A Report on the City of Lancaster's Existing and Possible Tree Canopy

Why is Tree Canopy Important?

Tree canopy (TC) is the layer of leaves, branches, and stems of trees that cover the ground when viewed from above. Tree canopy provides many benefits to communities, improving water quality, saving energy, lowering city temperatures, reducing air pollution, enhancing property values, providing wildlife habitat, facilitating social and educational opportunities, and providing aesthetic benefits. Establishing a tree canopy goal is crucial for communities seeking to improve their green infrastructure. A tree canopy assessment is the first step in this goal-setting process, providing estimates for the amount of tree canopy currently present in a city as well as the amount of tree canopy that could theoretically be established.

How Much Tree Canopy Does Lancaster Have?

An analysis of the City of Lancaster's tree canopy based on land cover data derived from high-resolution aerial imagery and LiDAR (Figure 1) found that 1,299 acres of the city were covered by tree canopy (termed Existing TC), representing 28% of all land in the city. An additional 45% (2,063 acres) of the city could theoretically be modified (termed Possible TC) to accommodate tree canopy (Figure 2). In the Possible TC category, 19% (863 acres) of the city was classified as Impervious Possible TC and another 26% was Vegetated Possible TC (1,200 acres). Vegetated Possible TC, or grass and shrubs, is more conducive to establishing new tree canopy, but establishing tree canopy on areas classified as Impervious Possible TC will have a greater impact on water quality and summer temperatures.
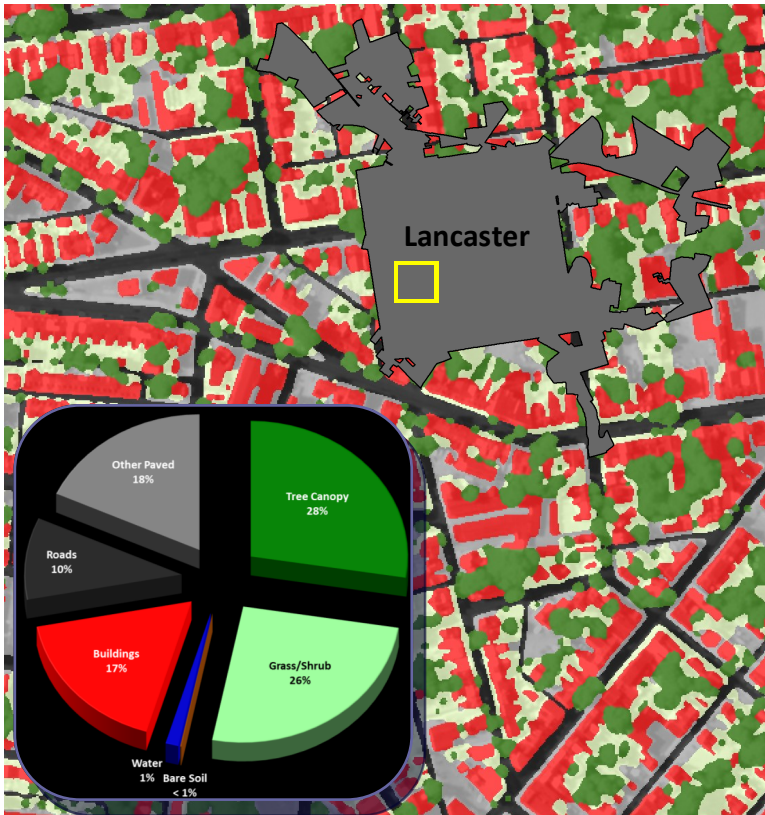

Figure 1: Land cover derived from high-resolution aerial imagery for the City of Lancaster.

