
Knox County	PC	Planned Commercial	1,309	32%	485	37%	378	29%	30%	32%	22	2%
	PC(k)	Planned Commercial (k)	144	52%	53	37%	12	8%	50%	52%	3	2%
	PC(k)/TO	Planned Commercial/Technology	52	21%	27	54%	12	24%	4%	21%	9	17%
	PC/F	Planned Commercial/Floodway	9	33%	6	66%	0	1%	31%	33%	0	3%
	PC/TO	Planned Commercial/Technology	263	16%	92	35%	123	47%	11%	16%	12	5%
	PR	Planned Residential	23,199	37%	8,496	37%	5,470	24%	35%	37%	334	1%
	PR(k)	Planned Residential (k)	584	48%	150	26%	134	23%	60%	48%	-69	-12%
	PR/F	Planned Residential/Floodway	57	58%	19	34%	4	7%	58%	58%	0	0%
	PR/HZ	Planned Residential/Historical	3	56%	1	38%	0	6%	76%	56%	-1	-20%
	PR/TO	Planned Residential/Technology	698	30%	255	37%	201	29%	32%	30%	-15	-2%
	PR/TO(k)	Planned Residential/Technology	104	44%	24	23%	27	26%	50%	44%	-6	-6%
	RA	Low Density Residential	17,904	48%	6,112	34%	2,942	16%	46%	48%	354	2%
	RA(k)	Low Density Residential (k)	11	35%	5	49%	2	15%	32%	35%	0	2%
	RA/F	Low Density Residential/Floodway	1	59%	0	23%	0	17%	64%	59%	0	-5%
	RA/HZ	Low Density Residential/Historical	53	38%	24	45%	8	15%	43%	38%	-3	-5%
	RA/TO	Low Density Residential/Technology	215	45%	72	33%	47	22%	40%	45%	10	5%
	RAE	Low Density Residential/Estate	1,497	45%	499	34%	298	20%	44%	45%	11	1%
	RB	General Residential	7,338	45%	2,677	37%	1,248	17%	44%	45%	89	1%
	RB/F	General Residential/Floodway	3	67%	0	19%	0	0%	83%	67%	0	-16%
	RB/TO	General Residential/Technology	5	75%	1	25%	0	0%	73%	75%	0	2%
SC	Shopping Center	254	21%	80	31%	117	46%	19%	21%	6	2%	
SC/F	Shopping Center/Floodway	2	44%	1	45%	0	11%	58%	44%	0	-14%	
T	Transition	29	38%	12	41%	6	20%	35%	38%	1	3%	
T(k)	Transition (k)	7	31%	2	22%	3	47%	24%	31%	0	7%	
Totals			258,806	51%	92,336	37%	25,156	10%	51%	51%	904	0%

Resources

American Forests. 2002. Urban Ecosystem Analysis Knox County, Tennessee.

https://knoxvilletn.gov/UserFiles/Servers/Server_109478/File/PublicService/Trees/AFC_2002.pdf.

Nowak, David J., Anne B. Cumming, Daniel Twardus, Robert E. Hoehn III, Christopher M. Oswalt, and Thomas J. Brandeis. 2009.

Urban Forests of Tennessee, 2009. https://knoxvilletn.gov/UserFiles/Servers/Server_109478/File/PublicService/Trees/USF_2009.pdf

PlanIT Geo. 2019. Trees Knoxville Urban Canopy Study.

<https://documentcloud.adobe.com/link/track?uri=urn:aaid:scds:US:59dd4010-311d-4c60-9610-210fc2d69ef7>

University of Illinois College of Agricultural, Consumer and Environmental Sciences. (2018, September 25). Schoolyard tree cover predicts math performance in high-poverty urban schools. ScienceDaily. Retrieved June 14, 2021 from

www.sciencedaily.com/releases/2018/09/180925075111.htm

University of Illinois College of Agricultural, Consumer and Environmental Sciences. (2020, November 9). Trees set sixth-graders up for success. ScienceDaily. Retrieved June 14, 2021 from

www.sciencedaily.com/releases/2020/11/201109124724.htm

U.S. Census Bureau (2019). American Community Survey 5-year estimates. Retrieved from Census Reporter Profile.

<https://censusreporter.org/profiles/14000US47093004401-census-tract-4401-knox-tn/>