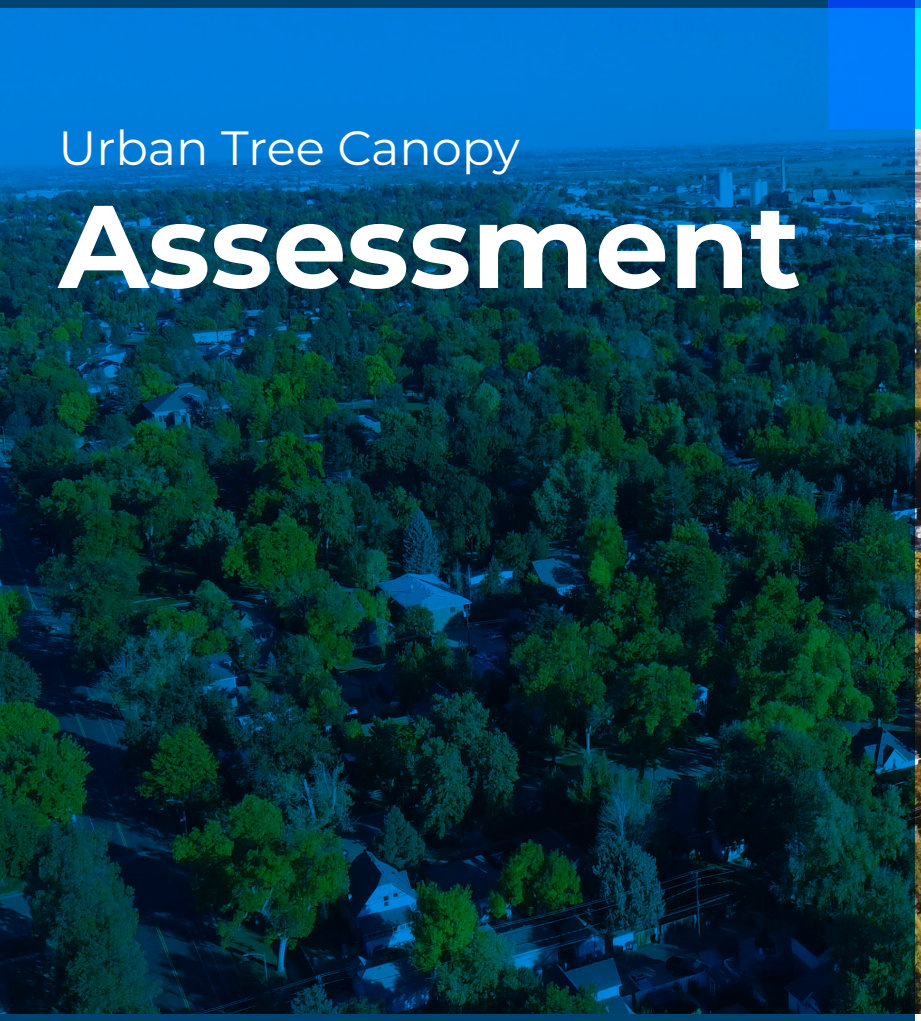
Urban Tree Canopy

Assessment

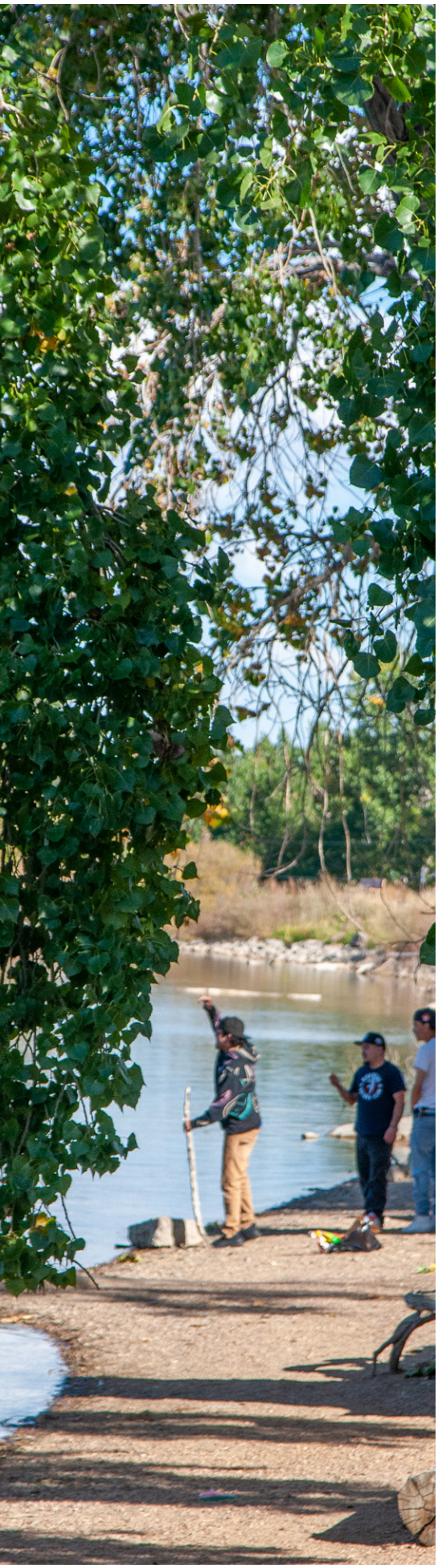


Boulder County, Colorado

February | 2025

PlanIT Geo
developers of TreePlotter

Boulder County



Boulder County, Co

Tree Canopy Assessment

> **Investing in urban forestry is investing in the resilience of our cities.**
>
> -Katharine Burgess,
>
> Vice President, Land Use and Development
>
> Smart Growth America

Prepared by

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Prepared for

Boulder County, Colorado

Completed

January 2025

Table of

Contents

Executive

Summary

For this report, 'Boulder County' or 'urban areas of Boulder County' refers to the combined area of all seven municipalities and the three unincorporated urban zones, not the entire county. Refer to Figure 1 to see the extent of the assessed area.

Background of this Analysis

Urban tree canopies are constantly changing. Growth and plantings contribute to the canopy; development, disasters, disease, and pests can diminish it. Through meticulous evaluation, this report provides a comprehensive understanding of the changes in tree canopy within the urban areas of Boulder County, situated at the foothills and plains of Colorado's Rocky Mountains. It presents findings at various geographic boundaries, enlightening us about how tree canopy is distributed in the county and the environmental changes that require attention.

This assessment evaluated urban tree canopy (UTC) and possible planting area (PPA) in 2021 within this study area. The *Boulder County study area encompasses seven incorporated areas —Boulder, Erie, Lafayette, Longmont, Louisville, Lyons, and Superior. Each municipality holds the Arbor Day Foundation Tree City USA status, with the City of Longmont holding this recognition for the longest duration of time with 44 years. Their awards underscore the community's dedication to green initiatives, creating nature-based solutions, and maintaining urban forests to benefit more than 320,000 residents and visitors.

Project Methodology

This study provides a near-current overview of land cover in the Boulder County area, utilizing 2021 imagery from the USDA's National Agriculture Imagery Program (NAIP). The results enable the county to revise existing strategies and develop new ones for protecting and expanding the forest. Machine learning techniques were used 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.** 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 2013 to 2021
- Measure the ecosystem services provided by the tree canopy
- Identify areas where tree canopy can be expanded (Possible Planting Area analysis)
- Provide data to inform future planning and to establish canopy coverage targets

Boulder County's Urban Forest Insights

Boulder County's assessment area covers 64,384 land acres, excluding surface water. With the entire county spanning 464,640 acres, this assessment area represents approximately 14% of the total county area. As of 2021, 9,963 acres (16%) of the assessment area was covered by tree canopy. This landscape includes a mix of pervious and impervious surfaces, with impervious surfaces accounting for 31% of the county. Most existing canopy is positioned over pervious surfaces, rather than providing shade for roads and sidewalks. Notably, private lands dominate the study area, accounting for 82% of the assessed land; however, only 17% of this private land is covered by trees, compared to a slightly lower 13% canopy coverage on public lands. Despite this uneven distribution, with 76% of the county's public land available for new trees (PPA), there exists a considerable opportunity for expanding tree coverage, especially in the right-of-way, parks, and open spaces throughout the county.

Boulder County has acquired data for the seven municipalities within its region, facilitating efforts to establish a tree canopy baseline. Collecting this crucial data is the first step in enabling the municipalities to set achievable goals for enhancing their tree canopy. Currently, these municipalities have an average canopy cover of 13%. Cities such as Longmont and Boulder have shown significant changes; Longmont increased its canopy by 2% (317 acres), whereas the City of Boulder saw a 2% decrease (-289 acres) in tree coverage. With a vast potential planting space totaling 29,481 acres across all municipalities, this study is essential for advancing urban forestry and sustainable development in the region. This proactive approach underscores the urgency and significance of strategic urban planning and community collaboration in fostering a resilient and environmentally sustainable landscape.

Recommendations

Municipalities and stakeholders should use this analysis to develop a strategy to protect and expand Northern Colorado's urban forest. This study revealed that the total study area contains 10,387 acres of tree canopy. Each municipality has the potential to significantly enhance tree coverage, as they each have over 40% of their land available for tree planting. There is a collective opportunity to expand canopy cover using the available 30,032 acres suitable for planting more trees across both public and private properties throughout the county. Through partnerships, education, and outreach programs to private landowners, Boulder County, and its various stakeholders can aim to plant resilient climate appropriate trees to provide shade in urban areas and increase environmental equity. Municipalities along the Front Range region have an exciting opportunity to expand the quality and quantity of their current tree canopy to benefit future generations.

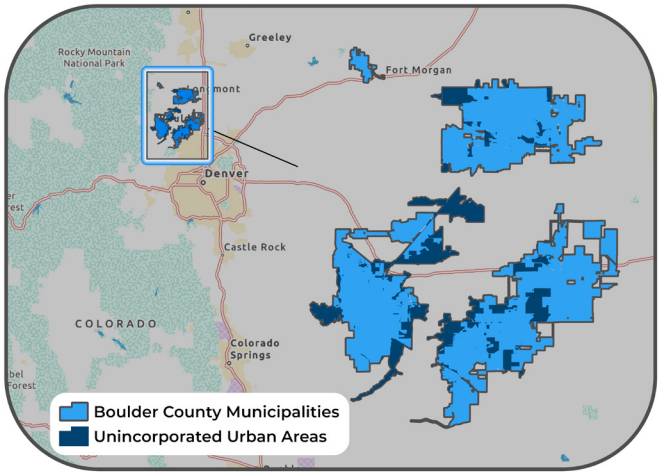


Figure 1. The Boulder County assessment area covers approximately 103 square miles, representing a portion of the county's total 726 square miles.

Note that this map includes portions of Longmont and Erie that extend beyond the county boundary. These areas are not part of the countywide AOI but are included in the municipality-specific geography. The complete assessment levels are detailed on Page 5.

16%
Urban tree canopy

47%
Possible Planting Area

31%
Impervious surface area

Figure 2. Based on the analysis of 2021 high-resolution imagery throughout Boulder County.

Project

Methodology

This study mapped land cover, urban tree canopy, and possible planting areas using the sources and methods described below. These data sets provide the foundation for the metrics reported at the selected geographic assessment scales.

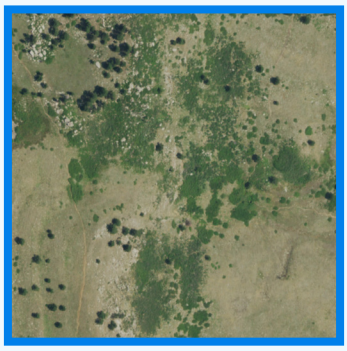
Data Sources

This assessment utilized high-resolution (60-centimeter) multi-spectral imagery from the US Department of Agriculture's National Agriculture Imagery Program (NAIP), collected in 2021, to derive land cover data and classify all types of land cover. Additionally, 1-meter resolution NAIP imagery from 2013 was utilized for historical tree canopy classification.

Mapping Land Cover

The land cover data set from the EarthDefine US Tree Map provides six distinct land cover classes. EarthDefine utilizes machine-learning techniques to extract tree canopy cover and other land cover types from the latest NAIP imagery. Figure 3 below describes the six land cover classes identified by this process.

Tree Canopy
leaves, branches, and stems generally greater than 10-15' tall



Shrubs
Woody plants with multiple stems arising from the base, generally less than 10' tall

Other Vegetation
healthy grasses, herbaceous plants, open pastures and turf grass

Bare Soil and dry vegetation
exposed earth, sand, or dead/ dormant grasses

Impervious Surfaces
roads, sidewalks, parking lots, buildings, and other paved areas

Water
rivers, lakes, ponds, reservoirs, and wetlands

Figure 3. This study identified six (6) unique land cover classes within the 2021 assessment imagery: tree canopy, shrubs, other vegetation, bare soil and dry vegetation, impervious surfaces, and water.

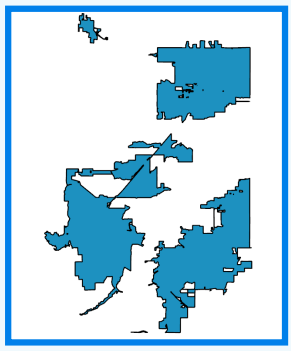
Identifying PPA and Unsuitables Areas for Planting

In addition to quantifying Boulder County's existing urban tree canopy (UTC) cover, areas suitable for planting trees (PPA-Possible Planting Area) to increase canopy cover were identified. To identify PPA, areas absent of tree canopy cover were classified as either PPA or unsustainable for planting. Unsuitable areas for tree planting, such as recreation fields, utility corridors, etc., were manually delineated and overlaid with the existing land cover data set (Figure 4). The final classifications include PPA Vegetation, Unsuitable Impervious, Unsuitable Vegetation, Unsuitable Soil, and Water.

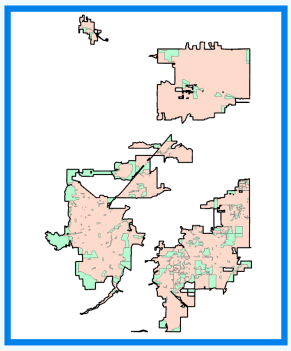
Figure 4. The study identified vegetated areas where it would be feasible for tree plantings but undesirable based on their current usage (left) in the data as "Unsuitable" (right).

