

URBAN TREE CANOPY ASSESSMENT

STRATFORD, CONNECTICUT
DECEMBER | 2024



Funding for this assessment was provided by the USDA, Forest Service Urban and Community Forestry Planning Grant administered by the Connecticut Department of Energy and Environmental Protection (DEEP).

**3,488****ACRES OF CANOPY****33%****OF STRATFORD'S LAND
AREA WAS COVERED
WITH CANOPY IN 2023**

EXECUTIVE SUMMARY

PURPOSE AND METHODS

Tree canopies are constantly changing. Growth and plantings add to and expand canopy coverage; development, disasters, disease, and pests can take it away. Canopy assessments based on aerial imagery can track these changes precisely. This report evaluates changes in tree canopy within Stratford, Connecticut, located in Fairfield County on the Long Island Sound. It summarizes findings at the town-wide, property ownership, FEMA floodplains, voting districts, and census block groups levels to better understand how tree canopy is distributed within the town.

Based on 2023 imagery from the USDA's National Agriculture Imagery Program (NAIP), this study provides a near-current view of land cover in Stratford. This enables the Town of Stratford to revise existing strategies and develop new ones for protecting and expanding the forest. This study used machine learning techniques to create land cover data to facilitate more uniform comparisons in future tree canopy assessments. Following US Forest Service standards, this assessment focuses on tree canopy as a percentage of land, excluding water. The key goals of this tree canopy cover assessment include:

- **Quantify the amount and location of tree canopy and other land cover types**
- **Analyze the change in canopy cover from 2012 to 2023**
- **Measure the ecosystem services provided by the tree canopy in the community**
- **Identify areas where tree canopy can be expanded (Possible Planting Area analysis)**
- **Provide data to inform future planning and to establish canopy coverage goals**

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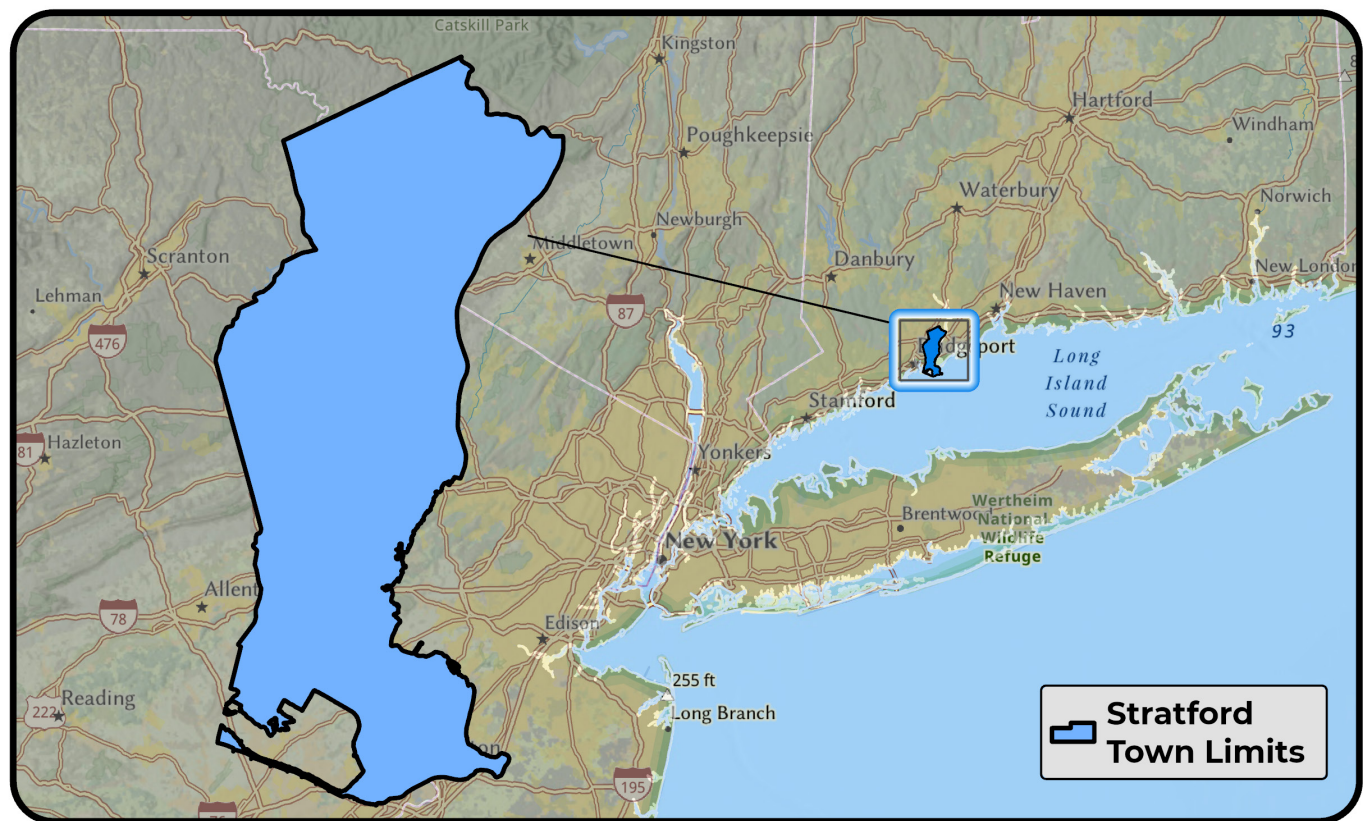


Figure 2. The Town of Stratford is located in southern Connecticut, covering 20 square miles on the Long Island Sound.

STRATFORD'S URBAN FOREST

In 2023, over a third of Stratford (33%) was covered with tree canopy. The remaining portion of the town was split between areas unsuitable (40%) and suitable for planting (28%).

Stratford's tree canopy cover was assessed in 2012 and 2023. Over the 11-year study period, Stratford's tree canopy cover decreased. Within the current town boundary, tree canopy decreased by 604 acres, a 5.7% decrease. While it's likely that the canopy coverage fluctuated over the past eight years, the imagery used in this assessment provides a snapshot of the canopy at the time the imagery was collected.

It is possible that canopy growth can be attributed to the growth of existing trees, the transition of "non-treed" vacant land areas to forest cover, and tree planting. Large canopy losses, on the other hand, can typically be traced back to tree removal for development or major tree-damaging environmental events. However, these are not definitive findings of the assessment and further investigation may be required to determine the exact causes of changes in canopy growth.



Figure 1. Based on an analysis of 2023 and 2012 high-resolution imagery.

PROJECT METHODOLOGY

MAPPING LAND COVER

This assessment utilized high-resolution (60-centimeter) multi-spectral imagery from the US Department of Agriculture’s National Agriculture Imagery Program (NAIP), collected in 2023, to derive land cover data and classify all types of land cover. Additionally, 1-meter resolution NAIP imagery from 2012 was utilized for historical tree canopy classification.

The land cover data set, sourced from the EarthDefine US Tree Map (<https://www.earthdefine.com/treemap/>), provided a six-class land cover data set. EarthDefine employs machine-learning techniques to extract tree canopy cover and other land cover types from the latest 2023 NAIP imagery.



Figure 4. This study identified six (6) unique land cover classes within the 2023 assessment imagery: tree canopy, shrubs, other vegetation, bare soil and dry vegetation, impervious surfaces, and water.