Project Background

The goal of the project was to apply the USDA Forest Service's TC assessment protocols to the City of Lancaster. The analysis was conducted based on year 2010 data. This analysis of the City of Lancaster's tree canopy (TC) was conducted in collaboration with the PA Department of Conservation and Natural Resources Bureau of Forestry, City of Lancaster, Lancaster County, the University of Vermont, and the Northern Research Station. The Spatial Analysis Laboratory (SAL) at the University of Vermont's Rubenstein School of the Environment and Natural Resources conducted the assessment.
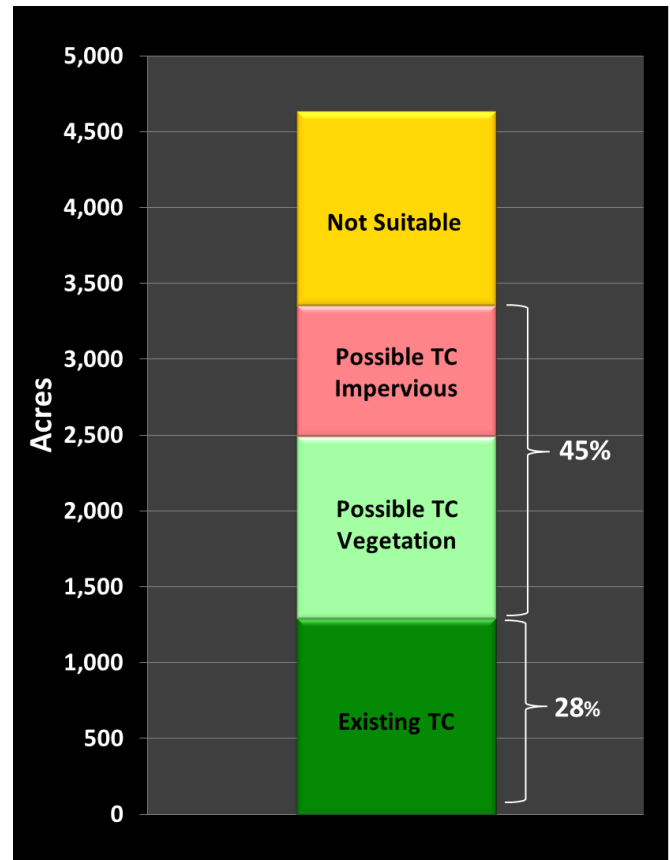

Figure 2: TC metrics for the City of Lancaster based on % of land area covered by each TC type.

Key Terms

TC: Tree canopy (TC) is the layer of leaves, branches, and stems of trees that cover the ground when viewed from above.

Land Cover: Physical features on the earth mapped from aerial or satellite imagery, such as trees, grass, water, and impervious surfaces.

Existing TC: The amount of urban tree canopy present when viewed from above using aerial or satellite imagery.

Impervious Possible TC: Asphalt or concrete surfaces, excluding roads and buildings, that are theoretically available for the establishment of tree canopy.

Vegetated Possible TC: Grass or shrub area that is theoretically available for the establishment of tree canopy.

Mapping the City of Lancaster's Trees

Prior to this study, the only comprehensive remotely sensed estimates of tree canopy for the City of Lancaster was from the 2001 National Land Cover Database (NLCD 2001). While NLCD 2001 is valuable for analyzing land cover at the regional level, it is derived from relatively coarse, 30-meter resolution satellite imagery (Figure 3a). Using high-resolution aerial imagery acquired in 2010 (Figure 3b), in combination with LiDAR and advanced automated processing techniques, land cover for the city was mapped with such detail that trees as short as 6ft tall were detected (Figure 3c). NLCD 2001 estimated a mean percent tree canopy of 10% for the City of Lancaster largely because it failed to capture many isolated trees.

a. NLCD 2001 Percent Tree Canopy (30m)

100%

0%

b. 2010 Aerial Imagery (3.28 ft)
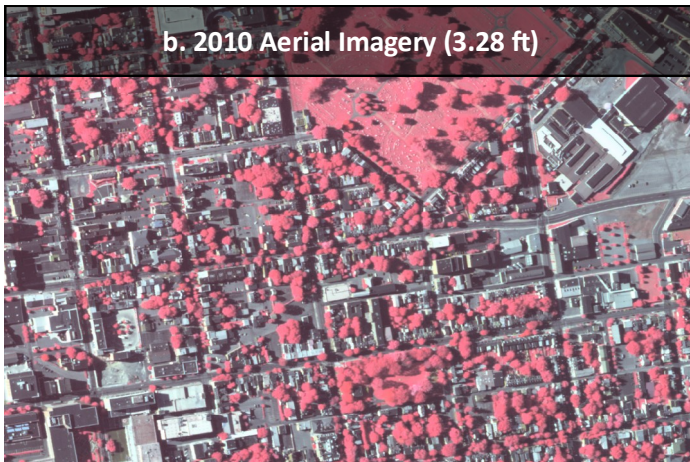
c. Land Cover Derived from 2010 Aerial Imagery