Defining Assessment Levels

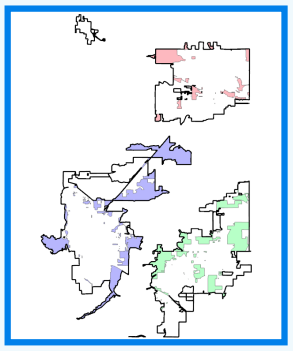
The urban tree canopy and related metrics were analyzed across various geographic boundaries to best serve Boulder County and its stakeholders. These include **Boulder County, distinctions between public and private lands, unincorporated urban areas, municipalities, land ownership types, generalized land use classes, watersheds, disproportionately impacted areas, and census block groups.**



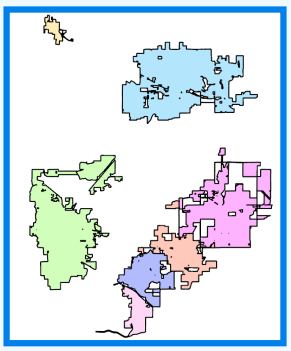
Boulder County



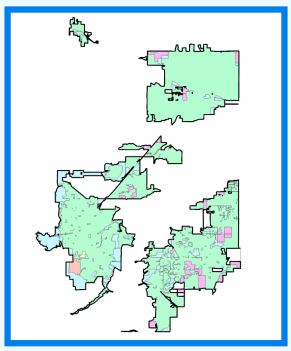
Public and Private Lands



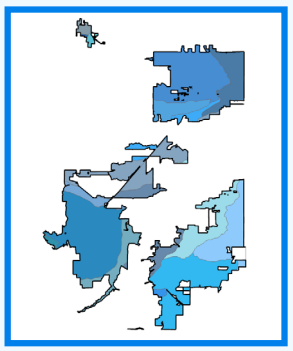
Unincorporated Urban Areas



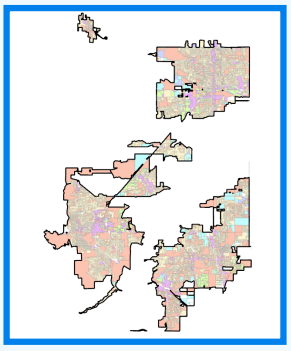
Municipalities



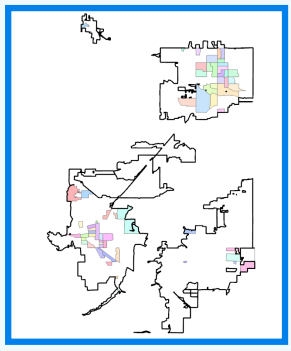
Land Ownership



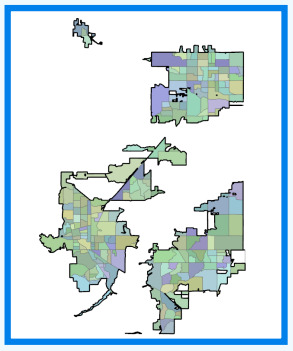
Watersheds



Generalized Land Use Classes



Disporportionately Impacted Areas



Census Block Groups

Figure 5. The tree canopy study explored nine (9) distinct geographic boundaries in this analysis: Boulder County, distinctions between public and private lands, unincorporated urban areas, municipalities, land ownership types, watersheds, generalized land use classes, disproportionately impacted areas, and census block groups.

State of the canopy and

Key Findings

Decision-makers of each municipality should use the results of this study to design a strategic approach to identifying existing canopy and future planting areas. Land cover and distribution of existing and potential urban tree canopy maps presented below are based on the entire assessment area. The area is described in six land cover classes: tree canopy (over impervious and pervious surfaces), shrub/scrub, soil and dry vegetation, other vegetation, impervious surfaces, and water. The county-wide land cover data below outlines the basic types of land cover classes, including surface water. *This land cover data is distinct from the urban tree canopy data, which includes potential planting areas and unsuitable areas based on land area excluding water bodies (explained in more detail on page 8).*

In 2021, Boulder County's land cover was categorized as follows: 16% tree canopy, 44% non-canopy vegetation, 31% impervious surfaces, and 3% each for soil/dry vegetation, water, and shrubs.

Land Cover Distribution

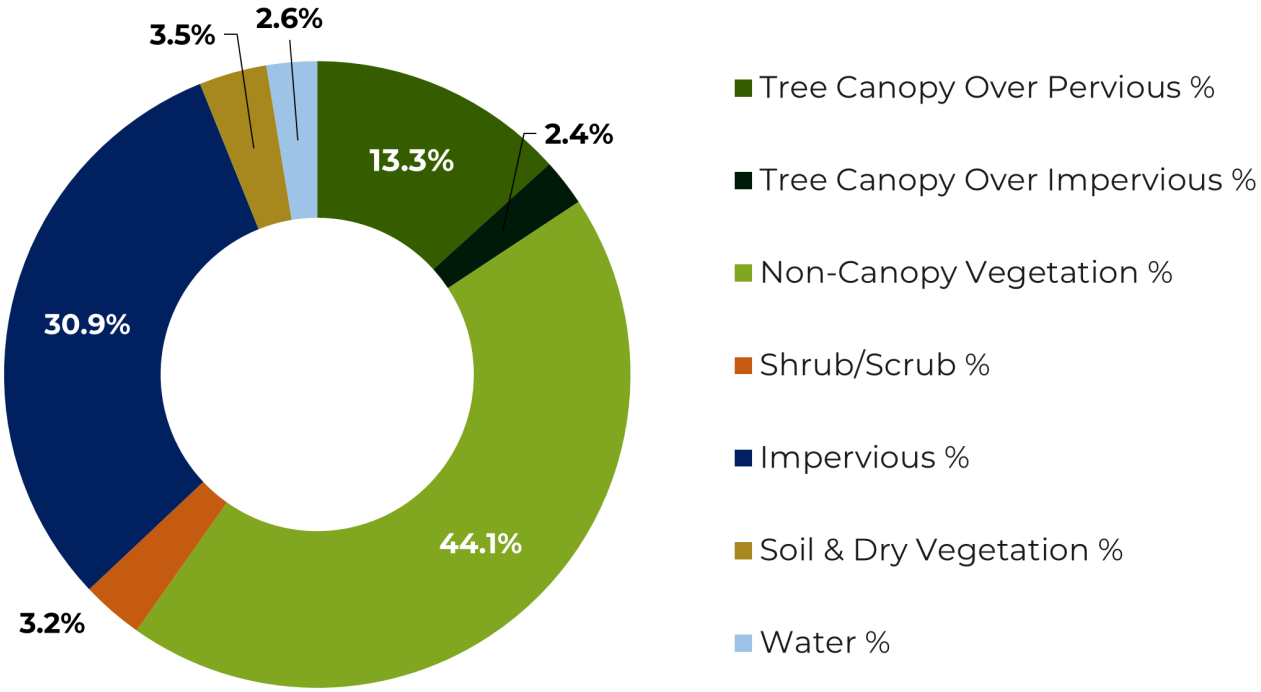
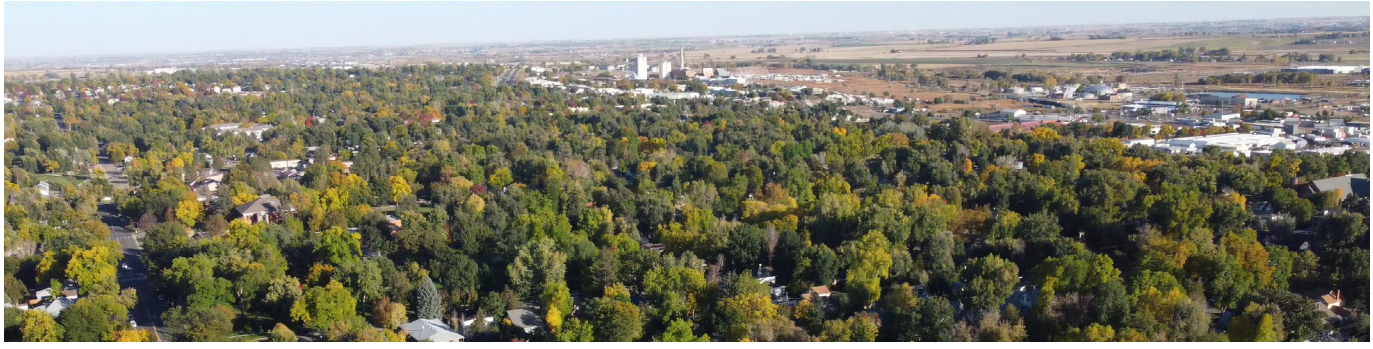


Figure 6. Land cover classification results (percentages based on the total study area of Boulder County, including water bodies). The tree canopy is divided between areas over impervious surfaces and areas over pervious surfaces.



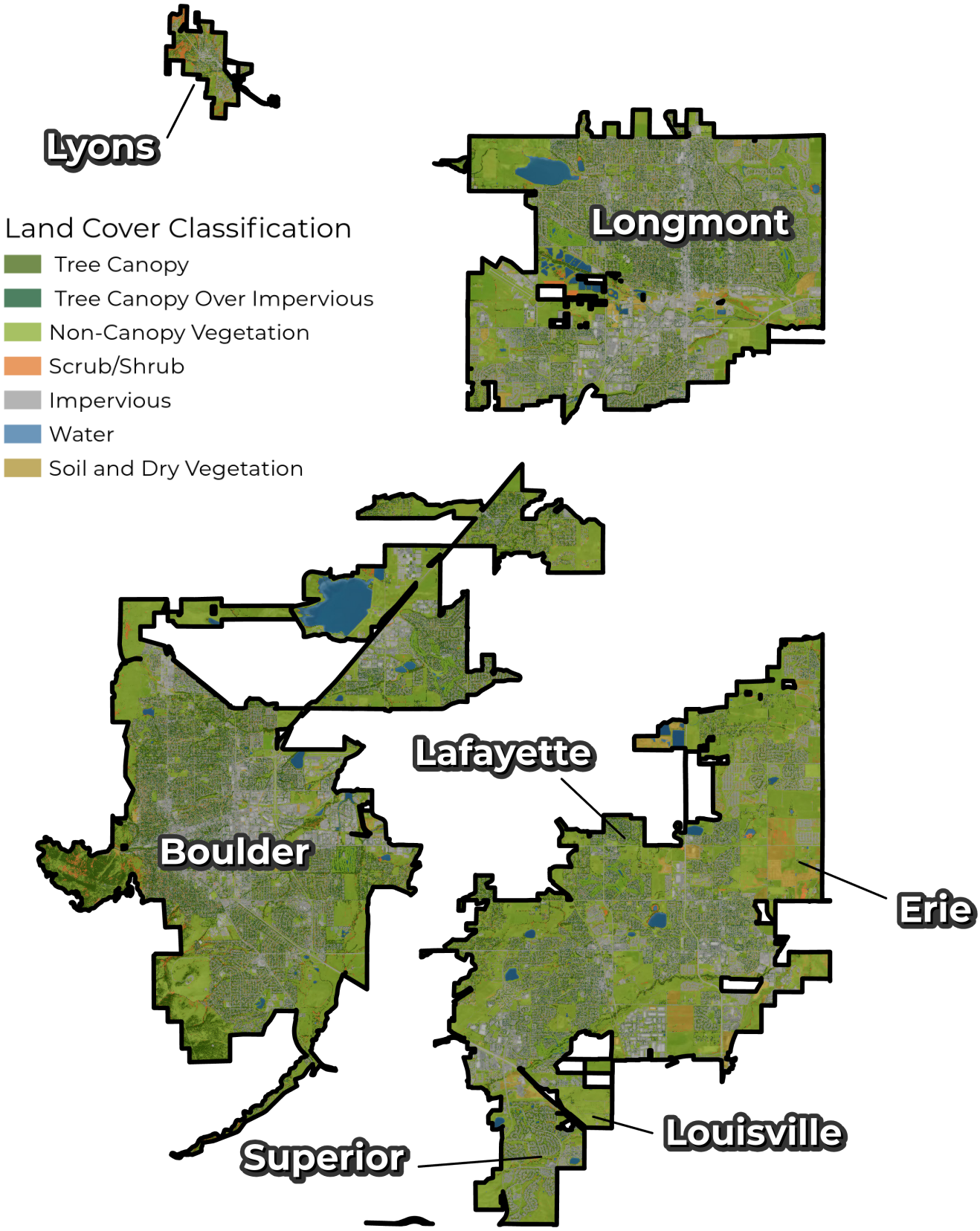


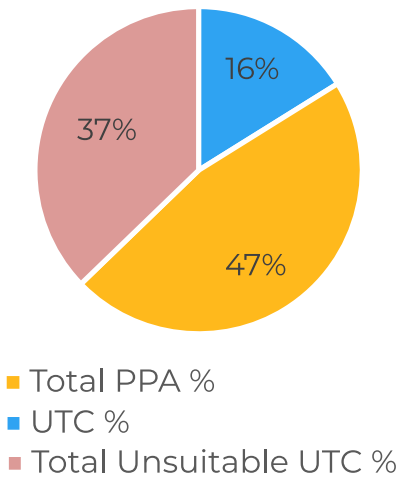
Figure 7. Distribution of land cover classes throughout Boulder County.

County-wide Tree Canopy Cover

When removing the 1,723 acres of surface water, Boulder County occupies 64,384 acres of land. In 2021, 16% of Boulder County's land area was covered by tree canopy, and 47%, or 30,031 acres, were available to plant trees (PPA). The county could theoretically reach up to 63% tree canopy cover if all plantable space were utilized.

However, planting trees in specific land cover categories is not feasible. About 31% of the county was covered with impervious surfaces such as roads and parking lots. An additional 6% of the area consisted of recreational sports fields and bare earth, with the latter likely due to ongoing development. These combined areas leave 37% of Boulder County unsuitable for tree planting. Unsuitable areas were primarily composed of 20,437 acres of impervious surfaces.

UTC Potential in Boulder County



Distribution of unsuitable planting areas in Boulder County

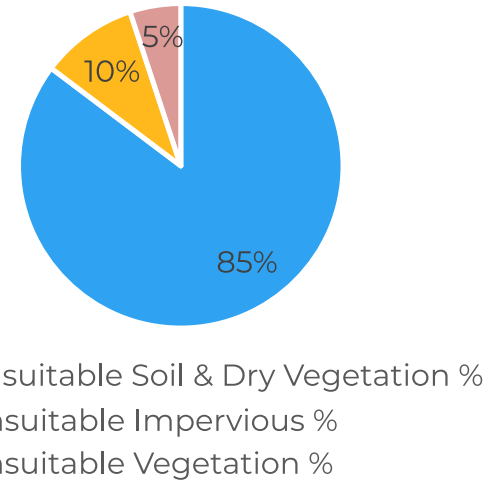


Figure 8. Tree canopy, possible planting area, and area unsuitable for tree canopy (left). The total unsuitable area is broken down by unsuitable soil, unsuitable impervious, and unsuitable vegetation percentages (right) within the Boulder County study area.

County-wide Tree Canopy Change

In the eight years between 2013 and 2021 , Boulder County had a modest increase in urban tree canopy. The county experienced a gain of 425 acres of canopy, equating to an addition of 0.7% UTC. For perspective, this gain is comparable to approximately half of the land area of the Town of Lyons.

It can be presumed that tree canopy likely fluctuated to some extent throughout the analysis time frame. This assessment serves as a snapshot of the canopy at the time of imagery collection in 2013 and 2021. Canopy gains can be attributed to three main factors: 1) new tree plantings and associated growth, 2) natural regeneration of areas previously classified as vegetation or shrubs, and 3) the growth or expansion of existing canopy. In contrast, canopy losses are generally due to clearing for residential or commercial development and damage from natural disasters such as storms and wildfires. Other potential causes of loss include tree mortality from climate change, hydrological shifts, or damage from pests and diseases.