IDENTIFYING POSSIBLE PLANTING AREAS

In addition to quantifying Stratford’s existing UTC (urban tree canopy), areas suitable for planting trees to increase canopy cover were identified. To identify PPA (possible planting area), areas absent of tree canopy cover were classified as either PPA or unsuitable for planting. Unsuitable areas for tree planting, such as recreation fields, utility corridors, golf courses, etc., were manually delineated and overlaid with the existing land cover data set (Figure 3). The final classifications include PPA Vegetation, Unsuitable Impervious, Unsuitable Vegetation, Unsuitable Soil, and Water.



Figure 3. The study identified vegetated areas where it would be feasible for tree plantings but undesirable based on their current usage (left) in the data as “Unsuitable” (right).

STATE OF THE CANOPY AND KEY FINDINGS

The results of this study can be used to design a strategic approach to identifying existing canopy and future planting areas. The land cover data presented below depict the current town limits of Stratford.

Figure 5 illustrates the distribution of land cover in Stratford, including water bodies. Tree canopy covers over a third of the town, representing 33% of Stratford's land area. Buildings and roads make up another 33%, while vegetation like grass and low shrubs account for approximately 30%. Water bodies cover 4% of the area, and lastly, bare soil and shrub/scrub areas each represent 1% or less of the town boundary.

Table 1. Land cover classes in acres and percent in Stratford.

Class	Acres	Percent
Impervious Surfaces	3,677	33%
Tree Canopy	3,488	33%
Non-Canopy Vegetation	3,313	30%
Water	4	4%
Soil/Dry Vegetation	110	1%
Shrubs	96	<1%

Land Cover Classification

- Tree Canopy
- Tree Canopy Over Impervious
- Non-Canopy Vegetation
- Scrub/Shrub
- Impervious
- Water
- Soil and Dry Vegetation

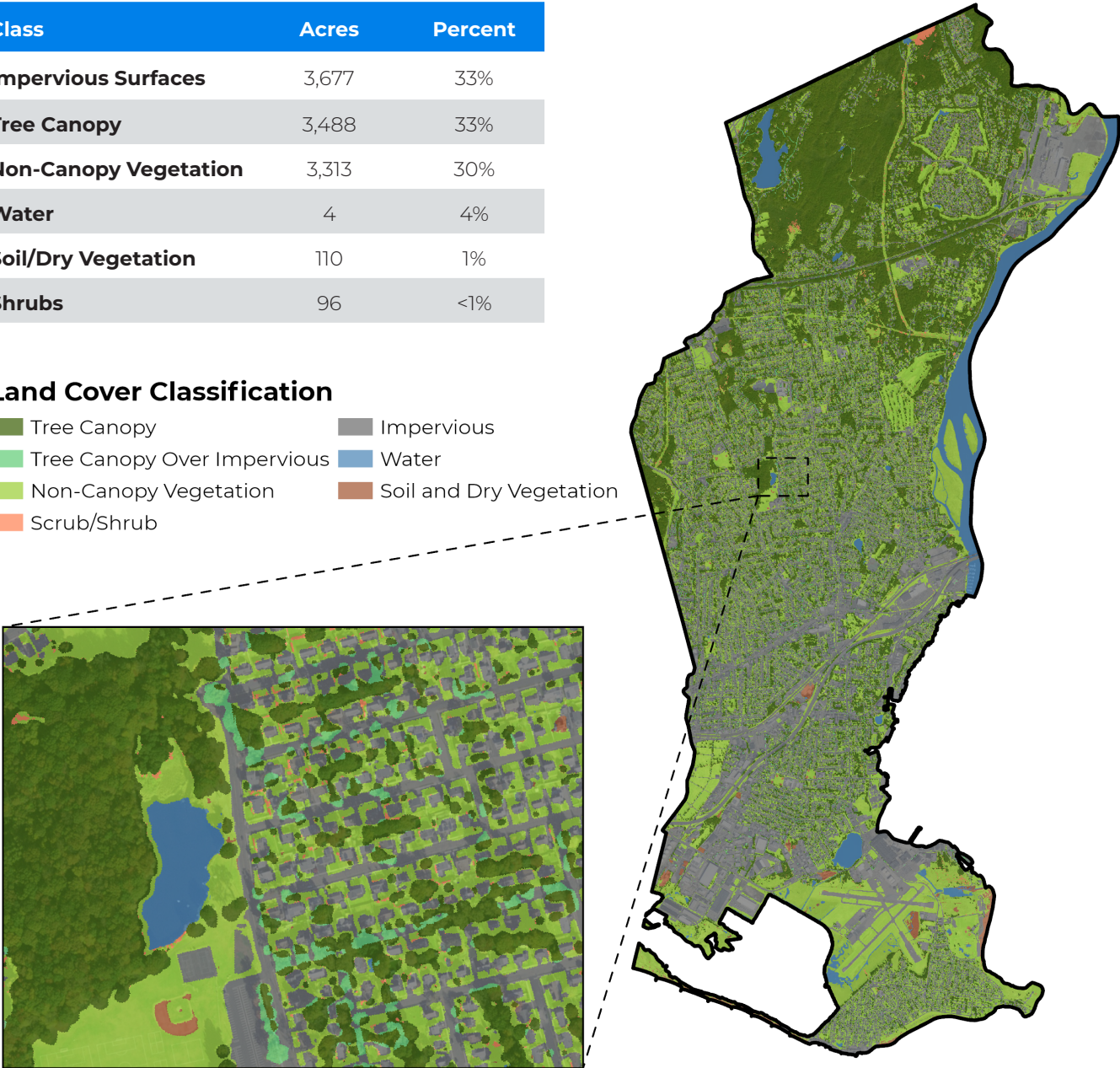


Figure 5. Land cover classification results (percentages based on the total area of Stratford including water bodies).


TOWN-WIDE TREE CANOPY COVER

After excluding the 452 acres of surface water (including the Housatonic River), the Stratford town boundary occupies 10,684 land acres. Thirty-three percent of Stratford’s land area is covered by tree canopy. Twenty-eight percent, or 2,946 acres, are available to plant trees (PPA). However, planting trees in some land cover classes is not feasible, and the remaining 40% of land is considered unsuitable, primarily due to 3,677 acres of impervious surfaces.

In 2012, Stratford had 4,092 acres of tree canopy, meaning the town has lost canopy (-5.7% decrease or -604 acres) over the 11-year study period.

Table 2. Tree canopy potential in acres and percent in Stratford.

Class	Acres	Percent
Existing Canopy	3,488	33%
Possible Planting Area	2,956	28%
Unsuitables	4,241	40%



Stratford has lost **5.7%** tree canopy cover between 2012 and 2023.