Tree Canopy
Grass/Shrub
Bare Soil
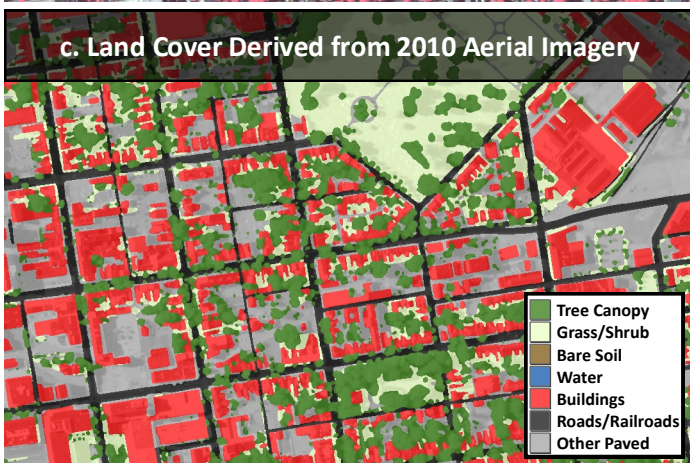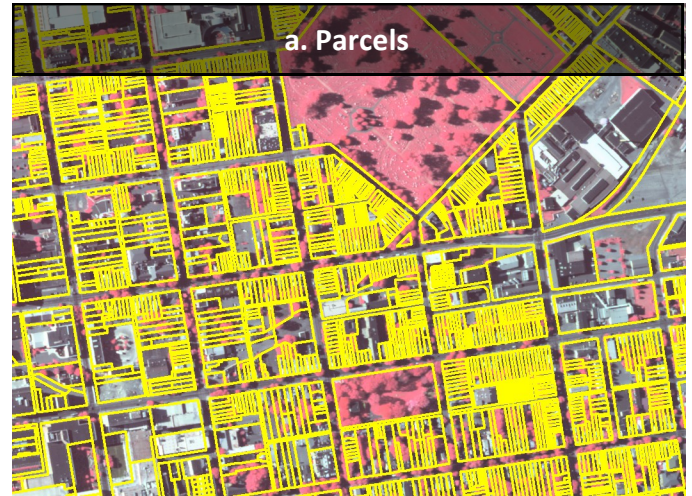Water
Buildings
Roads/Railroads
Other Paved

Figure 3a, 3b, 3c: Comparison of NLCD 2001 to high-resolution land cover.
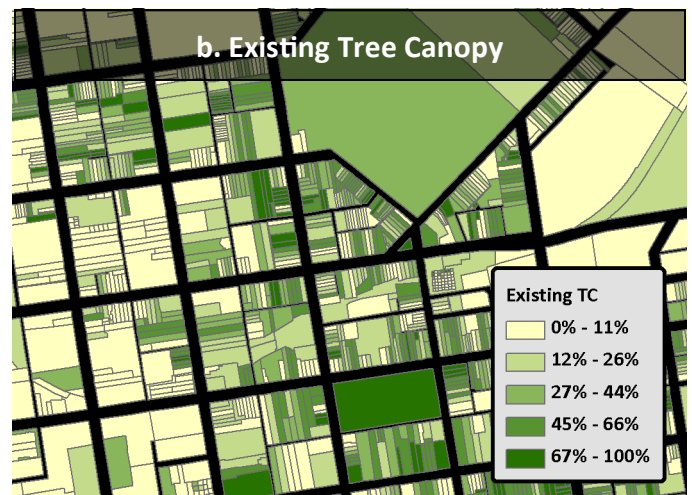
Parcel Summary

After land cover was mapped city-wide, Tree Canopy (TC) metrics were summarized for each property in the city's parcel database (Figure 4). Existing TC and Possible TC metrics were calculated for each parcel, both in terms of total area and as a percentage of the land area within each parcel (TC area ÷ land area of the parcel).