2013:
9,963
Acres of Canopy

2013-2021:
+425
Acres of Canopy

2021:
10,387
Acres of Canopy

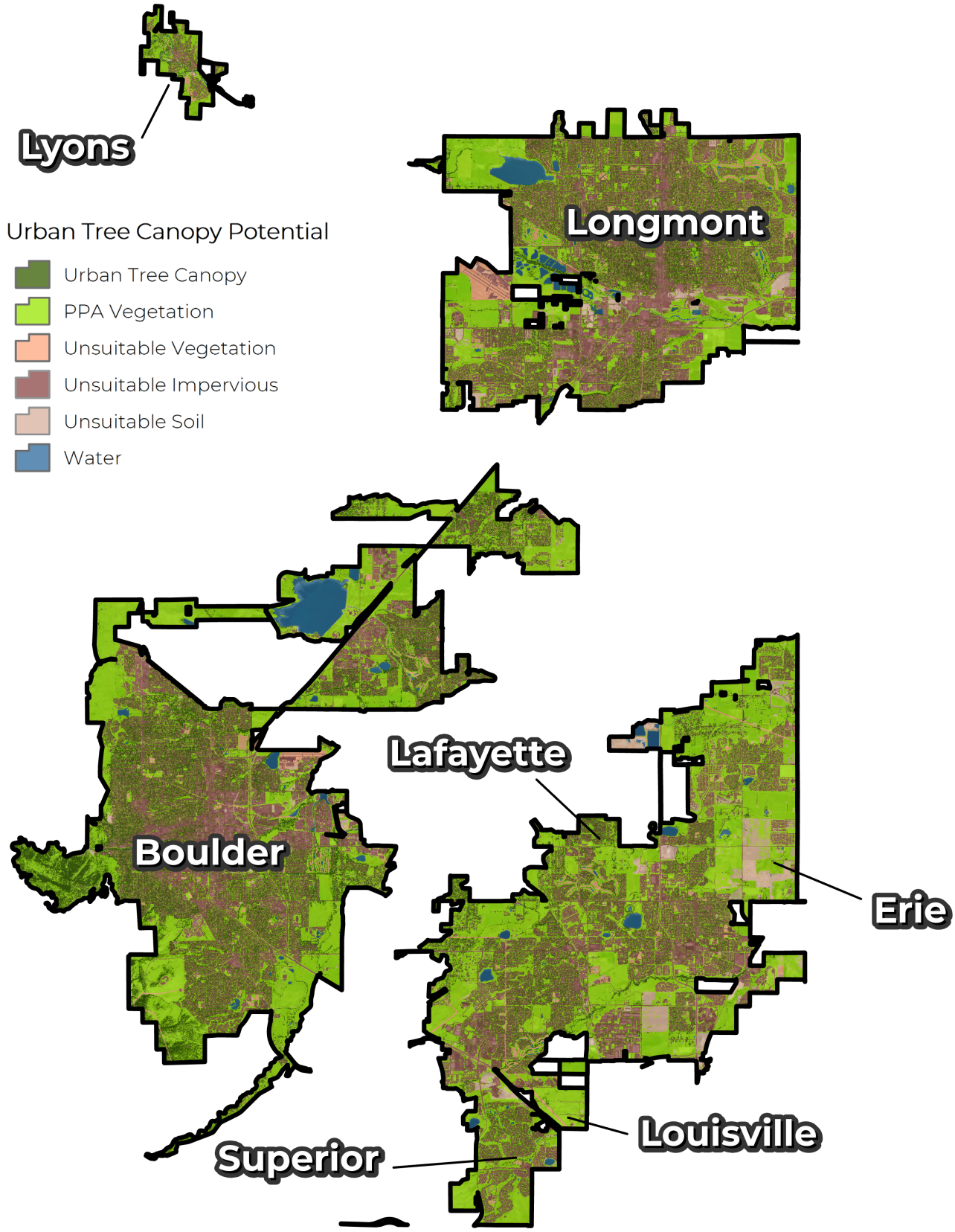


Figure 9. Distribution of UTC, possible planting area, and areas unsuitable for UTC within the county.

Canopy and Impervious Surfaces

The county's 10,387 acres of tree canopy were further divided into subcategories based on whether the canopy was overhanging pervious or impervious surfaces. While the benefits of tree canopy over pervious surfaces are obvious to most, it's important to highlight the advantages of tree canopy over impervious surfaces. These include localized cooling through shading and increased storm-water interception, which is crucial in creating a livable urban environment.

Boulder County's tree canopy predominantly overhangs pervious surfaces, at 85%, while just 15% overhangs impervious surfaces. However, there is significant potential for improvement. By planting more trees in rights-of-ways, along streets and sidewalks, and in other public areas, as well as strengthening ordinances for planting around parking lots in new developments, the county can effectively offset the harmful effects of impervious surfaces, instilling optimism for a greener future.

Tree Canopy Cover by Municipalities

The seven municipalities within Boulder County were analyzed to understand how the county's tree canopy is distributed across different jurisdictions. This collective effort aims to achieve cohesive regional canopy goals and provide crucial urban forestry metrics for each municipality. Collectively, these municipalities maintain an average canopy cover of 13%, a little less than the overall assessment area.

All geographic boundaries were confined to Boulder County's limits, except for municipalities. The boundaries of these incorporated areas were not clipped to the county to provide a thorough overview of all seven jurisdictions.

Municipal Specific Insights:

1. City of Longmont
   - Longmont occupies the largest land area within Boulder County, representing 29% of it and contributing an equal percentage to the region's UTC distribution. However, Longmont has the third-smallest canopy cover, with just 13% of its land area containing trees.
   - Longmont contained more impervious surfaces than trees, with the 3rd largest percentage of impervious surfaces. Impervious surfaces such as roads, houses, and other structures occupied 34% of the city, covering nearly 7,000 acres.
   - However, Longmont offers the largest ares of plantable area, with 8,428 acres (45% of the city) of PPA. Longmont has the most plantable space in the county, making up 29% of the total area available for planting. Longmont also had the largest percentage of water within its boundaries. Over 1,300 acres of water (7%) within this city would greatly benefit from the shade, avoided runoff, and other benefits that local trees would provide.
   - Longmont experienced the largest area increase in canopy out of all the seven municipalities. Tree canopy expanded by 317 acres (+2%) over eight years.

2. City of Boulder
   - The City of Boulder is the second largest city within the county. Boulder boasted the highest tree coverage among the municipalities, covering 21% of its area. This accounted for nearly half (43%) of the canopy within the county.
   - It had the smallest proportion of plantable space within its boundaries at 41%, a figure that Lafayette also shared. Since the city is so large, it still offers a significant amount of land available for planting efforts, with 7,035 acres (41% of the city's land area) available for new trees.
   - Boulder contained significant coverage of impervious surfaces. Almost 6,000 acres (34% of the city) were covered with impermeable surfaces such as roads, buildings, and sidewalks.
   - Boulder experienced the largest loss of canopy area in eight years. The 2% decrease equates to 289 acres of canopy removed from Boulder's urban forest during this study period.
3. Town of Erie
   - Erie is the third largest town in the study area and has a notably low canopy cover, at just 4%, the lowest of the seven municipalities.
   - Despite Erie's low UTC, it holds significant growth potential. With 7,313 acres of PPA available (54% of the city), there are ample opportunities for canopy expansion.
   - Erie contained the lowest percentage of impervious surfaces, with just 18% of its land covered.
   - Erie experienced the second-largest increase in canopy throughout the assessment period. From 2013 to 2021, the town gained 202 acres of canopy (a 1% increase).
4. City of Lafayette
   - Lafayette was tied for the third-largest canopy cover percentage. This city represents 9% of the total study area but had more trees than its share, with 10% of the county-wide canopy cover distribution.
   - This city is tied with Boulder for the lowest potential for new trees, with 41% of its land available for planting.
   - Lafayette experienced the largest percentage increase in canopy, 3%. Although this increase equates to just 156 acres, its canopy has increased by 24% relative to 2013 canopy levels.
5. City of Louisville
   - Louisville occupies over 5,000 land acres and is tied with Lafayette for the third densest canopy cover (14%).
   - This city has ample room for new trees, with 2,331 acres of plantable space. This equates to almost half (46%) of the city that is areas suitable for new trees.
   - Louisville had the second-largest percentage of impervious cover at 35%. Planting trees near streets and other impervious surfaces can reduce localized temperatures, improve air quality by removing particulate matter, and reduce noise pollution.
   - Louisville increased its canopy by a modest 2%. These 78 additional acres increased the canopy from 11% in 2013 to 13% in 2021.
6. Town of Superior
   - Superior is one of the smallest municipalities in this study.
   - Superior maintained a canopy cover under 10%, emphasizing a need for focused tree planting efforts to enhance its urban forest. Over half (55%) of Superior was plantable space just waiting to be utilized!
   - The tree canopy increased by 2% within the town boundaries. The 44-acre increase translates to roughly 6 acres of canopy a year.

7. Town of Lyons
   - Lyons is the smallest municipality studied in this analysis, representing just 1% of the total assessed area.
   - This town had the second densest canopy cover at 17%.
   - Lyons demonstrated the greatest potential for canopy expansion among the municipalities, with 58% of its land available for tree planting.
   - In addition to Boulder, Lyons is the only other municipality to lose canopy. Although this loss was small, just 15 acres, this translates to 2% of Lyon's canopy lost in eight years.

Distribution of UTC %

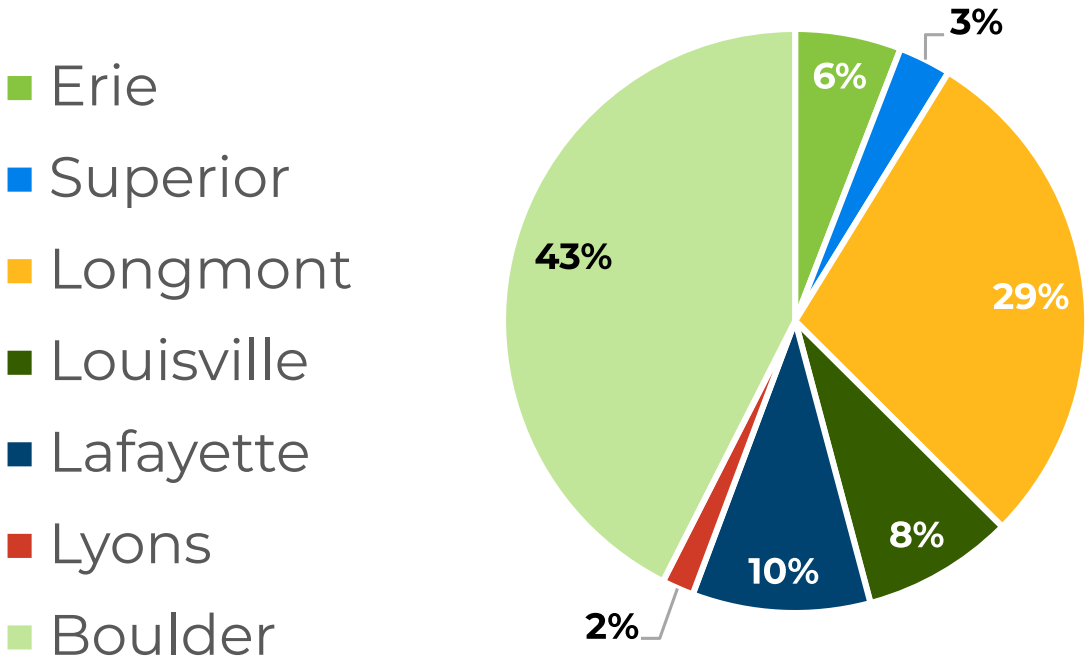


Figure 10. Distribution of tree canopy throughout Boulder County's municipalities.

Regional Trends:

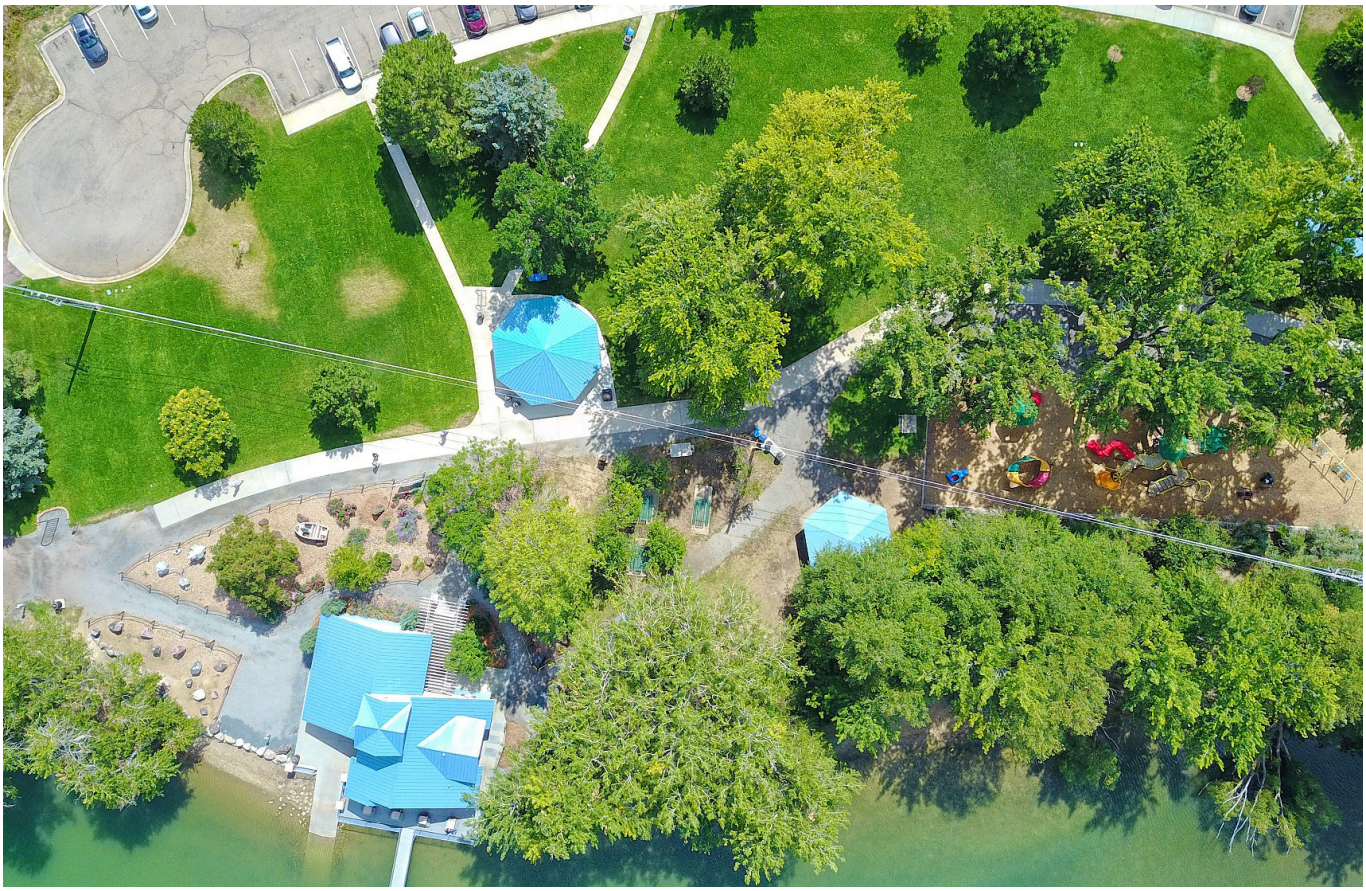
- Most municipalities have witnessed increased tree canopy, with five out of the seven recording growth. However, Boulder and Lyons saw a 2% reduction in tree coverage.
- Overall, Boulder County enjoyed a net increase of almost 430 acres (+1%) in tree canopy over eight years.
- By effectively leveraging the extensive plantable space (30,030 acres or 47% of the county), all seven municipalities could at least double their respective canopy coverages, substantially enriching the urban forest landscape across Boulder County.

This collective approach provides urban forest metrics that can be used to set realistic canopy targets, highlighting existing canopies, municipalities' capacity for new trees, and identifying potential planting spaces. These results also emphasize the critical role of urban forestry in sustainable urban planning. For more details on setting canopy goals, refer to the Canopy Target section on page 30 of this report.

Table 1. Distribution of tree canopy, plantable space, and canopy change throughout Boulder County's municipalities and urbanized areas.