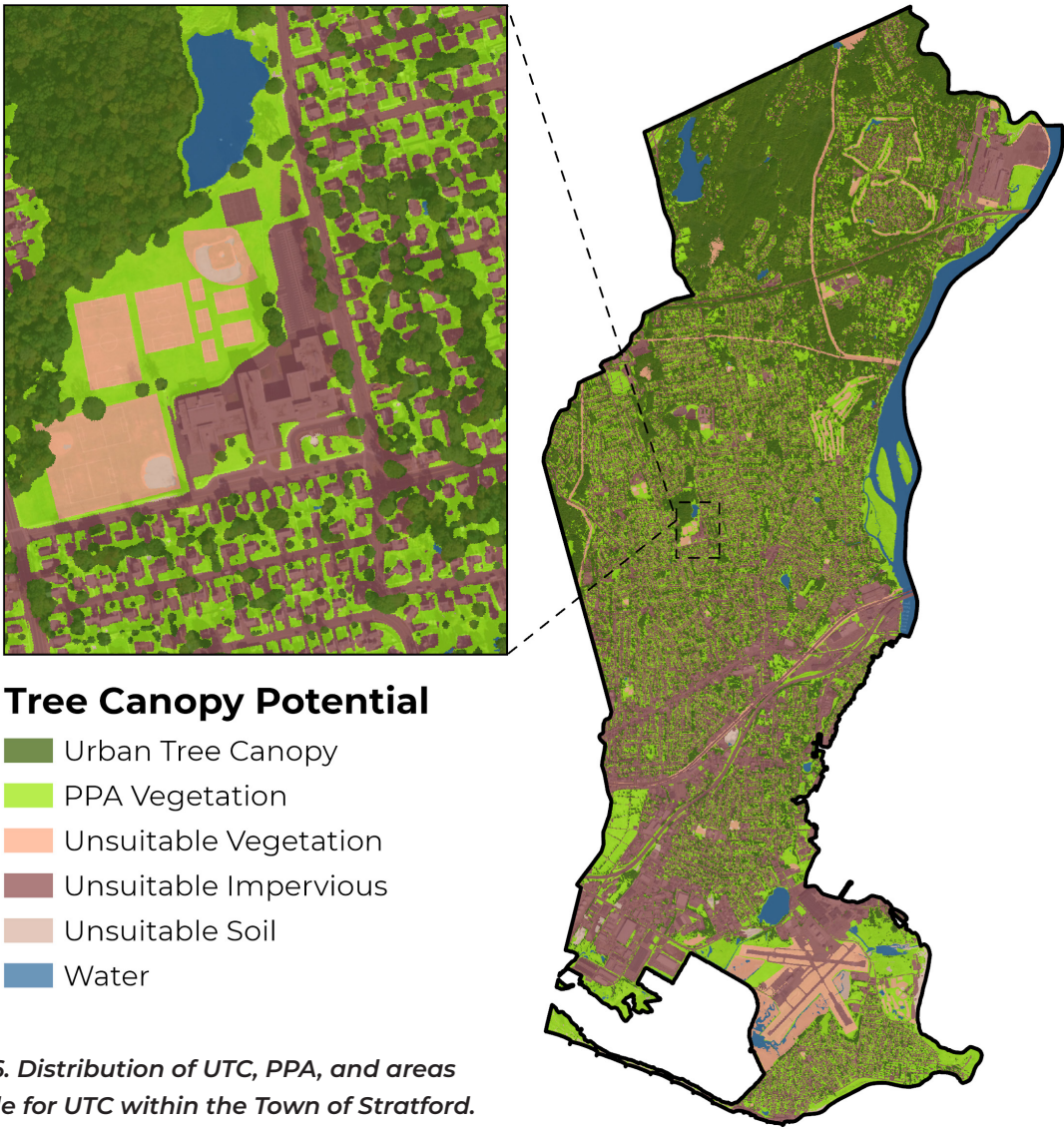


Figure 6. Distribution of UTC, PPA, and areas unsuitable for UTC within the Town of Stratford.

TREE CANOPY COVER BY PROPERTY OWNERSHIP

Private and public properties each offer unique opportunities and approaches to tree planting and maintenance. Within Stratford, private property makes up 84% of the town's area and provides 2,345 acres of urban canopy, accounting for 76% of the total canopy coverage. Public property, covering only 15% of the town's area, contributes 723 acres, or 24% of the canopy. Notably, town-owned land has a higher average urban tree canopy percent of 52%, compared to an average UTC of 31% on private properties.

Private and public properties contain 30% and 27% potential planting area relative to their size, respectively. This translates to 2,227 acres of PPA on private property and 379 acres of PPA on public property.

Between 2012 and 2023, canopy loss on both private and public properties contributed to an overall loss. Private properties lost 417 acres (-5.6%) of tree canopy while public property lost 47 acres (-3.4%).

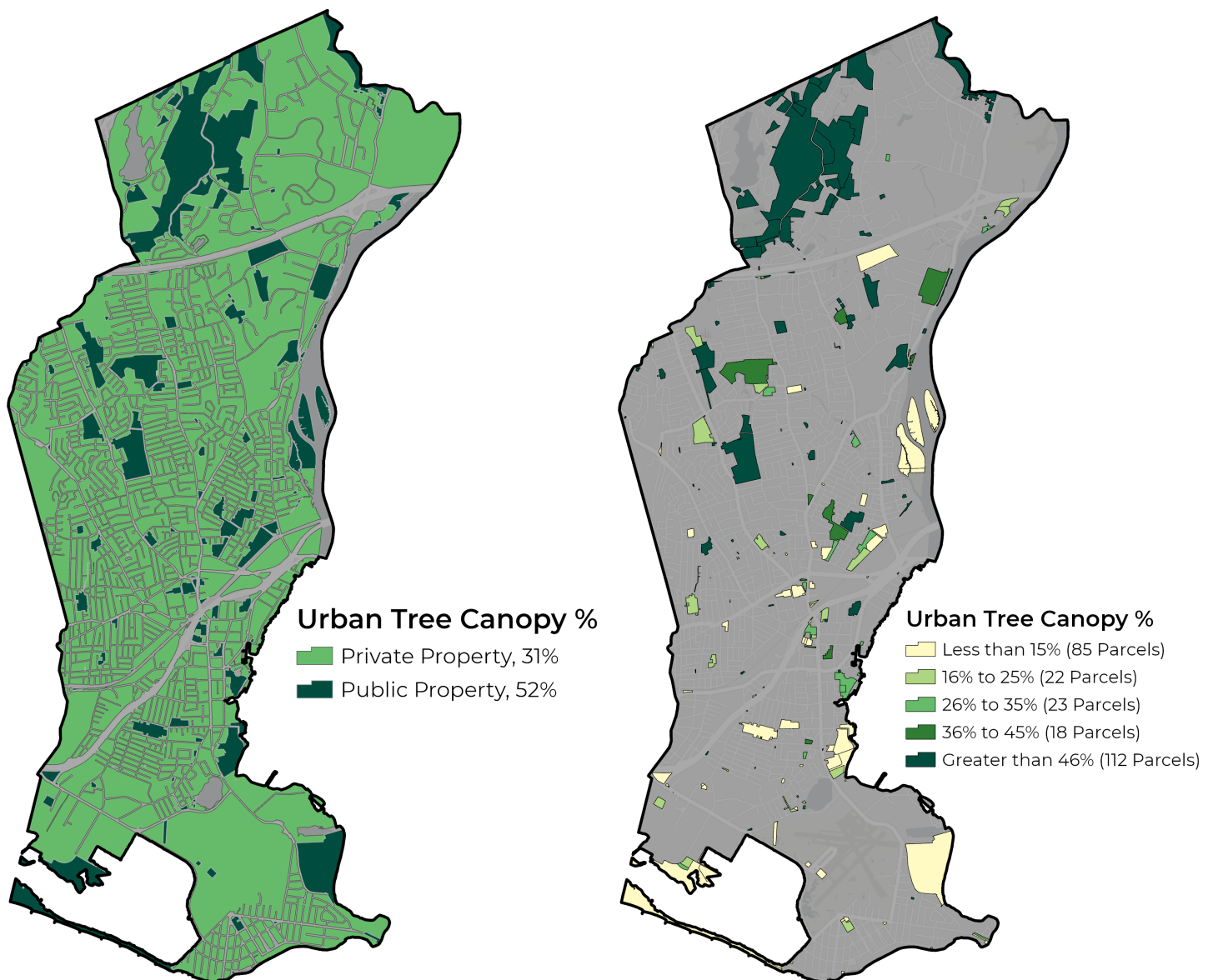


Figure 7. UTC by public versus private property (left) and UTC by public parcels (right).