a. Parcels

b. Existing Tree Canopy

Existing TC

0% - 11%
12% - 26%
27% - 44%
45% - 66%
67% - 100%

c. Possible Tree Canopy

Possible TC
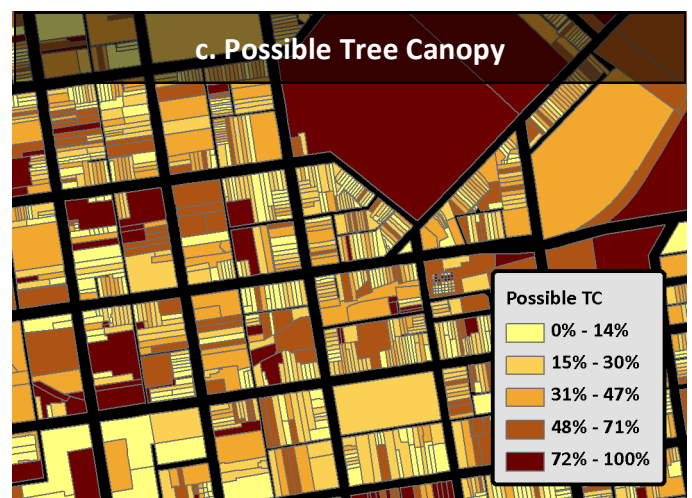
0% - 14%
15% - 30%
31% - 47%
48% - 71%
72% - 100%

Figure 4a, 4b, 4c: Parcel-based TC metrics. TC metrics are generated at the parcel level, allowing each property to be evaluated according to its Existing TC and Possible TC.

Lancaster County maintains a comprehensive land use layer for the County which includes Lancaster City. For the this study the land use data were aggregated into thirteen general categories. Existing and Possible tree canopy was summarized for the thirteen aggregated land use classes (Figure 5, Table 1). For each land use category, Tree Canopy (TC) metrics were calculated as a percentage of all land in the city (% Land), as a percentage of land area in the specified land use category (% Category), and as a percentage of the area for TC type (% TC Type). Residential land use had the largest amount of tree canopy of any land use category with 31% of all tree canopy. Residential land use also had the largest percentage of land area covered by tree canopy (9%). Residential land use had most of the Possible Vegetated TC available to support tree plantings (32%) while Commercial and Retail Trade had the most Impervious Possible TC (36%) available for planting trees of all land use categories. Vacant Lands also had a high percentage of Existing TC (39%), Possible Vegetated TC (33%), and Possible Impervious TC (18%).
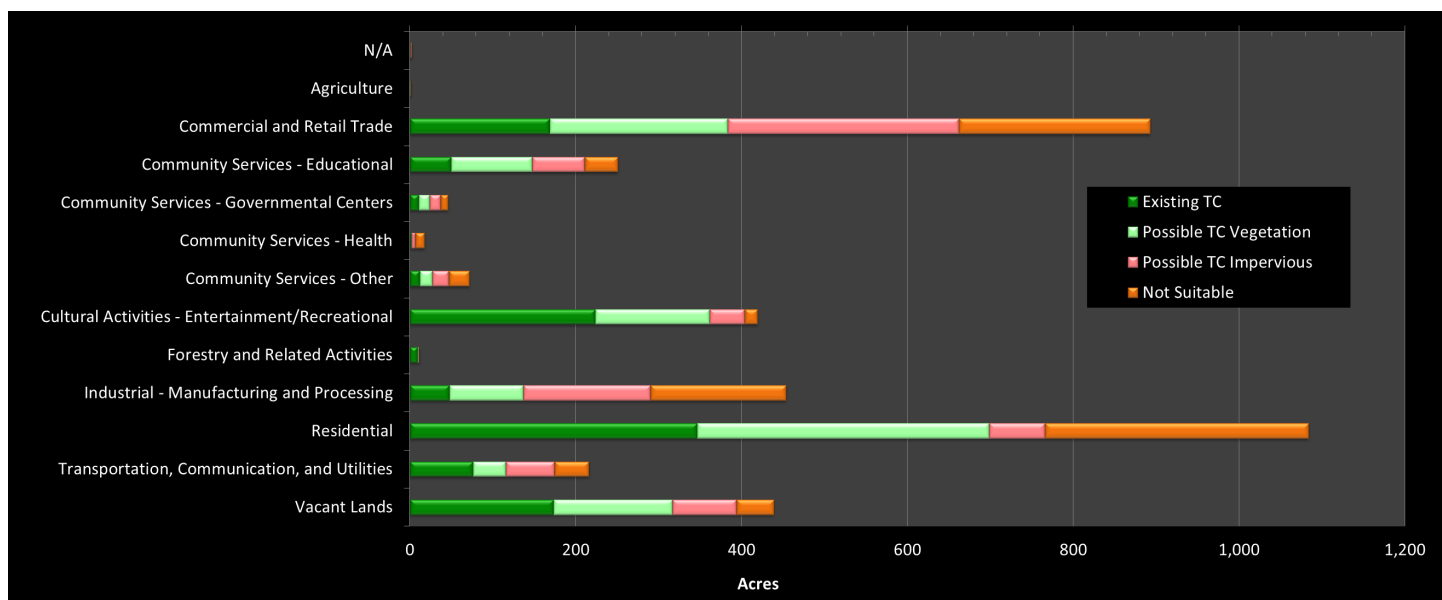

Figure 5: Tree Canopy (TC) metrics summarized by land use category.