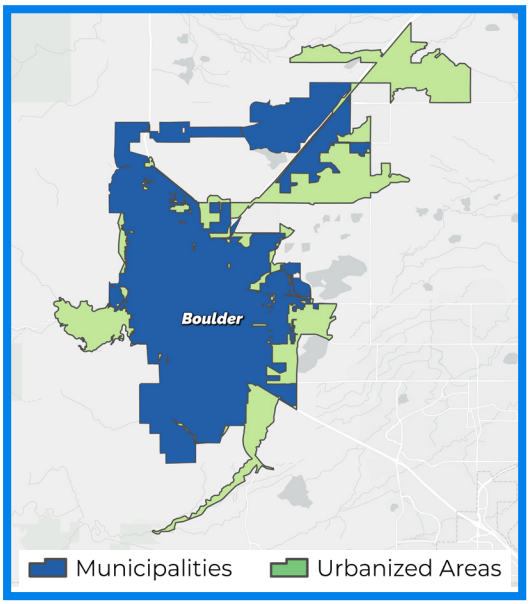
Municipalities	Land Acres	UTC (Acres)	UTC %	Total PPA (Acres)	Total PPA %	Total Impervious %	UTC Change 2013-2021 (Acres)	Raw Change (%)
Boulder	17,109	3,521	21%	7,035	41%	34%	-289	-2%
Erie	13,505	487	4%	7,313	54%	18%	202	1%
Lafayette	5,938	816	14%	2,462	41%	36%	156	3%
Longmont	18,697	2,372	13%	8,428	45%	34%	317	2%
Louisville	5,113	695	14%	2,331	46%	35%	78	2%
Lyons	867	146	17%	503	58%	20%	-15	-2%
Superior	2,568	242	9%	1,409	55%	30%	44	2%
Unincorporated Urbanized Areas	15,072	2,552	17%	9,432	63%	13%	6	0%

**Please note that the municipality geography encompasses all cities combined, including portions of Longmont and Erie that extend beyond the county boundary, including the three urbanized areas. Additionally, there is some overlap between municipal boundaries and urban areas.*

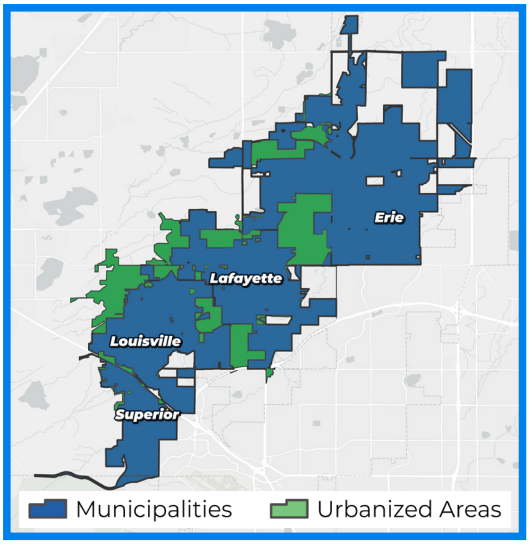


Tree Canopy by Boulder County's Unincorporated Urban Areas

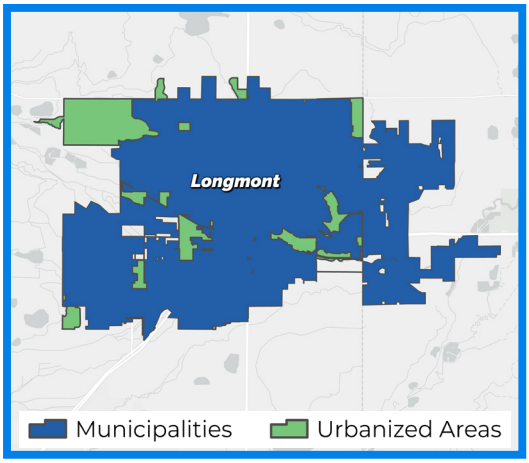
Cities are expanding to enhance the lives of current community members and accommodate future residents. The unincorporated areas of Boulder County were selected according to the 2010 US Census Bureau data to isolate only the urban parts of these unincorporated regions. These areas are defined by the Census Bureau as having at least 2,500 residents (commonly referred to as high-density residential areas), and they typically include a mix of residential, commercial, and other urban land uses centered around an urban core. Together, these three distinct urban regions cover a total of 15,072 acres.



Unincorporated Urban Area West: The Boulder, CO UA, which includes neighborhoods such as *Gunbarrel, Niwot, Twin Lakes, and areas along South Foothills Highway, is the largest assessment boundary covering 7,715 acres. About a quarter (24%) of this area was covered with trees, with 56% (about 4,200 acres) available for potential planting.



Unincorporated Urban Area South: The Lafayette-Louisville-Erie, CO UA encompasses over 5,000 acres, including communities near Parkdale, Annette Brand Park, and Alexander Dawson School Airport. Trees covered only 9% of this area (almost 500 acres), yet 68% of the land (3,635 acres) is available for planting.



Unincorporated Urban Area North: The Longmont, CO UA surrounding Longmont's City boundaries is the smallest area at just 2,050 acres. Similarly to the landcover metrics within UA South, only 9% of this area contained trees (almost 200 acres). This area boasted the most land available for planting with 73% PPA (1,179 acres).

Over the eight-year study period, all three areas maintained relative stability. UA West areas experienced the largest canopy loss, with a decrease of 11 acres, corresponding to a mere 0.1% reduction. Conversely, the unincorporated areas surrounding Lafayette, Louisville, and Erie saw the most significant gain, with 17 acres of new trees, amounting to a 0.3% increase.

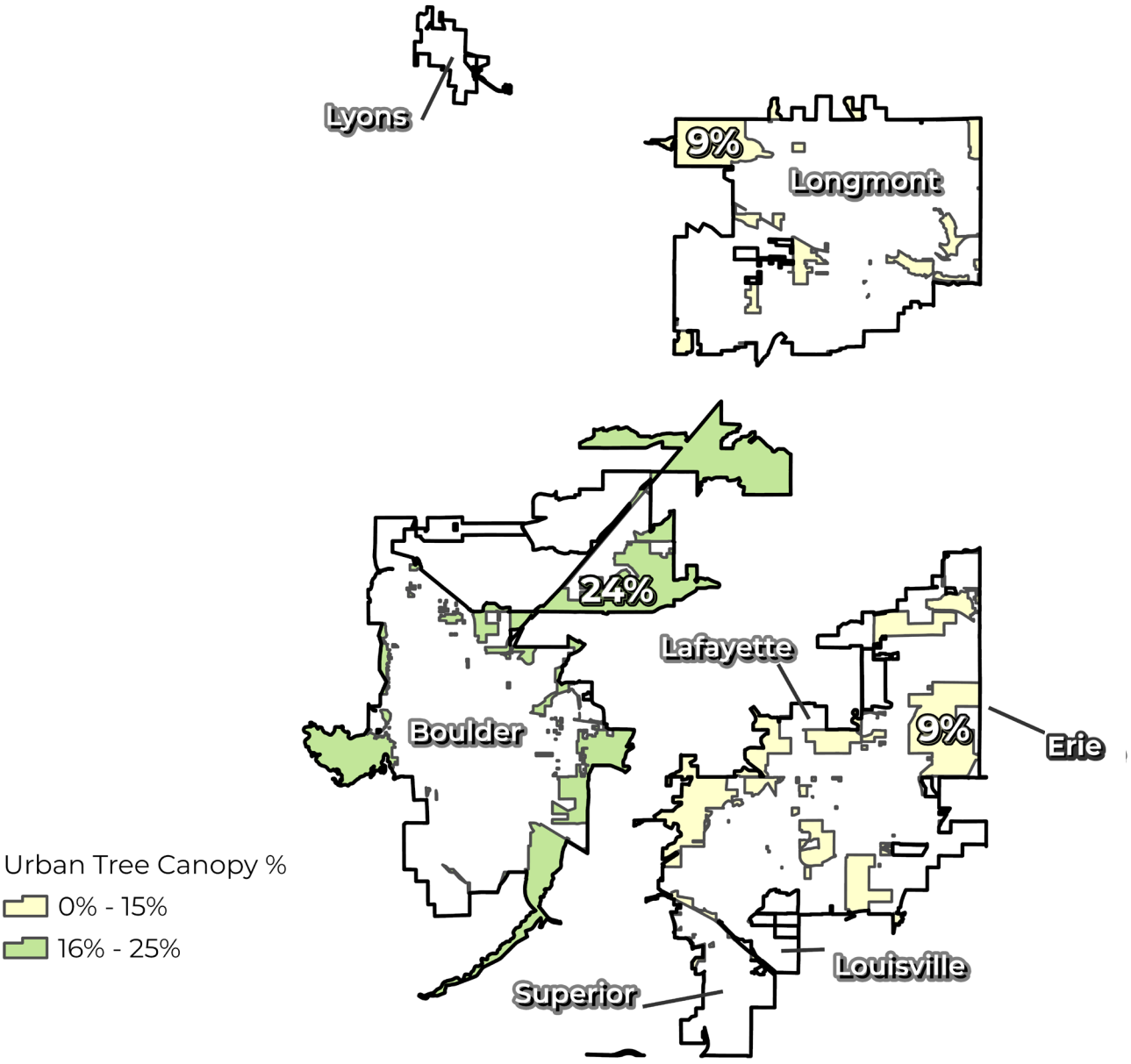


Figure 11. Urban tree canopy throughout Boulder County's three unincorporated urban areas.

Census designated urbanized areas surrounding Lafayette, Louisville, and Erie contain 3,659 acres of plantable space.

Tree Canopy Cover by Private vs. Public

Tree canopy coverage was evaluated across lands managed by municipalities and private landowners in Boulder County. Of the total study area, ownership data was available for 64,382 acres, representing 83% of the total area. The remaining 17% of the assessed area had no private or public designation (no data available).

Among the analyzed land, 82% was owned by private landowners in Boulder County. However, only 17% of the 52,697 acres of private land had tree coverage, while public land had even less, with trees covering only 13%.

Canopy distribution revealed that 85% of the county-wide canopy was on private land. Plantable space was more evenly distributed between land ownership types, though the majority, 71%, is still on private land, compared to 29% on public land. Within these ownership categories, 76% of public land is available for planting, compared to 40% of private land suitable for more trees.

Private land saw a net increase in canopy, gaining 548 acres, about 1% of all private land. In contrast, public land experienced a canopy reduction, with a loss of 123 acres or 1% of its existing canopy, largely due to natural disasters, pest infestations, diseases, and aging trees.

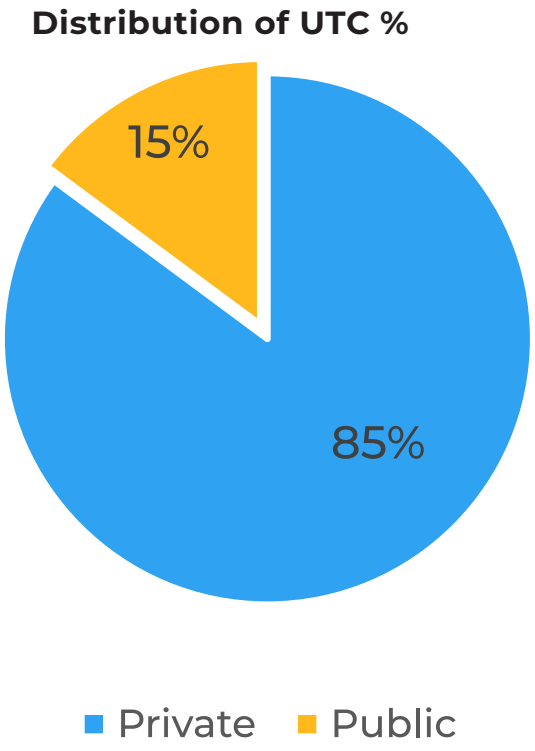
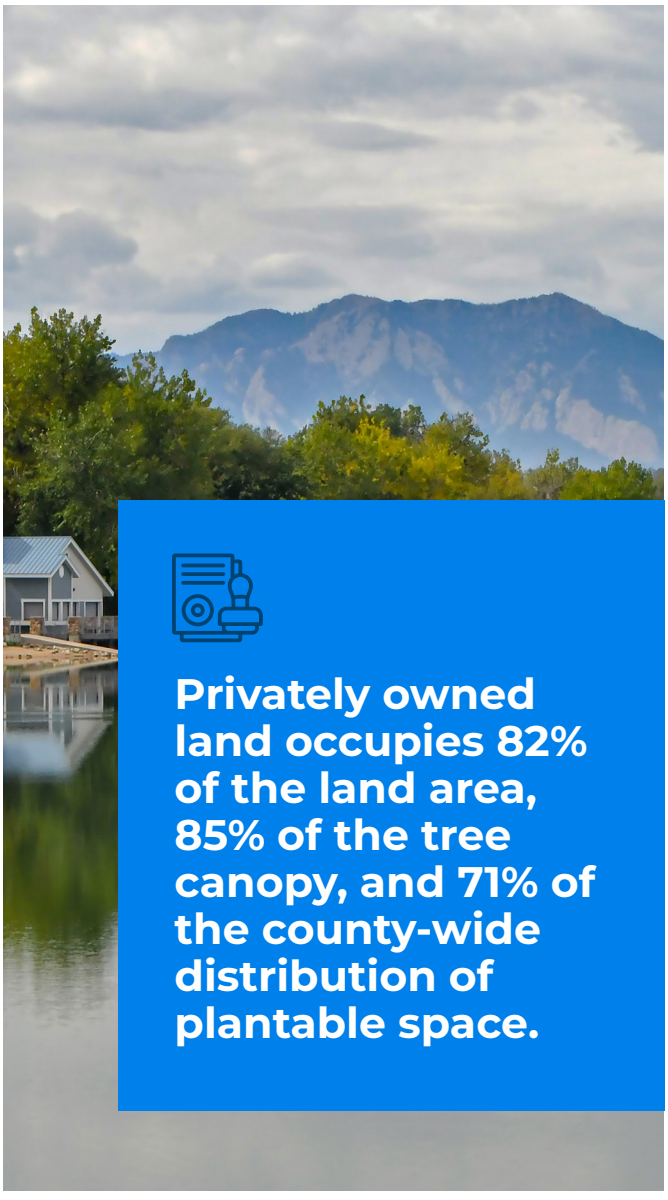


Figure 12. Distribution of canopy on public lands compared to private property.



Tree Canopy Cover by Ownership

Tree canopy metrics in Boulder County were assessed and categorized into seven distinct land ownership classifications: *City, County, Federal, Non-governmental organization (NGO)/Land Trust, Private, School Districts, and State*. Identifying land ownership of the potential planting areas highlights which landowners should be targeted for future tree planting and maintenance programs. This strategic approach aids in planning and engaging with relevant stakeholders for future urban forestry initiatives.

Most of the land and tree canopy area was found on private property, which accounted for 81% of all land and 85% of all canopy. However, trees only cover 17% of the private land area. City-owned land was the second largest ownership class, accounting for 13% of the county's land area with a similar 17% canopy cover. These 1,421 acres of canopy on City-owned land represent 14% of the county-wide tree distribution. Conversely, County-owned lands contained the lowest canopy cover, with just 4% of their land occupied by trees.

Despite the relatively low canopy cover percentage, private land has significant potential for expansion, with 21,000 acres available for planting. NGO/Land Trust lands exhibited the highest percentage of PPA, with 83% of their land available for new trees. City-owned lands also offered substantial plantable space, with over 6,300 acres available. City-managed lands had over four times more potential canopy area than the existing canopy.

Federal lands comprise the largest percentage of impervious cover, with nearly half (49%) of their land comprising hard, impervious surfaces. However, these lands hold almost 50 acres of PPA, which could significantly bump their UTC from 7% to 49% if fully utilized.

Over the eight-year assessment period, private lands saw the most significant canopy gain (558 acres), with Private and School Districts being the only two ownership classes to increase their canopy. In contrast, City-owned lands experienced the largest loss of canopy (119 acres). County-owned land remained relatively stable, with a loss of just 3 acres. School Districts had the largest percentage increase (+2%), but since they represent a small area (55 acres), this increase only translates to an additional acre of canopy.

Distribution of UTC %

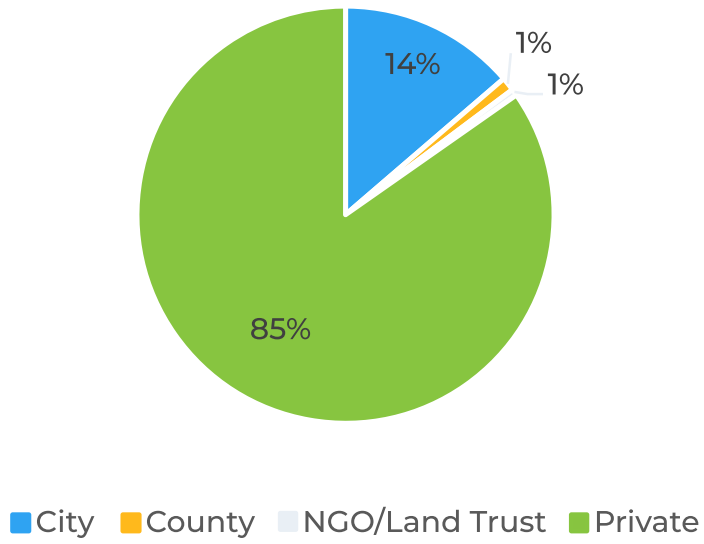


Figure 13. Distribution of canopy by ownership type.