TREE CANOPY COVER BY FEMA FLOODPLAINS

Trees play a vital role in mitigating stormwater runoff, filtering pollutants and sediments, and thereby reducing flooding and improving water quality. To understand the impact of tree cover on flood management, tree canopy and PPA metrics were evaluated within three FEMA-designated floodplain types: 100-year floodplains, 500-year floodplains, and regulatory floodway zones, which together, contribute 590 acres of canopy. The 100-year floodplain encompasses the majority of the area across these types, accounting for 89% of the total floodplain distribution and 77% of the urban tree canopy.

Although it makes up just 6% of the total floodplain area, the 500-year floodplain has the highest urban tree canopy at 42%, surpassing the canopy coverage of the 100-year floodplain and regulatory floodway, which have 16% and 35% UTC, respectively. The 100-year floodplain includes 1,446 acres of PPA, offering an opportunity to mitigate the negative effects of its 37% impervious surface coverage, the highest among the floodplain types. Expanding tree canopy in flood zones, however, must be approached carefully to align with floodplain management practices. In areas like South End, strategies should focus on planting resilient tree species capable of withstanding severe weather events, minimizing the potential for fallen trees to disrupt utilities and transportation during major storms.

Over the 11-year period, all floodplain types experienced tree canopy loss. The 100-year floodplain saw the largest total canopy loss, with a reduction of 110 acres, contributing to an overall loss of 125 acres (-4.0%) across all floodplain types. Relative to its size, the regulatory floodway had the highest proportional canopy loss, with a decrease of 9 acres (-5.1%).

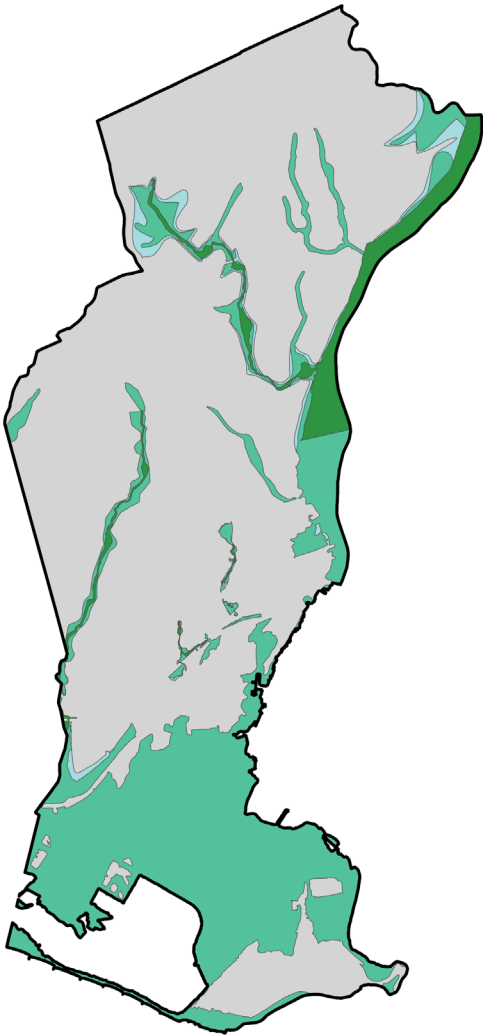


Figure 8. Possible planting area by FEMA floodplain type.

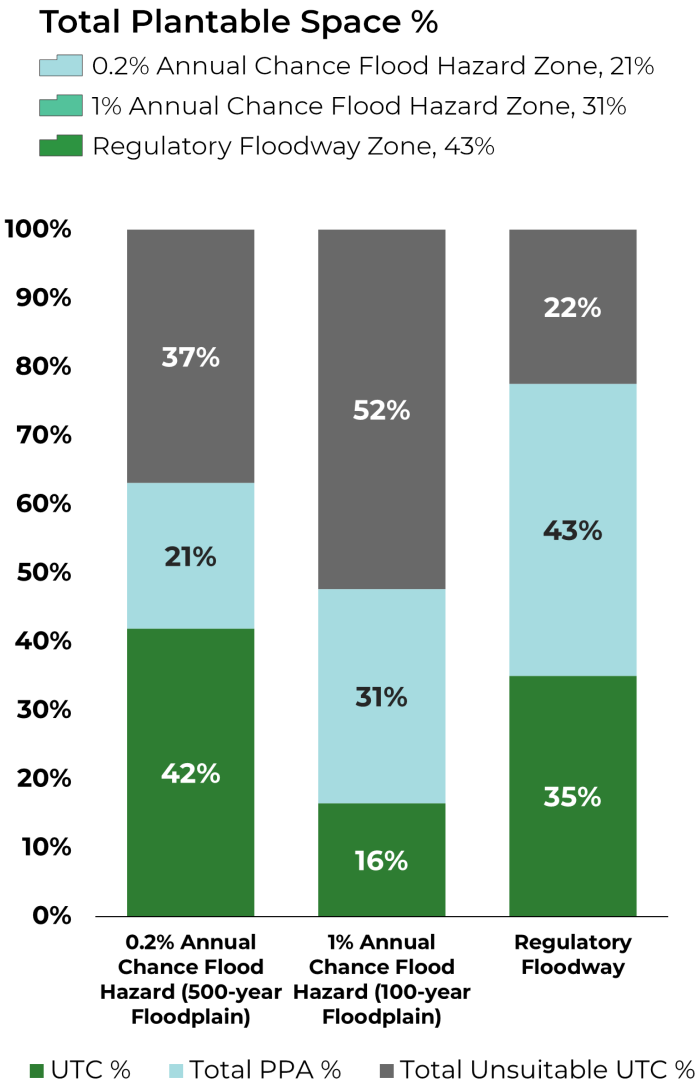


Figure 9. UTC potential by FEMA floodplain type.

TREE CANOPY COVER BY VOTING DISTRICTS

Tree canopy was assessed across Stratford's 10 voting districts, providing insights to guide policy decisions and allocate resources for tree planting and urban forestry initiatives within political boundaries. Tree canopy coverage varies significantly among districts, ranging from 9% to 62%. District 9 has the highest UTC at 62%, also contributing the largest share of the town's canopy at 34% (1,177 acres).

In contrast, District 1 has the lowest UTC at 9%, with only 5% of the town's overall canopy. However, it has the second-highest proportion (35%) and distribution (22%) of potential planting area. District 4, with the highest impervious surface coverage at 59%, also has the second-lowest tree canopy coverage at 13%. Notably, a quarter of District 4's land is available as PPA, offering an opportunity to reduce the negative impacts of impervious surfaces, such as localized heat, through strategic tree planting.

Between 2012 and 2023, all voting districts had a net loss in tree canopy. District 2 had the largest percent decrease in canopy (-8.9% or -76 acres) and District 8 had the largest acreage loss of canopy (-97 acres or -4.6 %). Each district llost at least 25 acres of tree canopy.