Land Use	Existing TC			Possible TC Vegetation			Possible TC Impervious		
	% Land	% Category	% TC Type	% Land	% Category	% TC Type	% Land	% Category	% TC Type
N/A	0%	19%	0%	0%	9%	0%	0%	48%	0%
Agriculture	0%	65%	0%	0%	21%	0%	0%	14%	0%
Commercial and Retail Trade	4%	19%	15%	5%	24%	19%	7%	31%	36%
Community Services - Educational	1%	20%	4%	2%	39%	9%	2%	25%	8%
Community Services - Governmental Centers	0%	22%	1%	0%	30%	1%	0%	28%	2%
Community Services - Health	0%	6%	0%	0%	5%	0%	0%	26%	1%
Community Services - Other	0%	17%	1%	0%	21%	1%	1%	28%	3%
Industrial - Manufacturing and Processing	1%	11%	4%	2%	20%	8%	4%	34%	20%
Residential	9%	32%	31%	9%	32%	32%	2%	6%	9%
Transportation, Communication, and Utilities	2%	35%	7%	1%	18%	4%	2%	27%	8%
Vacant Lands	4%	39%	15%	4%	33%	13%	2%	18%	10%

$$\% \text{ Land} = \frac{\text{Area of TC type for land use category}}{\text{Area of all land}}$$

$$\% \text{ Category} = \frac{\text{Area of TC type for land use category}}{\text{Area of all land for specified land use}}$$

$$\% \text{ TC Type} = \frac{\text{Area of TC type for land use category}}{\text{Area of all TC type}}$$

The % Land Area value of 9% indicates that 9% of Lancaster's land area is covered by tree canopy in the Residential land use class.

The % Land value of 32% indicates that 32% of land in the Residential land use category is covered by tree canopy.

The % TC Type value of 31% indicates that 31% of all tree canopy is in the Residential land use category.

Table 1: Tree Canopy (TC)metrics were summarized by land use category. For each land use category, TC metrics were computed as a percentage of all land in the city (% Land), as a percentage of land in the specified land use category (% Category), and as a percentage of the area for TC type (% TC Type).