Private property, which constitutes 85% of all canopy cover, has significant potential for expansion, with 21,000 acres available for planting.

Tree Canopy Cover by Generalized Land Use

To better understand human impact on natural environments, tree canopy and plantable space were assessed across the County using the 2010 State Parcel Data Land Use dataset, summarized into seven generalized land use classes: Agricultural, Commercial, Government, Industrial, Other, Residential, and State-Associated Utility. More detailed data can be accessed via Boulder County's TreePlotter CANOPY app.

Residential areas, constituting 44% of the land use area, had the densest canopy cover at 25%, contributing to 66% of the county-wide canopy. Government areas followed with 2,298 canopy acres, representing 25% of the total canopy. Agricultural areas had the smallest canopy cover at 6%, primarily because these lands are managed for crop production or grazing, not tree cover. Agricultural lands frequently undergo significant changes due to planting and harvesting cycles, making tree canopy a less relevant metric for assessing the health of these agricultural lands.

Areas for plantable space ranged from 26% to 88%. Land use areas designated for government purposes offer the most potential for planting, with 13,018 acres available. These areas typically house public buildings, schools, parks, and military installations, making them ideal candidates for tree-planting initiatives due to their public use and benefit.

Commercial zones had the smallest proportion of plantable space, with only 26% (just over 1,000 acres) available for greening near shopping centers and store entrances. These areas also featured the highest percentage of impervious surfaces—over 57% or approximately 2,200 acres. It is crucial to capitalize on the available plantable space in these land-use areas to counteract issues like increased temperatures and flooding risks associated with these impervious surfaces.

Every land use type experienced an increase in canopy cover except for government areas, which saw a reduction of 102 acres over eight years, translating to a 1% loss or about 12.5 acres annually. The largest increases in canopy were observed in industrial areas, which grew by 2%, and residential areas, where canopy expanded by nearly 300 acres during the study period.

Land and Canopy Acres by Generalized Land Use

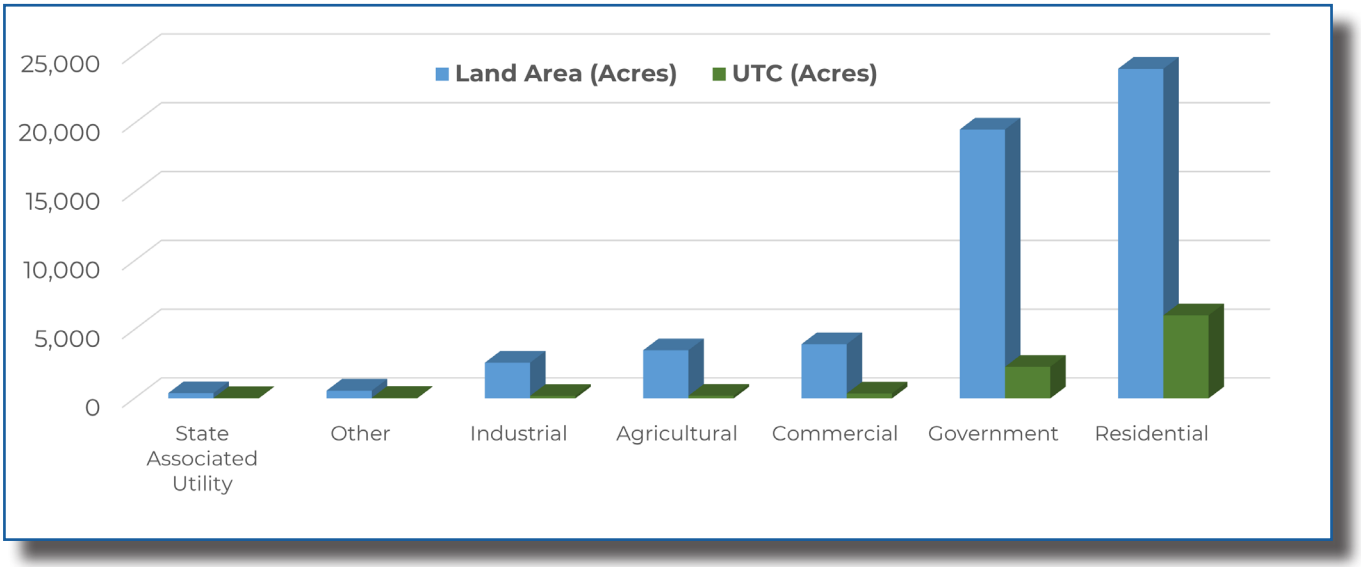


Figure 14. Urban tree canopy acres by general land use.

Table 2. Land use acres, urban tree canopy percent, plantable space percent, and urban tree canopy change by generalized land use categories.

Land Use Type	Total Area (Acres)	Land Area (Acres)	Dist. of Land Area %	UTC (Acres)	UTC %	Dist. of UTC %	UTC Change 2013-2021 (Acres)	Raw Change (%)
Agricultural	3,614	3,497	6%	194	6%	2%	**8**	0%
Commercial	3,972	3,942	7%	359	9%	4%	**42**	1%
Government	21,067	19,550	36%	2,298	12%	25%	**-102**	-1%
Industrial	2,604	2,595	5%	183	7%	2%	**45**	2%
Other	583	566	1%	44	8%	0%	**0**	0%
Residential	24,002	23,965	44%	6,040	25%	66%	**299**	1%
State Associated Utility	387	384	1%	28	7%	0%	**3**	1%
Totals	**56,229**	**54,499**	**100%**	**9,146**	**17%**	**100%**	**293**	**1%**

Government land use type was the only land-use class that lost canopy from 2013 to 2021.

Tree Canopy Cover by Watersheds

Urban forests regulate storm water runoff, reduce flooding, and support a healthy water cycle. Boulder County's assessment area had about 1,724 acres of surface water spread across its 20 watersheds. Tree canopy metrics were assessed in each watershed to help maintain the health of these water bodies. Trees planted within these areas help intercept and absorb storm water runoff, preventing it from carrying harmful pollutants into surface water bodies.

Bear Canyon Creek-Boulder Creek is the largest among these watersheds, covering almost 13,000 land acres and hosting the most substantial tree coverage with 3,285 acres, or 26% of its land. Bummers Gulch-Boulder Creek boasted the densest tree cover, with 57% of its land shaded by trees. McIntosh Lake-Saint Vrain Creek also contributed significant canopy with 1,591 acres, representing 15% of the County's trees.

Regarding potential planting areas, Middle Coal Creek and Bear Canyon Creek-Boulder Creek offered a large area for new plantings, each providing over 4,000 acres and contributing significantly to county-wide totals with 16% and 14%, respectively. Although Upper Big Dry Creek had the highest PPA percentage at 83%, this watershed had minimal impact, with only 2 acres available due to its small size (3 land acres).

Dry Creek, with the highest concentration of impervious surfaces at 49%, had a substantial 867 acres of PPA. Strategically planting native trees in this area could increase its canopy coverage from 10% to 46%. Climate resilient trees that can tolerate occasional flooding are essential for reducing the adverse effects of floods, absorbing significant amounts of rainwater and snow melt, increasing soil permeability, and preventing erosion along riverbanks.

Among the 20 watersheds, 10 experienced an increase in canopy cover, 7 witnessed a decrease, and the remaining 3 remained relatively unchanged. Notably, Bear Canyon Creek-Boulder Creek saw a decrease of 347 acres, losing 3% of its canopy. Conversely, Boulder Reservoir, Calkins Lake-Saint Vrain Creek, Lower Coal Creek, Middle Coal Creek, and McIntosh Lake-Saint Vrain Creek gained over 100 acres. Bummers Gulch-Boulder Creek faced the largest percentage decrease, with a 5% loss over eight years.

UTC Potential (%) by Watersheds

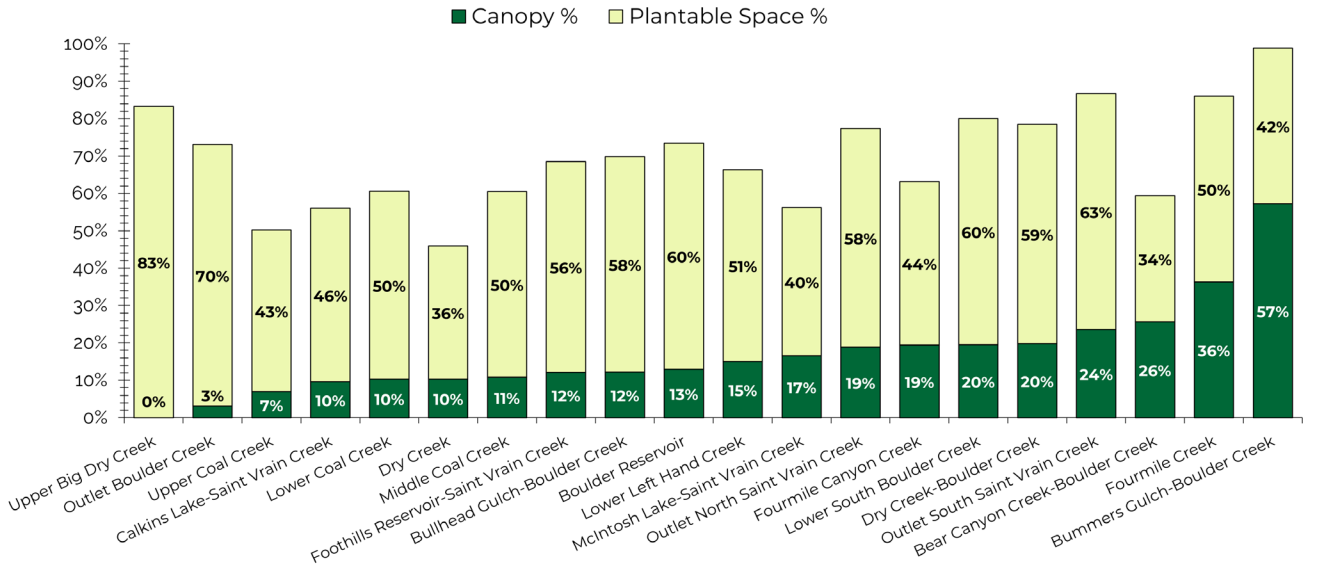


Figure 15. Urban tree canopy potential by watersheds.

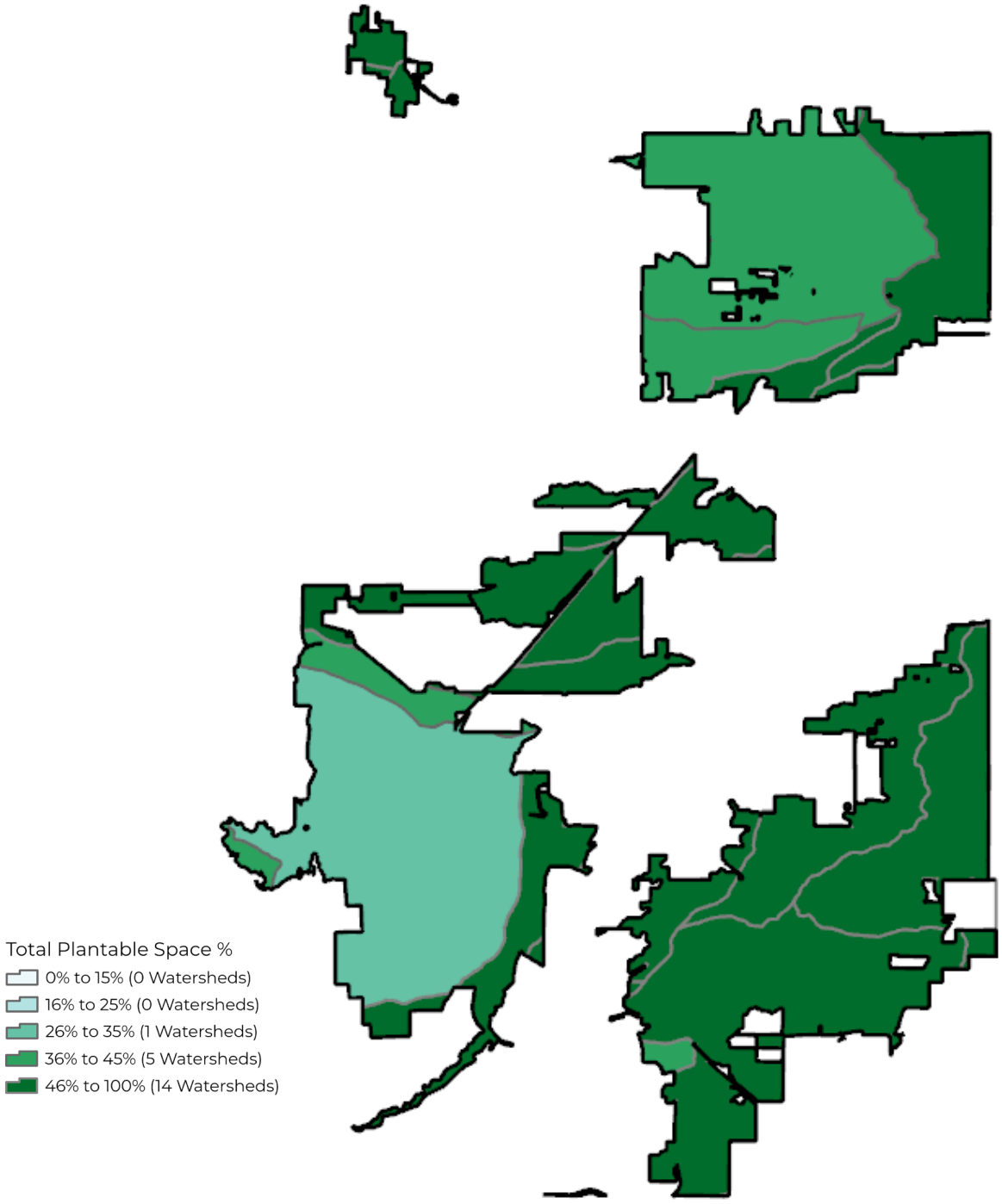


Figure 16. Possible planting area percent by watersheds.

Bear Canyon Creek-Boulder Creek contributes significant canopy with 3,286 acres, representing 32% of the County's trees.