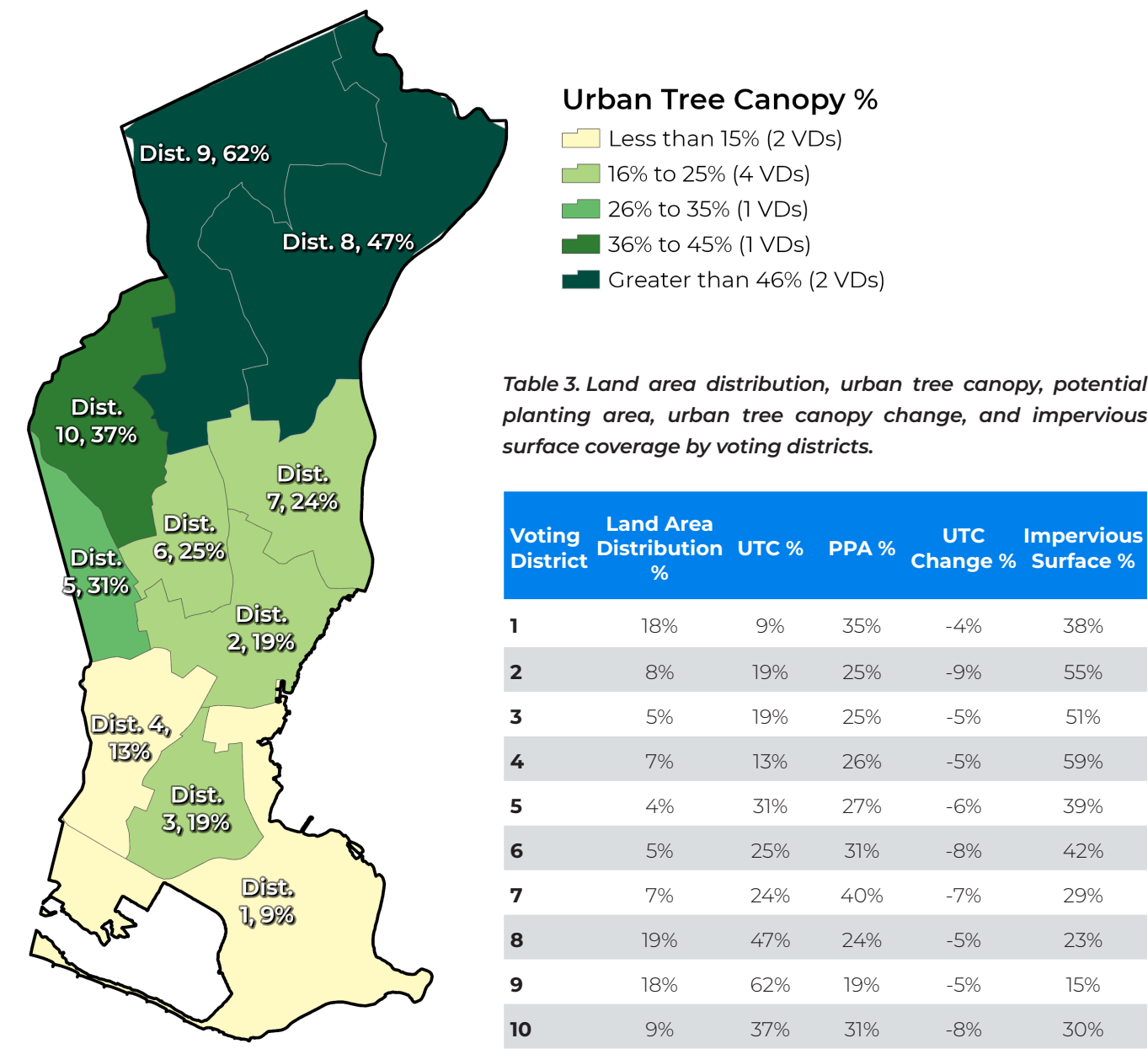



Figure 10. UTC by voting districts.

TREE CANOPY COVER BY ZONING

Tree canopy was assessed on 21 permitted zoning classes, to identify any relationships between the town's zoning classes and tree canopy cover. This approach provides insights for urban planning and environmental management, facilitating targeted strategies for sustainable urban development. Of the zoned areas, the One-Family Residential Districts (comprising four zones: Residential-1, Residential-2, Residential-3, and Residential-4 Districts) make up 63% of the town's land area and 77% of the overall tree canopy.

Examining proportional tree canopy coverage, Office Park Districts have the highest average UTC at 63%. Fifteen zoning classes fall below the town-wide average canopy coverage of 33%. However, the five zoning classes with higher-than-average UTC collectively contain over 50% of the town's total canopy acres. Non-zoned areas, Waterfront Business Districts, and Coastal Industrial Districts each have at least 47% PPA, the highest among zoning classes. In terms of PPA distribution, the four main residential zones previously mentioned contain the largest share, with 2,023 acres, or 68% of the total PPA. These residential zones present substantial opportunities for engaging residents in tree planting efforts to boost canopy cover on private land.

Over the 11-year period, only two of the 21 zoning types showed canopy gains: Office Park Districts (+4.5%) and Housing Opportunity Development Districts (+2.8%). However, these gains total just over one acre, as these zones cover only a small portion of the town's area. The three largest residential zones—R-1, R-3, and R-4—saw the greatest canopy losses by area, with a combined decrease of 432 acres. Proportionally, Retail Commercial CNC Districts experienced the largest percentage loss in canopy, with a 19.8% decrease, equating to a reduction of 3 acres.



Residential zones R-3 and R-4, combined, lost the most canopy acres (-340 acres) and should be prioritized for tree planting and canopy preservation efforts.

Table 4. Land area distribution, urban tree canopy, potential planting area, urban tree canopy change, and impervious surface coverage by zoning classes.

Zoning Class	Land Area Distribution %	UTC %	PPA %	UTC Change %	Impervious Surface %
ADD Airport Development Zone	2%	0.2%	12%	0%	36%
ARH Zone	0.0%	2%	4%	-9%	94%
Retail Commercial CA District	4%	7%	11%	-3%	80%
Retail Commercial CF District	0.4%	19%	11%	-5%	68%
Retail Commercial CNC District	0.2%	25%	13%	-20%	60%
Housing Opportunity Development District	0.0%	38%	19%	3%	43%
Limited Business Civic Center District	0.3%	8%	11%	-6%	80%
Limited Business B District	1%	33%	18%	-2%	49%
Light Industrial MA District	10%	14%	19%	-4%	60%
General Industrial MB District	2%	5%	13%	-2%	77%
Coastal Industrial MC District	2%	8%	47%	-6%	41%
Non-zoned Areas	0.3%	11%	51%	-4%	2%
Office Park District	0.3%	63%	10%	5%	20%
Resource Conservation District	7%	50%	32%	-3%	1%
Multifamily Family Residential District, R-1	8%	21%	29%	-7%	48%
One Family Residential District, R-1	22%	60%	20%	-4%	15%
One Family Residential District, R-2	2%	42%	36%	-4%	19%
One Family Residential District, R-3	19%	32%	37%	-7%	27%
One Family Residential District, R-4	20%	25%	33%	-9%	40%
Industrial Runway District	0.3%	0.0%	0%	0%	84%
Waterfront Business District	1%	6%	48%	-7%	32%

TREE CANOPY COVER BY CENSUS BLOCK GROUPS

Stratford’s census block groups represent clusters of census block boundaries, organized into even population divisions. These areas serve as a key unit for assessing the equitable distribution of tree canopy across the town and can be readily linked to demographic and socio-economic data published by the American Community Survey (ACS). Of the 39 block groups within the town, 11 had higher-than-average UTC of 33% while 20 had less than 25% UTC. In general, average census block group canopy cover increased from south to north (i.e. the census block groups further north had the highest canopy cover and visa versa).

The town’s largest block group, 09-001-081300-4, located in the northwest corner, has the most tree canopy area (948 acres) and the highest canopy coverage at 79%. In contrast, two block groups that are adjacent to each other in the southernmost part of town, 09-001-080500-1 and 09-001-080500-2, have the lowest UTC at 8% and 7%, respectively. These two block groups also offer the highest share of potential planting area, with 11% (332 acres) and 8% (246 acres), respectively. Block group 09-001-080200-3, situated on the town’s west side south of Barnum Ave and north of the train tracks, has the highest impervious surface coverage at 67% and would benefit from its 12 acres of potential planting area to increase its low UTC of 16%.

Between 2012 and 2023, all 39 census block groups experienced a decline in canopy cover. The largest percentage loss (-12.0%) occurred in block group 09-001-080800-3, which includes most of Long Brook Park. In terms of acreage, the largest block group, 09-001-081300-4, also saw the greatest reduction in canopy area, losing 47 acres.

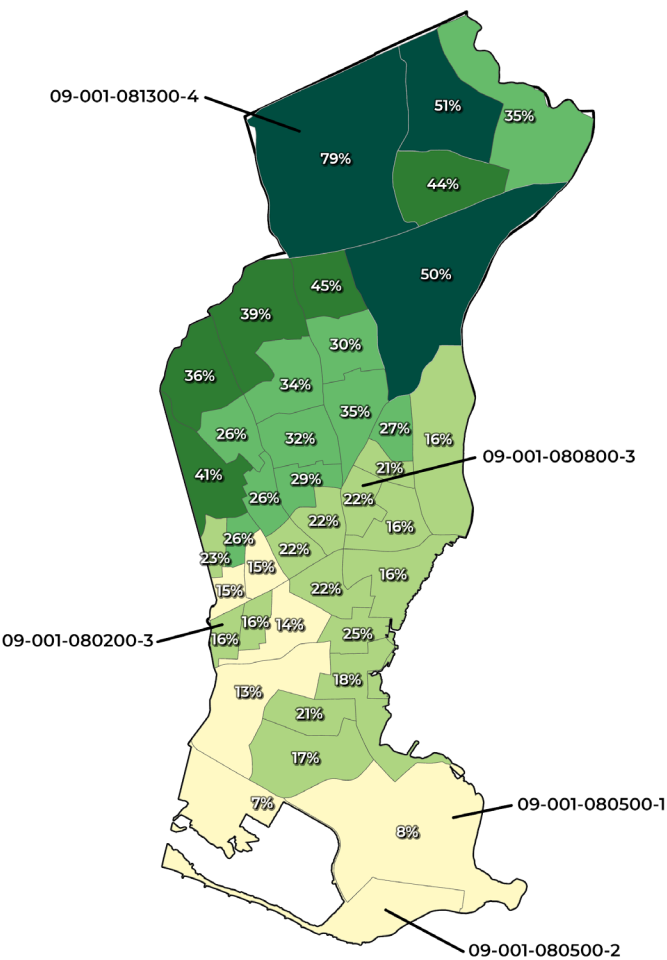


Figure 12. Tree canopy percent by census block groups.

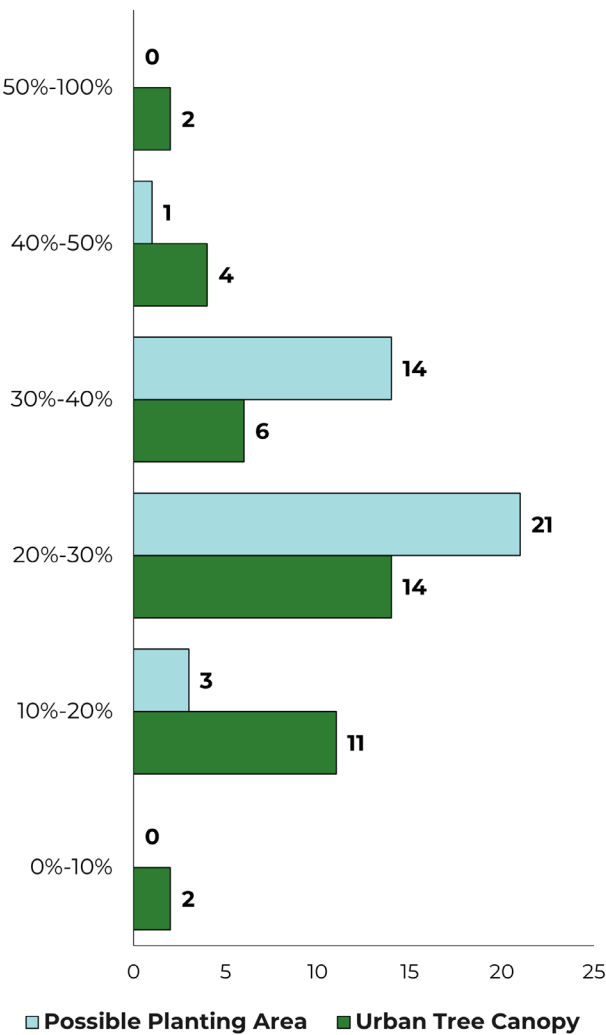


Figure 11. Distribution of census block groups within UTC and PPA ranges.

TREE CANOPY COVER BY DISADVANTAGED AREAS

To better understand the relationship between urban tree canopy metrics and socioeconomic factors, five census block groups were selected based on having the highest poverty rates among the 39 block groups assessed. Together, these block groups represent 16% of the town’s area and contribute 122 acres of tree canopy. All five have 25% or less UTC and poverty rates ranging from 20% to 36%. For context, the average poverty rate in Connecticut, based on the 2022 American Community Survey, is 10%, compared to Stratford’s town-wide average of 8%.

Census block group 09-001-080100-4, located along Stratford’s western border and covering 63 acres, has the highest poverty rate among all CBGs in the town. It has a 23% UTC and an opportunity to expand canopy by utilizing 16 acres of potential planting area, which accounts for 26% of its land area. Among the five block groups, 09-001-080400-3 is the largest, comprising 48% of the total area across these disadvantaged block groups. This block group, containing Frash Pond and the residential/commercial area west of it, has 52 acres (17%) of UTC and 70 acres available as PPA.