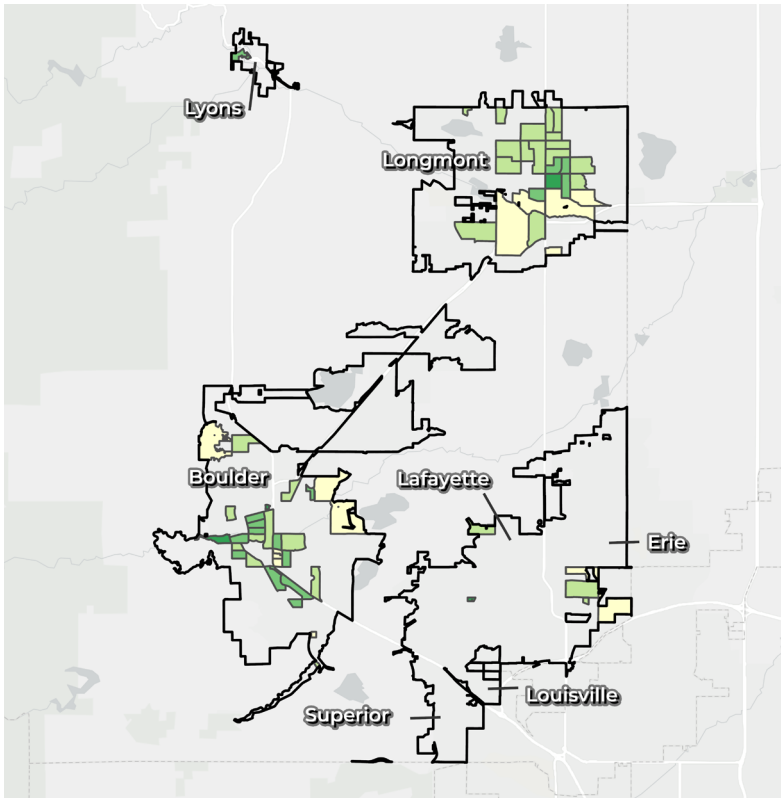
Tree Canopy Cover by Disproportionately Impacted Areas

In Colorado, disproportionately impacted (DI) areas refer to regions identified based on social, economic, and environmental factors where residents may face greater challenges from pollution and other environmental harms. These areas often have vulnerable populations disproportionately affected by poor environmental quality and limited access to resources needed to address these issues. The Colorado Department of Public Health and Environment's (CDPHE) EnviroScreen tool was used to select these areas, incorporating layers such as Disproportionately Impacted Community, Mobile Home Communities, and Federal CEJST – Justice40 for comprehensive mapping. Please refer to the state's full definition of DI communities here.

In Boulder County, 93 total DI areas were assessed, revealing an average canopy cover of 17%—higher than the county-wide average. Typically, disproportionately impacted communities have lower tree canopy coverage due to a variety of historical, economic, and political reasons. However, there are scenarios where such communities might have higher tree canopy levels. For instance, disproportionately impacted communities located in rural or peri-urban areas may naturally have higher tree canopies simply due to their proximity to less developed lands, as these areas may not have undergone extensive urban development that typically reduces tree cover.

The disproportionately impacted areas had an average plantable space of 32%, which is lower than the county average.

- Most areas (37) had a canopy cover of 20%-30%, and 38 areas had a similar amount of plantable space (20%-30%).
- The next most common range was 10%-20%, with 30 areas in this range for canopy cover and 33 areas for plantable space.
- Seven areas had very low canopy cover, below 10%, showing a significant lack of tree coverage. On the other hand, five areas had high plantable space, with 50%-100% of their land available for planting trees.



While there's good news that 28 (out of 63 total) of the DI areas gained canopy, the overall majority (35) showed a negative trend and lost canopy. Trees provide numerous health benefits, such as improving air quality, reducing urban heat island effects, and promoting physical activity and mental well-being. Losing tree canopy in these areas can negatively impact the health of residents who may already face other environmental and socioeconomic challenges.

Urban Tree Canopy %
- 0% to 15% (12 DI Areas)
- 16% to 25% (30 DI Areas)
- 26% to 35% (17 DI Areas)
- 36% to 45% (4 DI Areas)
- 46% to 55% (0 DI Areas)

Figure 17. Map of urban tree canopy in disproportionately impacted areas.

Tree Canopy Cover by Census Block Groups

Census block groups are collections of smaller census blocks organized to reflect even population divisions. These areas are crucial for evaluating the equitable distribution of tree canopy since they link directly to demographic and socio-economic data from the American Community Survey (ACS). There are 213 census block groups within Boulder County.

In Boulder County, the 207 census block groups had canopy covers ranging from 2% to 53%, with lower canopy typically found along the northern edges of municipalities. Notably, the largest census block group, encompassing the urban areas around the City of Boulder, had one of the lowest canopy covers at 3%. Conversely, the census block group with the highest UTC of 53% is located near Flagstaff Mountain along the western edge of Boulder.

Among the 213 census block groups, 175 have between 10% and 30% UTC percentages. The areas adjacent to major roadways, such as CO 199 and US 36, and farther south near Northwest Parkway, tend to have the lowest UTC percentages. Only 4 block groups boasted canopy coverage greater than 40% (both located in western Boulder).

Generally, the availability of PPA increases along the outskirts of municipalities, while lower PPA percentages are found near the downtown areas or city centers. 73 had PPA percentages ranging from 20% to 30%. However, PPA values generally exceeded UTC percentages, with 71 block groups having more than 40% of their area designated as potential planting zones, highlighting significant opportunities for urban forestry expansion.

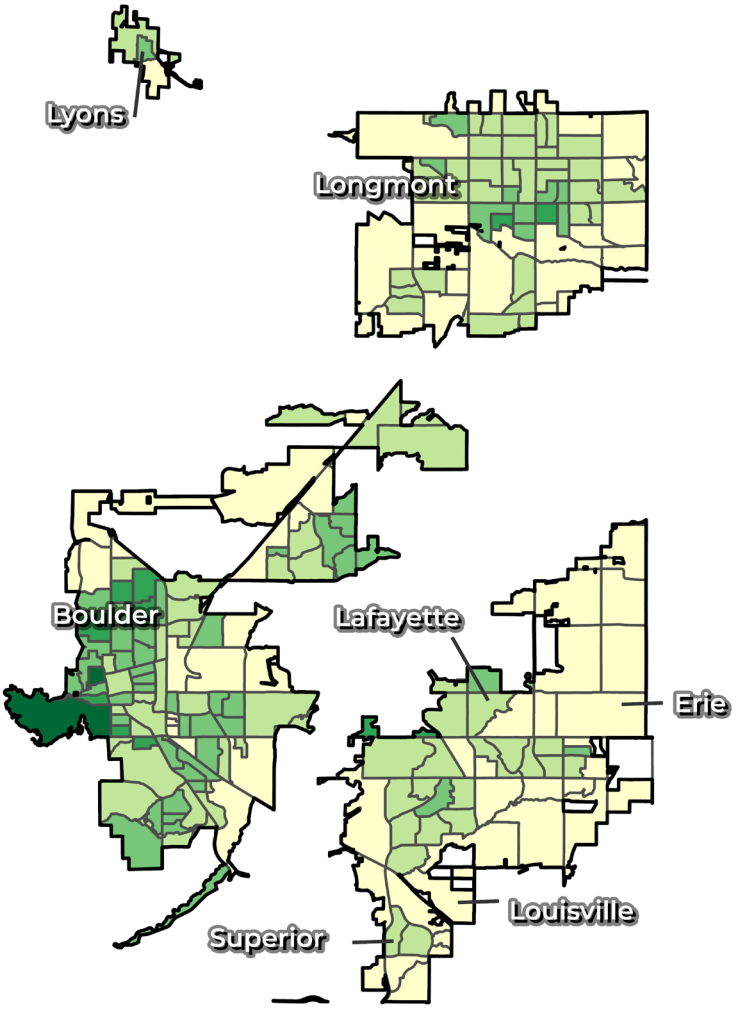


Figure 18. Urban tree canopy percent by census block groups.

Number of Census Block Groups by UTC Ranges

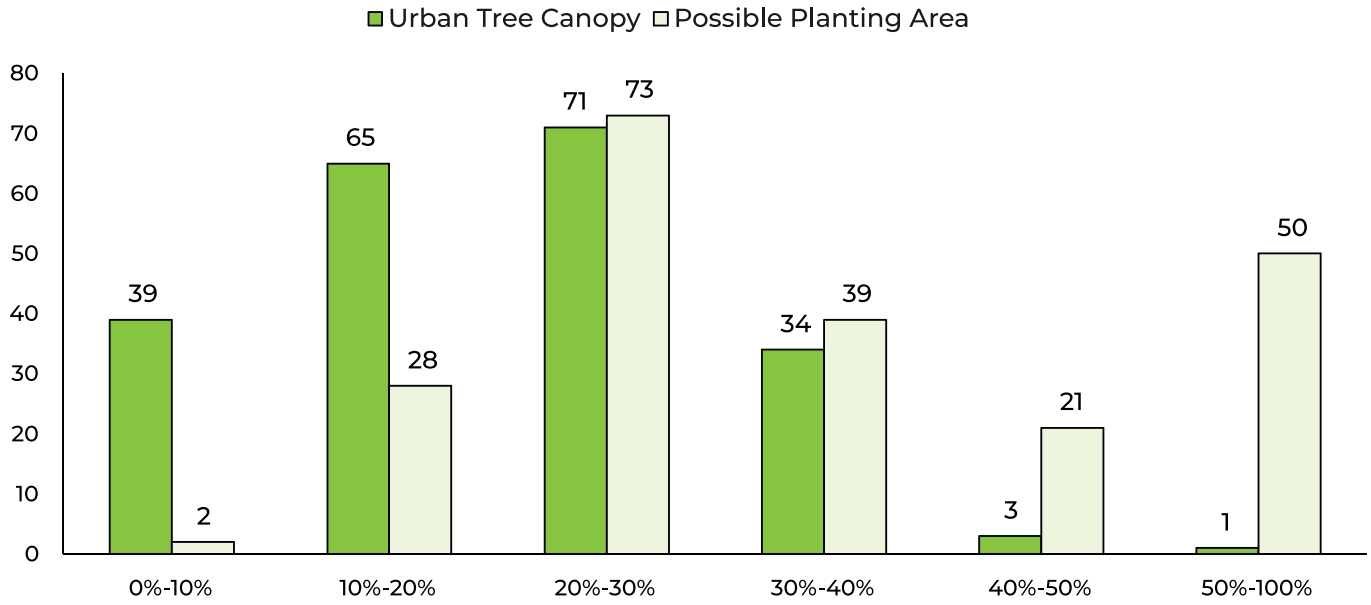


Figure 19. Number of census block groups within UTC and PPA ranges.

Generally, the availability of PPA increases along the outskirts of municipalities, while lower PPA percentages are found near the downtown areas or city centers.

Quantifying

Ecosystem Benefits

The urban tree canopy in Boulder County provides significant environmental and economic benefits, as revealed through advanced calculations using i-Tree tools, a science-based software suite from the USDA Forest Service. Several key values were quantified by inputting the municipality's combined total tree canopy area into the i-Tree Landscape tool, demonstrating the urban forest's impact on infrastructure cost savings, pollution reduction, and carbon storage. All seven municipalities were combined and used as the total study area to summarize the ecosystem benefits metrics, as opposed to the entire county.

Air Quality

Trees are vital for improving air quality; they produce oxygen, reduce air temperatures, indirectly reduce pollution, and mitigate public health risks by filtering harmful air pollutants. These pollutants can lead to severe health issues. In Boulder County, the tree canopy eliminates about 460 tons of air pollutants each year, providing an estimated value of over $1,556,616.

Storm-water and Water Quality

The county's trees play a crucial role in managing stormwater. They help reduce runoff, which diminishes flood risk, stabilizes the soil, lowers sedimentation in water bodies, and filters pollutants, enhancing water quality and habitat health. Boulder County's trees absorb over 92 million gallons of water annually, translating to stormwater management benefits worth approximately $826,158.

Carbon Storage and Sequestration

Trees in Boulder County actively contribute to carbon storage, accumulating about 368,760 tons in their biomass, worth over $62.8 million. Furthermore, each year, Boulder County's tree canopy captures and sequesters over nine thousand tons of carbon dioxide, adding a value of over $1,574,400. Carbon sequestration is crucial in combating climate change by removing carbon dioxide from the atmosphere.

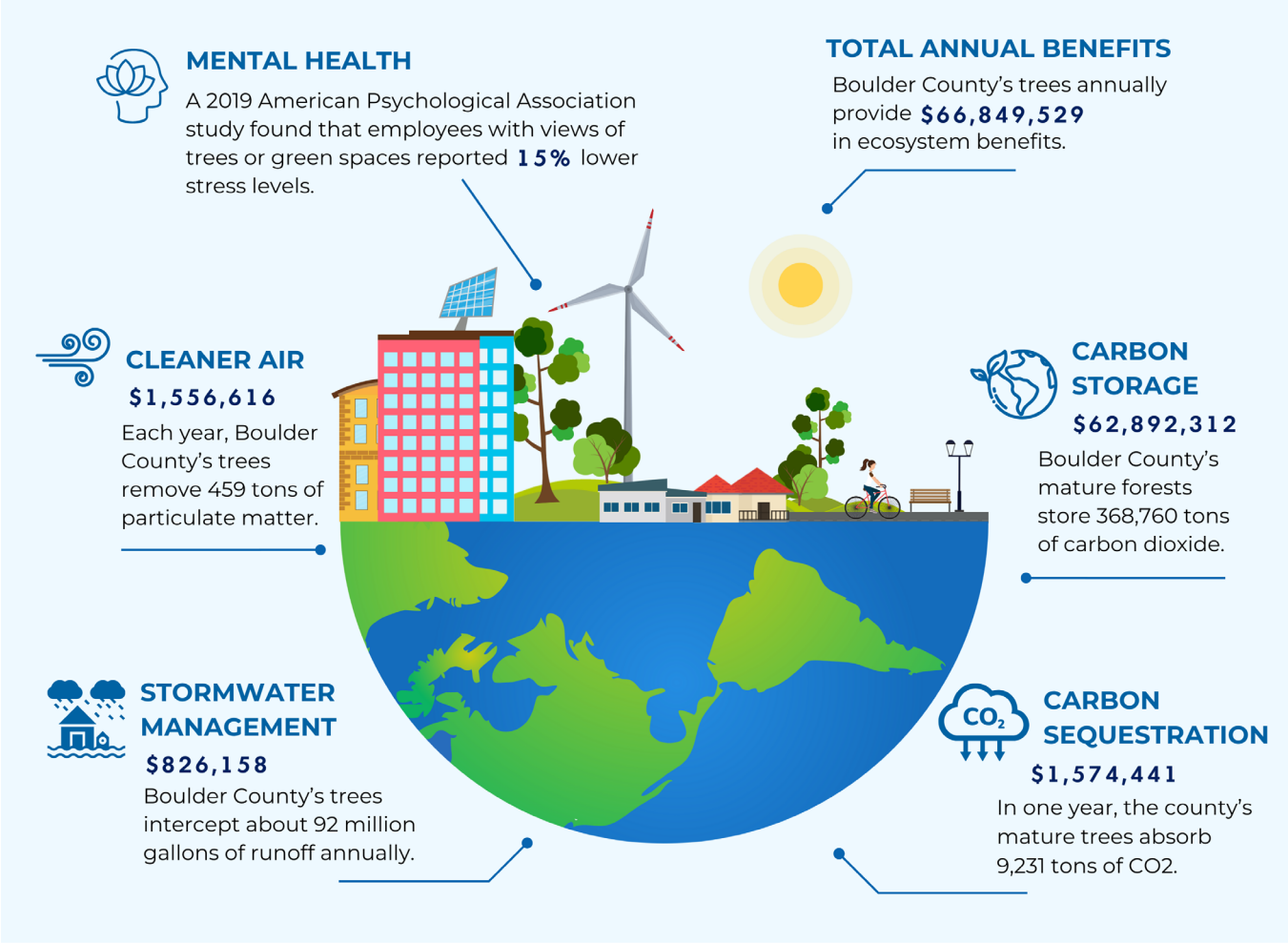


Figure 20. Ecosystem benefits throughout Boulder County's assessment area (14% of the total county). The data and calculations used in this analysis was sourced from i-Tree, a suite of tools developed by the USDA Forest Service and its partners to quantify the benefits and value of urban forestry. I-Tree provides reliable, science-based assessments of ecosystem services.

Table 3. Boulder County's ecosystem benefits.

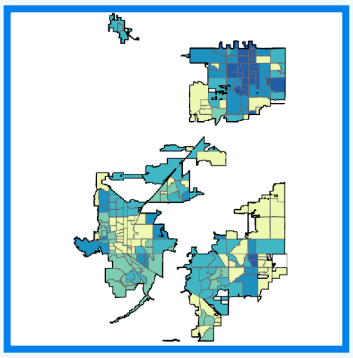
Benefit	Value		Dollar Amount
Atmospheric pollution removed (CO, NO2, O3, Particulate matter ≤ 10 Particulate matter ≤ 2.5 microns), SO2, and CO2)	459.33	tons of particulate	$1,556,616 total
Runoff avoided	92.3	million gallons/year	$826,158 $/year
Carbon dioxide (CO2) sequestered	9,231.49	tons/year	$1,574,441 $/year
Carbon dioxide (CO2) stored	368,760.08	tons/acre	$62,892,312 total

Tree Equity

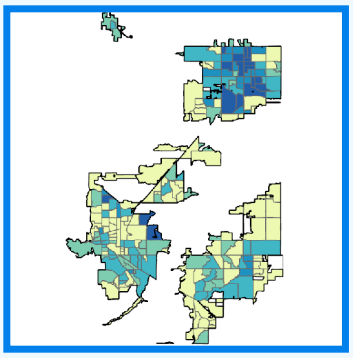
Analysis

Planting more trees in a community brings numerous benefits to its residents and visitors. To tailor these benefits to specific community needs, data on socioeconomic factors, demographics, and accessibility were analyzed using the Colorado Department of Public Health and Environment's (CDPHE) EnviroScreen tool. This interactive mapping tool evaluates communities in Colorado at the census block group (CBG) level, identifying those disproportionately affected by environmental hazards. It integrates CBG data with various environmental and health indicators. Each area was assessed and ranked based on its unique needs, with rankings displayed in a color gradient from dark blue (highest need) to light yellow (lowest need). An overall score was then created by combining the criteria listed below, reflecting the cumulative impacts of both environmental and social vulnerabilities.

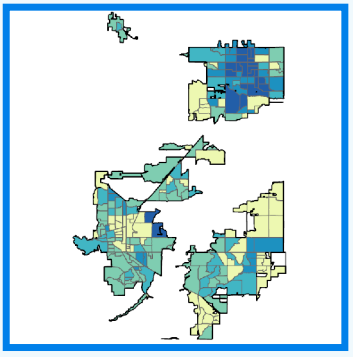
Equity Analysis Criteria



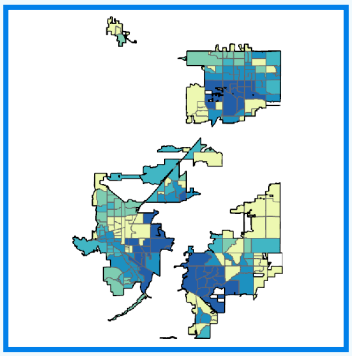
Sensitive Populations Score* - Measures the risk level of a community to environmental exposures and climate impacts concerning health. This score is derived from data on asthma hospitalization rates, cancer prevalence, diabetes prevalence, heart disease prevalence, life expectancy, low birth weight rates, mental health statistics, and the percentages of the population over 65 and under 5.



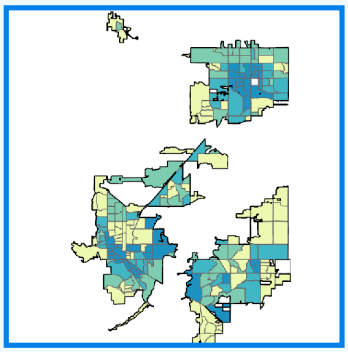
Demographics Score* - Reflects a community's social and economic vulnerabilities. This score is calculated using data on people living with disabilities, housing cost burden, educational attainment, limited English proficiency, income, and race and ethnicity.



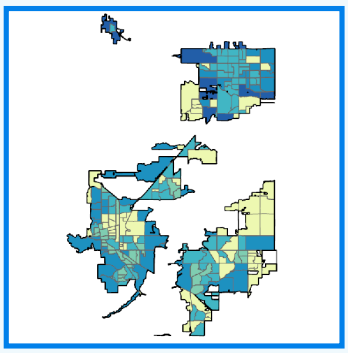
Health and Social Factors* - Combines the scores of Sensitive Populations and Demographics (defined above).



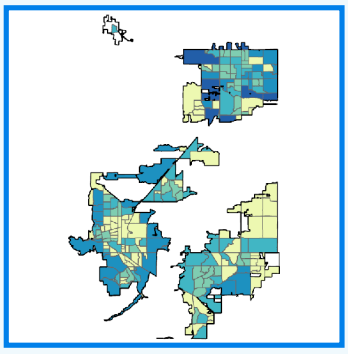
Environmental Effects Score* - Indicates the number of hazardous or toxic sites in a community relative to the rest of the state. This score averages data on the proximity to mining, oil and gas operations, impaired surface waters, wastewater discharge facilities, Superfund sites, hazardous chemical facilities, and hazardous waste facilities.



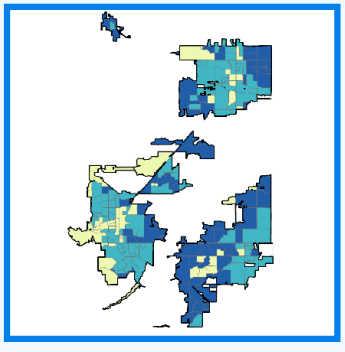
Environmental Exposure Score* - Reflects a community's exposure to specific environmental risks compared to the rest of the state. This score averages data on diesel particulate matter, traffic proximity, ozone, PM 2.5, air toxics, other air pollutants, lead exposure risk, drinking water violations, and noise.



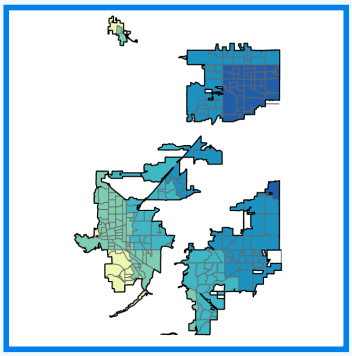
Climate Vulnerability Score* - Indicates a community's risk level for drought, flood, extreme heat, and wildfire relative to the rest of the state.



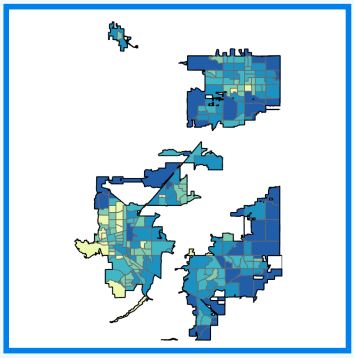
Pollution and Climate Burden* - Combines the scores from Environmental Exposures, Environmental Effects, and Climate Vulnerability (defined above).



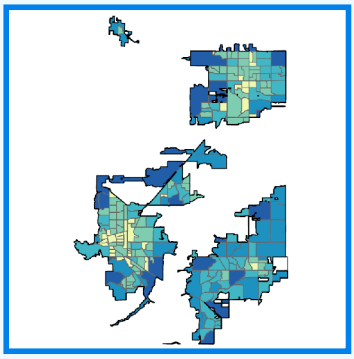
Stormwater Prioritization - This indicator identifies potential planting areas within 100' of all impervious surfaces and surface water bodies such as streams and ponds. This criterion prioritizes areas with higher percentages of PPA adjacent to these land cover types.



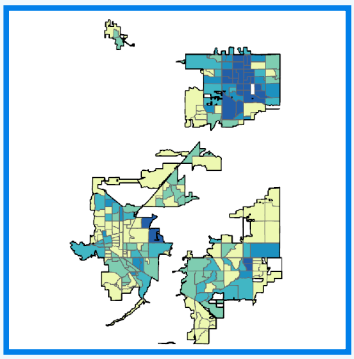
Urban Heat Island - Average summer maximum temperature, derived from the Boulder County Climate Portal. Census block groups were ranked from highest to lowest temperature, with higher temperatures indicating higher suitability for planting prioritization. All climate variables are based on LOCA Climate Data provided by Resilient Analytics.



Low UTC - 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 UTC - 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.



Overall - Overall prioritization rankings for Boulder County's census block groups are calculated by equally weighing all the above criteria. Lower rankings indicate higher priority for tree plantings.

**Definition sourced from Colorado's EnviroScreen Environmental Justice Mapping Tool User Guide. All scores from the EnviroScreen score are on a scale from 0 to 100, where the highest score represents the highest-burden/vulnerability. Full descriptions and scoring criteria can be found in the User Guide here: https://teeo-cdphe.shinyapps.io/COEnviroScreen_English/*

Canopy

Goal Setting

Boulder County aims to set an ambitious yet achievable goal of increasing urban tree canopy coverage to promote environmental sustainability. PlanIT Geo supported this effort by aligning the county's goals and resources with comprehensive tree canopy assessment data. To identify priority areas for tree planting, this assessment used the EnviroScreen tool to locate communities facing multiple environmental, socioeconomic, and demographic challenges. These communities have been designated as those most in need of increased tree canopy management.

Located in the Front Range, Boulder County experiences a semi-arid climate with snowy winters, hot summers, and occasional drought conditions. Expanding the tree canopy in this region offers numerous benefits. Trees act as natural stormwater managers, absorbing rainfall and filtering pollutants like road treatment materials before they reach key waterways such as Boulder Creek. By reducing erosion and sedimentation, trees help maintain healthy watersheds and lower the need for costly stormwater treatment infrastructure. Trees also provide energy-saving benefits by offering shade in the summer and insulation in the winter. Strategically planted trees can significantly reduce reliance on air conditioning and heating, leading to lower energy costs for residents and buisnesses.

According to the *Sustaining America's Urban Trees and Forests* report from the USDA Forest Service, urban trees deliver vital environmental, economic, and social benefits. Well-maintained urban forests and parks encourage walking, biking, and outdoor recreation, fostering healthier, more active lifestyles. This increased community activity strengthens neighborhoods by creating safer, more welcoming public spaces. Expanding Boulder County's urban tree canopy can continue to enhance environmental resilience, improve water quality, reduce energy costs, and promote a better quality of life for its residents.

Methodology

For Colorado's Front Range, an ideal urban tree canopy goal ranges ranging from 20-30% depending on area type, as outlined in the *Tree and Impervious Cover Change in U.S. Cities* report by the USFS. Residential areas start seeing benefits from a canopy coverage of around 25%, which helps with energy savings through shade and insulation. Commercial zones typically aim for 18-20%, focusing on balancing canopy expansion with infrastructure needs while also working to reduce heat islands and improving public spaces. Open spaces and parks in Boulder County can support even denser canopy cover goals. However, strategic tree selection remains key: large trees for residential shade and resilient, diverse species for long-term success.

An initial canopy goal has been set based on the CSFS's *Colorado's Urban Forests: Benefits and Recommendations* report and insights from PlanIT Geo's Urban Forestry Consulting Services team: a 25% canopy goal. To achieve this, the County must preserve the existing canopy and increase its coverage by 9%, in the study area by 2050.With the county's current canopy at 16%, achieving these goals involves increasing the utilization rate of plantable space, converting 5,709 acres of plantable space into tree canopy. This method focuses on improving the percentage of plantable space currently occupied by trees.

Focusing on utilization rates ensures targeted, data-driven goals that:

- Allocate resources to areas with the greatest canopy gaps
- Maximize existing plantable spaces for success and resilience
- Promote equity by prioritizing planting and maintenance in disproportionately impacted areas
- Establish realistic, adaptable targets for sustainable urban forestry

Results and Recommendations

Management strategies can be tailored based on how areas compare to the canopy goal of 25% and their current utilization rate of plantable space:

- **Close the Canopy Gap:** Prioritize tree-planting efforts in communities with the largest gaps between current and target canopy coverage. Areas with canopy gaps greater than 10% should be addressed first.
- **Allocate Resources Based on Needs:** Prioritze areas with a utilization rate less than 40%. This approach ensures that areas with larger plantable acreages are being used proportionately.
- **Balance Planting with Maintenance:** Areas that meet or exceed the 25% canopy goal should prioritize maintaining and protecting existing trees and mitigating canopy losses. Large, healthy, mature trees deliver long-term ecological benefits and reduce future planting needs.

Limited plantable space has made it physically impossible for three communities to reach the 25% canopy coverage target. These areas have been assigned an adjusted goal of 23%:

- Countryside Village mobile home community in the City of Longmont
- Census block group 80130126073 in the City of Boulder
- Census block group 80130136013 in the Town of Lyons

To offset these lower canopy goals, increased tree planting can be implemented in adjacent census block groups. Since the ecological benefits of urban tree canopy extend beyond community boundaries, enhancing canopy coverage in nearby areas will still positively impact the previously mentioned communities. These areas can adopt a longer-term horizon, such as 2060, allowing time for the strategic conversion of bare soil or impervious surfaces into plantable space. This integrated approach helps create a more resilient and interconnected urban forest while maximizing environmental benefits throughout the entire region.

Table 5. Priority areas for tree canopy expansion in Boulder County's mobile home communities. This table presents current tree coverage, available planting space, distance from canopy coverage targets, and municipal jurisdiction details.

Mobile Home Communities	Current Urban Tree Canopy	Plantable Space	Canopy Gap % (Target UTC - Current UTC)	Current Utilization Rate (UTC / UTC + PPA) %	Municipality
Ponderosa Mobile Home Park	6.6%	25.4%	18.4%	20.6%	Boulder
Weston Manor	9.6%	24.0%	15.4%	28.5%	Longmont
Mountain View Mobile Home Park	10.9%	16.7%	14.1%	39.6%	Longmont
St Vrain Mobile Home Park	13.1%	21.3%	11.9%	38.2%	Longmont
*Countryside Village of Longmont	15.1%	10.2%	7.9%	59.7%	Longmont
Mountain View Mobile Home Park	17.6%	31.4%	7.4%	35.9%	Lafayette
Banecks Family Park	18.7%	10.1%	6.3%	64.8%	Lafayette
224 Seward St	20.4%	20.8%	4.6%	49.5%	Lyons
Boulder Ridge	20.5%	32.3%	4.5%	38.9%	Lafayette
Patio Park Mobile Home Park	21.4%	4.8%	3.6%	81.7%	Longmont
San Lazaro Park	22.1%	19.2%	2.9%	53.5%	Boulder
Arbordale Acres	23.2%	18.4%	1.8%	55.8%	Lafayette
Sans Souci Cooperative	23.9%	39.7%	1.1%	37.6%	Unincorporated
Boulder Meadows	24.5%	26.5%	0.5%	48.1%	Boulder
Skylark Mobile Home Community	24.6%	16.5%	0.4%	59.8%	Lafayette

Table 6. Priority areas for tree canopy expansion in Boulder County's DI communities. This table presents census block groups' current tree coverage, available planting space, distance from canopy coverage targets, and municipal jurisdiction details.