Over the 11-year period, these five disadvantaged block groups collectively lost 34 acres of tree canopy, a net decrease of 5%. The largest block group, 09-001-080400-3, saw the greatest canopy loss by area, with a reduction of 13 acres, while block group 09-001-080100-4 experienced the largest proportional loss, with a 10% decrease in canopy coverage

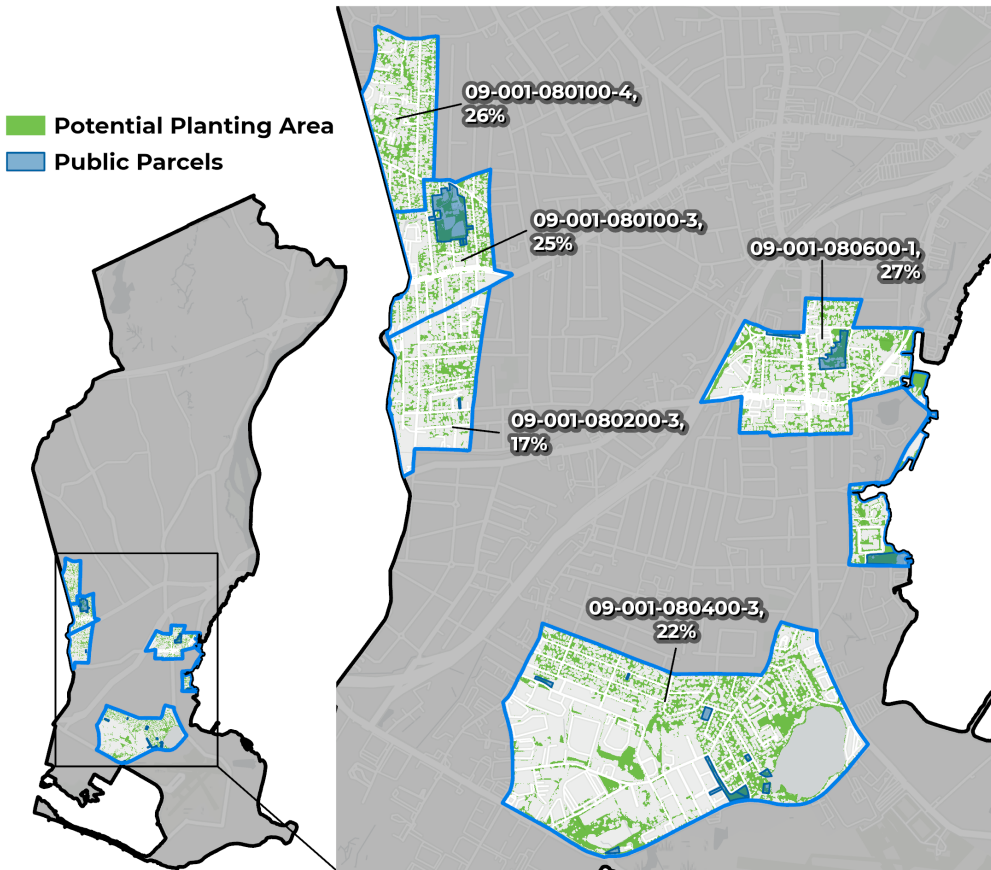


Figure 13. Disadvantaged areas in Stratford based on the census block groups with the highest poverty rate and their respective total potential planting area percent.

Table 5. Land area distribution, urban tree canopy, potential planting area, urban tree canopy change, and impervious surface coverage by disadvantaged areas.

Census Block ID	Land Area Distribution %	UTC %	PPA %	UTC Change %	Impervious Surface %
09-001-080400-3	48%	17%	22%	-4%	54%
09-001-080100-4	10%	23%	26%	-10%	51%
09-001-080100-3	11%	15%	25%	-4%	57%
09-001-080200-3	11%	16%	17%	-5%	67%
09-001-080600-1	21%	25%	27%	-6%	48%

TREE PLANTING PRIORITIZATION

Increased tree canopy cover can provide many benefits to a local community and its visitors. Several socioeconomic, demographic, and accessibility data sources were analyzed at the census block group (CBG) scale, and each was ranked according to the area's unique needs. Rankings are sorted from high priority (dark blue) to low priority (light yellow) and were calculated for each criterion as well as overall to show where multiple needs overlap.

- **Areas with Low Existing Tree Canopy:** prioritizes CBGs with higher percentages of areas not covered by tree canopy.
- **Possible Tree Canopy:** prioritizes CBGs with higher percentages of possible planting areas.
- **Poverty Rate:** percentage of residents living below the federally designated poverty level.
- **Unemployment Rate:** percentage of the labor force that does not have a job, are available to work, and are looking for a job.
- **Vulnerable Population:** the ratio of residents under the age of 18 or over 65 compared to the working-age population.
- **Median Household Income:** areas with lower median household incomes.
- **Educational Attainment:** percentage of the population without a high school diploma or the equivalent General Educational Development (GED).

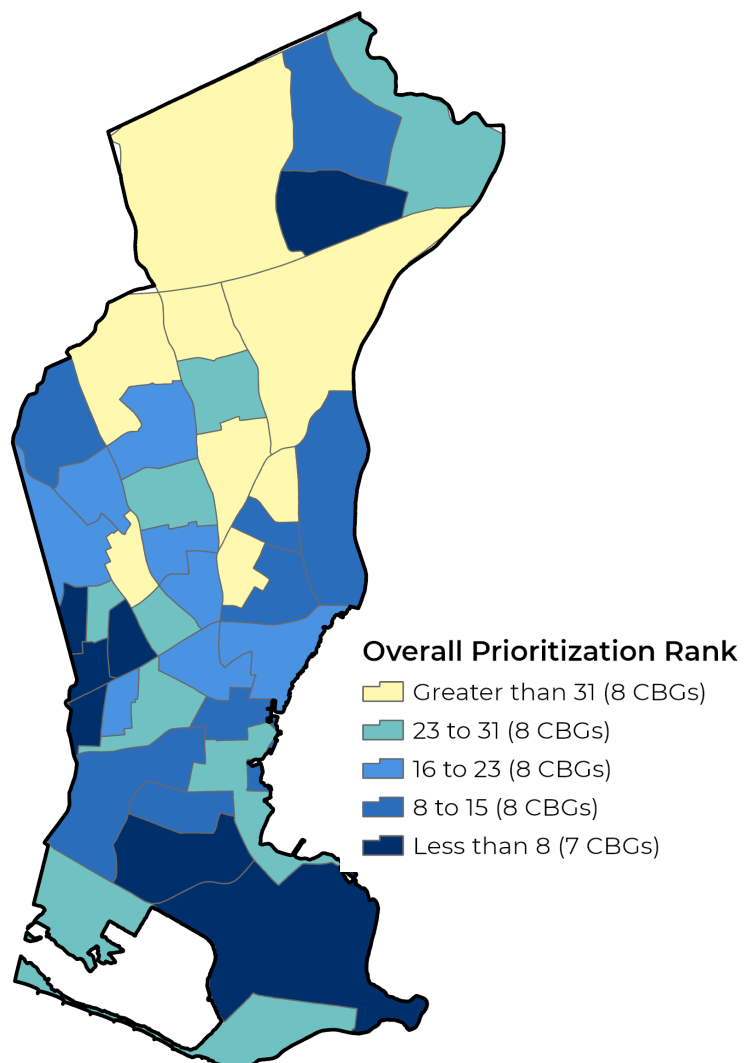
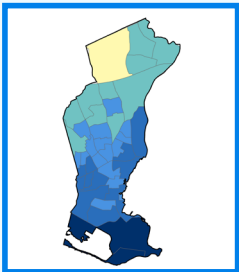
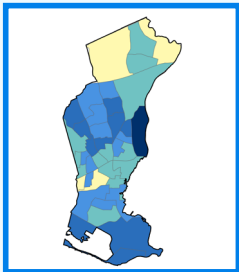


Figure 14. Overall prioritization rankings for Stratford's census block groups based on the seven above indicators. Lower rankings indicate an overall higher priority for tree plantings.