DI Census Block Groups	Current Urban Tree Canopy	Plantable Space	Canopy Gap % (Target UTC - Current UTC)	Current Utilization Rate (UTC / UTC + PPA) %	Municipality
80130608002	6.5%	59.7%	18.5%	9.8%	Lafayette
80130134012	7.0%	43.4%	18.0%	13.9%	Longmont
80130127072	15.2%	67.6%	9.8%	18.4%	Lafayette
80130121041	6.6%	25.4%	18.4%	20.6%	Boulder
80130127071	10.9%	30.9%	14.1%	26.1%	Boulder
80130132102	10.0%	24.8%	15.0%	28.8%	Longmont
80130133023	10.6%	25.4%	14.4%	29.5%	Longmont
80130126051	15.9%	37.4%	9.1%	29.9%	Boulder
80130134021	13.0%	27.4%	12.0%	32.3%	Longmont
80130608005	16.0%	33.5%	9.0%	32.3%	Lafayette
80130125104	24.6%	42.2%	0.4%	36.8%	Unincorporated
80130135071	19.7%	32.8%	5.3%	37.5%	Longmont
80130608004	18.6%	30.6%	6.4%	37.8%	Lafayette
80130133081	17.8%	28.9%	7.2%	38.2%	Longmont
80130133062	17.8%	28.8%	7.2%	38.2%	Longmont
*80130136013	9.3%	14.5%	13.7%	39.1%	Lyons
80130132123	18.7%	28.1%	6.3%	40.1%	Longmont
80130125111	16.4%	23.4%	8.6%	41.2%	Boulder
80130121052	22.5%	31.4%	2.5%	41.7%	Boulder
80130126071	11.2%	15.2%	13.8%	42.5%	Boulder
80130133071	16.9%	21.5%	8.1%	44.0%	Longmont
80130122031	24.4%	30.4%	0.6%	44.5%	Boulder
80130133053	20.8%	25.1%	4.2%	45.3%	Longmont
80130135033	19.1%	22.9%	5.9%	45.4%	Longmont
80130135053	21.1%	24.8%	3.9%	45.9%	Longmont
80130132101	16.0%	18.6%	9.0%	46.1%	Longmont
80130123002	20.6%	23.6%	4.4%	46.6%	Boulder
80130132113	14.2%	15.7%	10.8%	47.4%	Longmont
80130133082	24.3%	26.1%	0.7%	48.2%	Longmont
80130135032	22.5%	23.1%	2.5%	49.3%	Longmont
80130126072	15.3%	15.5%	9.7%	49.7%	Boulder
80130134025	24.3%	24.2%	0.7%	50.1%	Longmont
80130124012	24.1%	23.7%	0.9%	50.5%	Boulder
80130606001	15.5%	15.0%	9.5%	50.9%	Unincorporated
80130133072	23.7%	22.6%	1.3%	51.2%	Longmont
80130135052	20.4%	18.1%	4.6%	53.1%	Longmont
*80130126073	13.8%	10.5%	9.2%	56.9%	Boulder
80130135051	24.2%	17.2%	0.8%	58.5%	Longmont
80130124011	23.2%	14.7%	1.8%	61.2%	Boulder
80130122024	17.6%	10.7%	7.4%	62.2%	Boulder
80130122041	22.9%	10.8%	2.1%	68.0%	Boulder
80130132112	20.8%	9.2%	4.2%	69.4%	Longmont

Table 7. This table examines census block groups that fall within Longmont's jurisdiction but outside Boulder County boundaries. While geographically located in Weld County, these areas are included in the study due to Longmont's municipal oversight. For each census block group, the table details current tree canopy coverage, available planting space, gap between existing and 25% target canopy goal, and relevant municipal information.

DI Census Block Groups	Current Urban Tree Canopy	Plantable Space	Canopy Gap % (Target UTC - Current UTC)	Current Utilization Rate (UTC / UTC + PPA) %	Municipality
81230020101 - Weld County	3.9%	88.4%	21.1%	4.3%	Longmont
81230020071 - Weld County	14.7%	51.2%	10.3%	22.3%	Longmont
81230020072 - Weld County	15.5%	66.9%	9.5%	18.8%	Longmont

Perhaps more important than tree canopy cover goals and planting initiatives is the foundation of sound policies to preserve the existing urban forest. This key strategy ensures the establishment of robust protocols for tree replacement, retention, removal, mitigation, and enforcement. The communities listed in the following two tables have been designated for tree canopy maintenance rather than new planting initiatives. Maintenance strategies may range from implementing timely preventative pruning programs to adopting a no-net-loss approach, ensuring prompt replacement of any removed trees.

Table 8. Boulder County's mobile home communities identified as priorities for canopy maintenance rather than planting. This table includes current canopy coverage, available plantable space, the current utilization rate, and the municipal jurisdiction.

Mobile Home Communities	Current Urban Tree Canopy	Plantable Space	Current Utilization Rate (UTC / UTC + PPA) %	Municipality
Grand Meadow	27.2%	13.3%	67.2%	Longmont
Longmont Mobile Estates	27.3%	22.6%	54.7%	Longmont
Columbine Mobile Home Park	30.1%	18.7%	61.7%	Boulder
Emma St Trailer Park	32.7%	20.2%	61.9%	Lafayette
Castle Keep	34.7%	10.5%	76.8%	Longmont
Parco Dello Zingaro Mobile Home Park	35.2%	20.8%	62.9%	Louisville
Orchard Grove Mobile Home Park LLC	35.4%	18.6%	65.6%	Boulder
Boulder Vista Village Mobile Home Park	36.5%	28.1%	56.5%	Boulder
Mapleton Homes	36.6%	14.2%	72.0%	Boulder

Table 9. Boulder County's disproportionately impacted cenus block groups identified as priorities for canopy maintenance. This table includes current canopy coverage, available plantable space, the current utilization rate, and the municipal jurisdiction.

DI Census Block Groups	Current Urban Tree Canopy	Plantable Space	Current Utilization Rate (UTC / UTC + PPA) %	Municipality
80130122042	25.1%	22.6%	52.6%	Boulder
80130135034	25.8%	21.1%	55.0%	Longmont
80130126052	25.9%	23.2%	52.7%	Boulder
80130122032	26.2%	18.0%	59.3%	Boulder
80130132072	26.6%	16.6%	61.6%	Longmont
80130125071	28.0%	27.7%	50.3%	Boulder
80130122021	28.4%	16.9%	62.7%	Boulder
80130134011	28.6%	33.2%	46.3%	Longmont
80130122022	28.7%	12.0%	70.6%	Boulder
80130136012	29.3%	25.8%	53.1%	Lyons
80130125083	29.4%	24.8%	54.2%	Boulder
80130126074	29.6%	25.2%	54.0%	Boulder
80130127102	30.1%	18.7%	61.7%	Boulder
80130122023	30.1%	12.1%	71.3%	Boulder
80130125072	30.4%	20.0%	60.4%	Boulder
80130135031	31.1%	26.7%	53.8%	Longmont
80130133022	33.0%	15.3%	68.2%	Longmont
80130122033	33.0%	29.3%	53.0%	Boulder
80130124014	33.1%	20.3%	62.0%	Boulder
80130130041	34.4%	20.3%	63.0%	Louisville
80130134013	35.6%	17.2%	67.5%	Longmont
80130121021	36.6%	14.2%	72.0%	Boulder

Conclusions and Recommendations

Boulder County'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 mid-continental United States face numerous challenges. Forest fires, droughts, and other extreme weather events, pests, diseases, and development pose severe risks to the tree canopy.

The results of this assessment are not just numbers on a page. They are a strategic compass, a report card, and a baseline for Boulder's long-term canopy health. These findings are a road map, guiding planning, investment, and management strategies to ensure that the communities most in need of urban forest benefits gain access to necessary resources.

To protect tree canopy, the region should continue to have tree canopy assessments performed regularly through a TreePlotter CANOPY subscription or continue traditional projects. As the area grows, these data will be able to be used to ensure that urban forest policies and management practices prioritize its maintenance, health, and growth. Boulder County's urban forest provides the region with a wealth of environmental, social, and even economic benefits related to increased community pride and interest in region-wide initiatives and priorities. These results can be used to identify where the County should preserve existing tree canopy cover, where there are opportunities to expand canopy cover, and which areas would benefit most from investing valuable resources into the urban forest.

Recommendations

1. **Leverage the results of this assessment to promote the urban forest and set evidence-based canopy goals.**
   The findings of this assessment are pivotal for promoting investment in urban forest monitoring, maintenance, and management and offer essential support for state, county, and local budget requests and grant applications. These results can be used to craft targeted presentations and resources for government leaders, planners, engineers, resource managers, and the public to make an empirical case for urban forest needs and benefits.

   As the population grows and urbanization expands, preserving and growing the existing canopy is vital. These assessment findings can be used to develop short and long-term goals, such as establishing annual tree planting targets, improving the quality of tree cover by planting a wider variety of large maturing trees, or setting specific canopy coverage goals to reach by 2050.

2. **Identify areas to prioritize canopy expansion using TreePlotter CANOPY.**
   The ability to visualize urban tree canopy and plantable space metrics using mapping tools like TreePlotter™ CANOPY is crucial for regional stakeholders. This tool empowers Boulder County municipalities and other urban forestry stakeholders to harness the data from the UTC, PPA, and green equity analyses effectively. By creating detailed planting priority maps in the Plan tool, users can select priority census block groups by low UTC, high PPA, or specific socioeconomic criteria. This strategic approach to visualizing and selecting sites for canopy expansion allows for a more efficient allocation of urban forest management resources, significantly enhancing the impact and return on investment of these initiatives.

3. **Develop outreach programs toward private landowners.**
   Private properties hold 85% of the region's tree canopy and 71% of its plantable space. This indicates that the health of Boulder County's tree canopy largely depends on how private residents manage their trees. To preserve and enhance the area's tree biodiversity, promoting residential tree care initiatives could be crucial. It's important to integrate these insights into community outreach and educational programs aimed at both citizens and private landowners. By sharing this information, residents can better understand the changes in their local urban forests and the many benefits that trees provide. Implementing educational programs alongside initiatives like tree giveaways, planting events, and maintenance activities can significantly boost the urban tree canopy across the 21,000+ acres of plantable residential land.

4. **Promote Connective Canopies and Pollinator Pathways**
   Addressing habitat fragmentation is essential to a healthy urban forest. Encouraging the planting of diverse Colorado trees and plants in yards, schools, businesses, and public spaces is crucial. Native species are particularly beneficial as they are well-adapted to the local climate and soil conditions, enhancing the community's resilience to climate change. Planting diverse native species strengthens the ecological health of the community, as connected canopies and green spaces form vital migration pathways for various species. TreePlotter CANOPY, a web-based interactive canopy mapping tool, can be instrumental in advancing this initiative. The platform allows communities to identify and prioritize areas for planting, particularly those with gaps in canopy coverage or fragmented habitats. By visualizing current tree canopy, potential planting areas, and habitat corridors, decision-makers and residents can strategically plant where they will have the greatest ecological and social impact. TreePlotter CANOPY also enables long-term tracking of tree growth and canopy expansion, ensuring progress toward a healthier, more connected urban forest while fostering community participation and awareness.

5. **Integrate urban forestry into land use planning:**
   Incorporating urban forestry into land use planning means embedding forestry goals into overall urban planning documents like comprehensive land use plans, zoning ordinances, and development regulations to foster sustainable urban environments. These plans should emphasize tree preservation and allocate specific areas for greening. Zoning ordinances could either require or encourage the integration of green spaces in new developments, while development regulations should protect trees during and after construction. Local municipalities should review and adjust their codes to enhance tree preservation efforts, ensure space for existing trees during development, and reserve areas for planting large trees in public spaces to optimize the benefits trees offer.

REPORT

APPENDIX

Accuracy Assessment

Accuracy Assessment

Classification accuracy serves two primary purposes. Firstly, accuracy assessments provide information to technicians producing the classification about where processes need to be improved and where they are effective. Secondly, accuracy measures provide information about how to use the classification and how well land cover classes are expected to estimate actual land cover on the ground. Even with high-resolution imagery, slight differences in classification methodology and image quality can significantly impact overall map area estimations. The classification accuracy error matrix illustrated in Table A1 contains confidence intervals reporting the high and low values that could be expected to compare the classification data and the actual on-ground land cover in 2021. This accuracy assessment was completed using high-resolution aerial imagery, with computer and manual verification. This study did not include field verification.

The internal accuracy assessment was completed in these steps:

Four hundred, or approximately 3 points per square mile area in Boulder County's full area of interest (128 sq. miles including all municipalities and urban areas combined), were randomly distributed across the study area and assigned a random numeric value by a trained technician.

1. Each sample point was then referenced using the NAIP aerial photo and assigned one of the five generalized land cover classes (“Ref_ID”) mentioned above.
2. If the technician could not discern the reference value from the imagery, the point was dropped from the accuracy analysis. In this case, no points were dropped.
3. An automated script was then used to assign values from the classification raster to each point (“Eval_ID”). The classification supervisor provides unbiased feedback to quality control technicians regarding the types of corrections required. Misclassified points (where reference ID does not equal evaluation ID) and corresponding land cover are inspected for necessary corrections to the land cover. ^1
4. Accuracy is re-evaluated (repeat steps 3 & 4) until an acceptable classification accuracy is achieved.

Sample Error Matrix Interpretation

Statistical relationships between the reference pixels (representing the actual conditions on the ground) and the intersecting classified pixels are used to understand how closely the entire classified map represents Boulder County’s landscape. The error matrix in Table A1 represents the intersection of reference pixels manually identified by a human observer (columns) and the classification category of pixels in the classified image (rows). The blue boxes along the diagonals of the matrix represent agreement between the two-pixel maps. Off-diagonal values represent the number of pixels manually referenced to the column class classified as another category in the classification image.

Overall accuracy is computed by dividing the total number of correct pixels by the total number of pixels reported in the matrix (70 + 173 + 113 + 14 + 24 = 394/400 = 98.5%), and the matrix can be used to calculate per class accuracy percentages. For example, technicians manually identified 174 points in the reference map as non-canopy vegetation, and 173 of those pixels were classified as non-canopy vegetation in the classification map. This relationship is called the “Producer’s Accuracy” and is calculated by dividing the agreement pixel

total (diagonal) by the reference pixel total (column total). Therefore, the Producer's Accuracy for non-canopy vegetation is calculated as "173/174 = 0.994", meaning that one can expect that ~99% of all 2021 non-canopy vegetation in the Boulder County study area was classified as non-canopy vegetation in the 2021 classification map. This same procedure was utilized for tree canopy classifications as well.

Conversely, the "User's Accuracy" is calculated by dividing the number of agreement pixels by the number of classified pixels in the row category. For example, classification pixels intersecting reference pixels were classified as Tree Canopy, and 1 pixel was identified as canopy in the reference map. Therefore, the User's Accuracy for Tree Canopy is calculated as "70/72 =.972", meaning that ~97% of the pixels classified as Tree Canopy in the classification were actual tree canopy. It is important to recognize the Producer's and User's accuracy percent values based on a sample of the existing ground cover, represented by the reference pixels at each sample point. Interpretation of the sample error matrix results indicates this assessment accurately mapped land cover and, more importantly, tree canopy in Boulder County in 2021.

Table 4. Error matrix for land cover classifications in Boulder County, CO (2021).

Accuracy Assessment Results

Classification Data	Reference Data: Tree Canopy	Vegetation	Impervious	Soil / Dry Veg.	Water	Total Reference Pixels
Tree Canopy	70	1	0	0	1	72
Vegetation	1	173	0	0	1	175
Impervious	1	0	113	0	0	114
Soil / Dry Veg.	0	0	0	14	0	14
Water	0	0	0	1	24	25
Total	72	174	113	15	26	400

Overall Accuracy =	**99%**
Overall Margin of Error=	**1.4%**
Canopy Margin of Error =	**1.5%**

Producer's Accuracy	
Tree Canop	97%
Veg. / Open	99%
Impervious	100%
Bare Groun	93%
Water	92%

User's Accuracy	
Tree Canopy	97%
Veg. / Open Space	99%
Impervious	99%
Bare Ground / Soil	100%
Water	96%

Margin of error values reported at 90% confidence interval

Accuracy Assessment Results

Interpreting the sample error matrix offers some critical insights when evaluating Boulder County's urban tree canopy coverage and how well-aligned the land cover data are with interpretations by the human eye. The high accuracy of the 2021 data indicates that Boulder County's current tree canopy can be safely assumed to match the figures stated in this report (approximately 14%).

The same method was used to analyze historical imagery from 2014, but with a slightly different approach: points were classified only as canopy or non-canopy, instead of using a full six-classification strategy.

Table 5. Error matrix for tree canopy classification in Boulder County, CO (2013).

Classification Data	Tree Canopy	Vegetation	Total Reference Pixels
Tree Canopy	20	4	24
Vegetation	2	255	257
Total	22	259	281

Overall Accuracy =	97.9%
Overall Margin of Error =	1.4%
Canopy Margin of Error =	1.5%

Producer's Accuracy	
Tree Canopy	91%

Margin of error values reported at 90% confidence

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 urban forest. The tree canopy was generally taller than 10-15 feet tall.

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

FEBRUARY | 2025

Urban tree canopy

Assessment

Boulder County, Colorado

PlanIT Geo
developers of TreePlotter

Boulder County