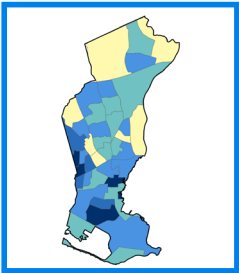
PRIORITIZATION VARIABLES



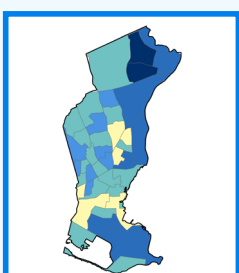
Areas with Low Existing Tree Canopy: This indicator highlights census block groups with low percentages of existing canopy cover. This criterion prioritizes areas with higher percentages of area that are not covered by tree canopy.



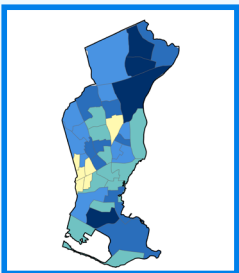
Possible Urban Tree Canopy: Identifying areas that can support tree plantings is the first step to expanding urban tree canopy cover in the future. This indicator shows the percentage of the total area available for planting within each census block group. This criterion prioritizes areas with higher percentages of possible planting areas.



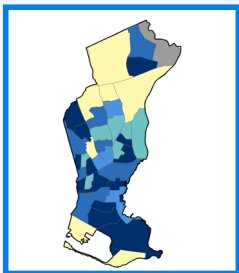
Poverty Rate: Trees provide many environmental and health benefits to nearby residents. This indicator shows the percentage of residents living below the federally-designated poverty level.



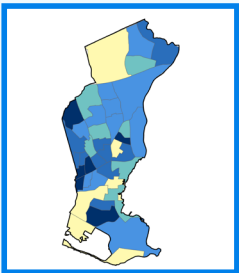
Unemployment Rate: Percentage of the labor force that does not have a job, are available to work, and are looking for a job as reported by the Census Bureau. Areas of high unemployment were considered high priority for planting.



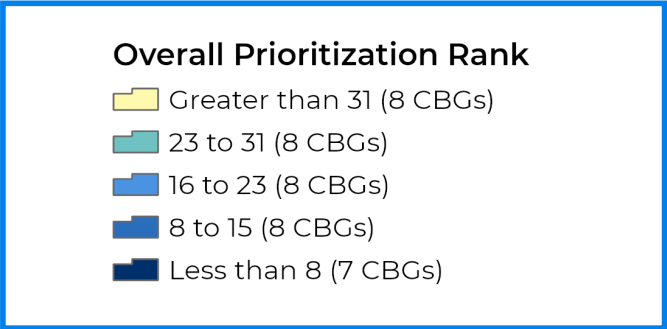
Vulnerable Population: Trees provide many environmental and health benefits to its residents. This indicator shows the ratio of residents under the age of 18 or over the age of 65 compared to the working-age population. This criterion prioritizes areas with larger ratios of vulnerable populations.



Median Household Income: Income inequality often occurs with environmental inequality where lower-income residents live in highly impervious areas with limited numbers of trees, parks, and other greenspaces. This criteria prioritizes areas with lower median household incomes.



Educational Attainment: The presence of trees aligns with improved educational performance and social connections. This criterion shows the percentage of the population without a high school diploma or the equivalent General Educational Development (GED) as reported by the U.S. Census American Community Survey 5-year summaries.



CONCLUSIONS AND RECOMMENDATIONS

Stratford's forests provide its community with resilience-boosting services, such as lowering air temperatures, improving public health, and expanding wildlife habitat. However, forests in the Eastern United States face numerous challenges. Tornadoes and other extreme storm events, pests, diseases, and development pose serious risks to tree canopy.

Assessments of Stratford's tree canopy, conducted regularly, serve multiple functions. These assessments can serve as a baseline, a report card, and a strategic compass for the town's long-term canopy health. The results of this assessment can help guide planning, investment, and management strategies to ensure that the communities most in need of forest benefits gain access to necessary resources.

RECOMMENDATIONS

1 Promote a Resilient Community Forest

The findings from this assessment provide valuable data to support the development of a more resilient community forest in Stratford. This information can strengthen state, county, and local budget requests, as well as bolster grant applications aimed at enhancing the town's resilience. Urban forests are critical for managing stormwater, as they reduce strain on infrastructure during heavy rains. Strategically placed trees can act as natural barriers against hurricanes and tornadoes, helping to minimize wind and wave damage, and protecting buildings and infrastructure from severe weather impacts.

2 Expand Canopy in Underserved Areas

Focus tree-planting efforts on neighborhoods identified in the prioritization analysis, particularly those with high impervious surfaces, low canopy cover, or high concentrations of residents in poverty. Planting in these areas can reduce urban heat islands, lower energy costs, and create calming spaces that reduce stress and encourage community engagement. Prioritizing these underserved areas maximizes the impact of forest management resources, ensuring an equity distribution of green infrastructure.

3 Integrate Tree Canopy Goals into Town Planning

As Stratford grows and urbanizes, it's crucial to preserve and expand the existing canopy. Use this assessment to establish short- and long-term goals, such as:

- Annual tree planting targets
- Increasing diversity by planting a wider variety of large, maturing trees
- Setting specific canopy coverage goals for future years.
- Review long-term land-use and development plans, to include policies to protect mature trees and enforce canopy ordinances for new developments.

4 Engage the Community and Partner with Private Landowners

Since much of Stratford's plantable space is on private land, community involvement is key to increasing canopy and mitigating canopy losses. Develop outreach programs to engage residents, schools, and local businesses in tree planting and care. Initiatives like Arbor Day celebrations, workshops, and volunteer planting events can educate the public about the benefits of trees and encourage participation. Pair these programs with tree giveaways, private property planting initiatives, and tree maintenance events to boost canopy growth on private land.

5 Monitor Progress and Adapt Strategies

Regular canopy assessments using updated imagery (available every 2-3 years) are essential to tracking progress and revising strategies as needed. Recurring assessments allow community forest stakeholders to stay informed about areas of canopy growth and loss, ensuring that management efforts remain effective and aligned with Stratford's goals. This continuous monitoring will provide the feedback needed to maintain a thriving, resilient urban forest.

GLOSSARY/KEY TERMS

Land Acres: The total land area in acres of the assessment boundary (excludes water).

Non-Canopy Vegetation: Areas of grass and open space where tree canopy does not exist.

Possible Planting Area - Vegetation: Areas of grass and open space where tree canopy does not exist, and it is biophysically possible to plant trees.

Shrub: Areas of shrub or other leafy and woody vegetation (smaller than 6ft tall) that are not classified as tree canopy.

Soil/Dry Vegetation: Bare soil and dried, dead vegetation.

Total Acres: Total area, in acres, of the assessment boundary (includes water).

Unsuitable Impervious: Areas of impervious surfaces that are not suitable for tree planting. These include buildings, roads, and all other types of impervious surfaces.

Unsuitable Planting Area: Areas where it is not feasible to plant trees. Airports, ball fields, golf courses, etc., were manually defined as unsuitable planting areas.

Unsuitable Soil: Areas of soil/dry vegetation considered unsuitable for tree planting. Irrigation and soil augmentation may be required to keep trees alive in these areas.

Unsuitable Vegetation: Areas of non-canopy vegetation that are not suitable for tree planting due to their land use.

Urban Tree Canopy (UTC): The “layer of leaves, branches and stems that cover the ground” (Raciti et al., 2006) when viewed from above; the metric used to quantify the extent, function, and value of the forest. The tree canopy was generally taller than 10-15 feet tall.

Water: Areas of open, surface water, not including swimming pools.



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