Zoning Analysis

Existing and Possible Tree Canopy (TC) was analyzed by Zoning category for Lancaster (Figure 6). Land zoned as Residential and Conservation/Park/Open Space account for 56% and 29% of the Existing TC by land area, respectively. Manufacturing/Central City and Residential Medium Density categories had the most acreage available for Possible TC with 437 acres and 301 acres representing 21% and 15% of the Possible TC by zoning category.
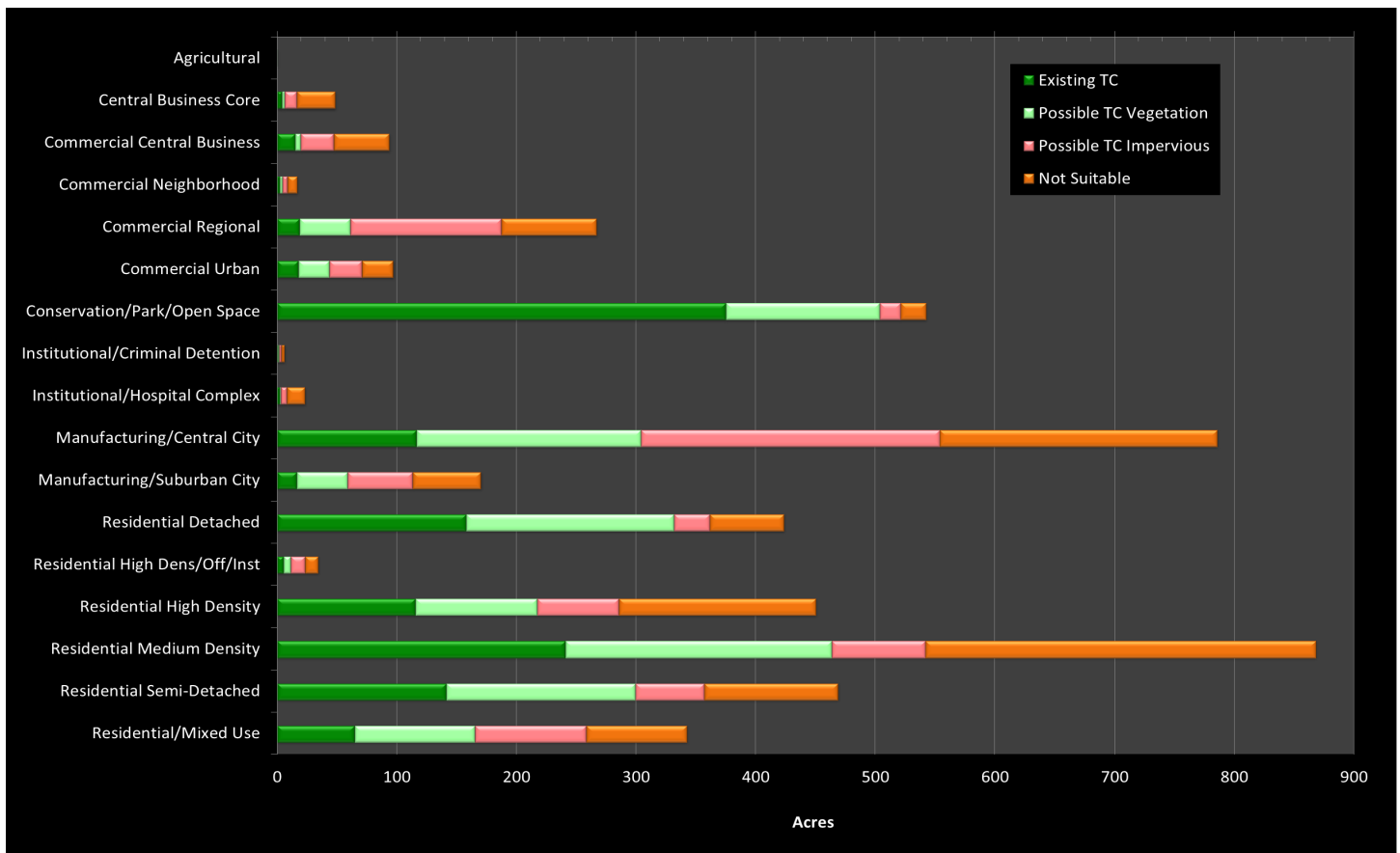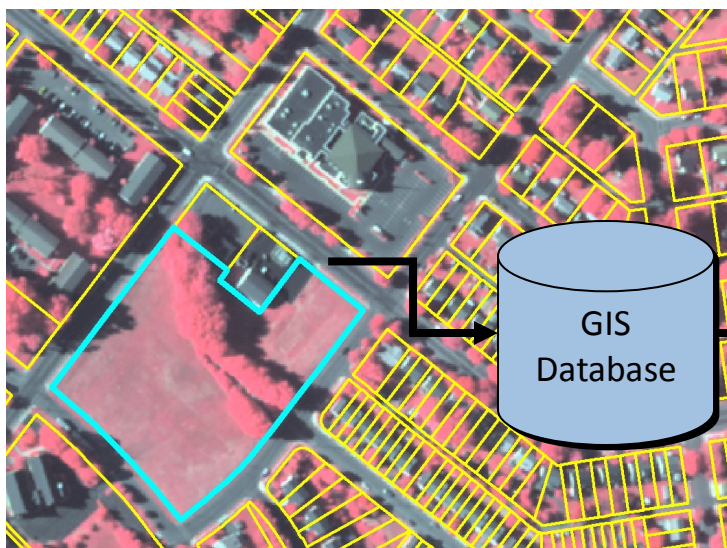

Figure 6: Tree Canopy (TC) metrics summarized by zoning category.

Decision Support

Parcel-based Tree Canopy (TC) metrics were integrated into the city's existing GIS database (Figure 7). Decision makers can use GIS to query specific TC and land cover metrics for a parcel or set of parcels. For example, this information can be used to estimate the amount of tree loss in a planned development or set TC improvement goals for an individual property.
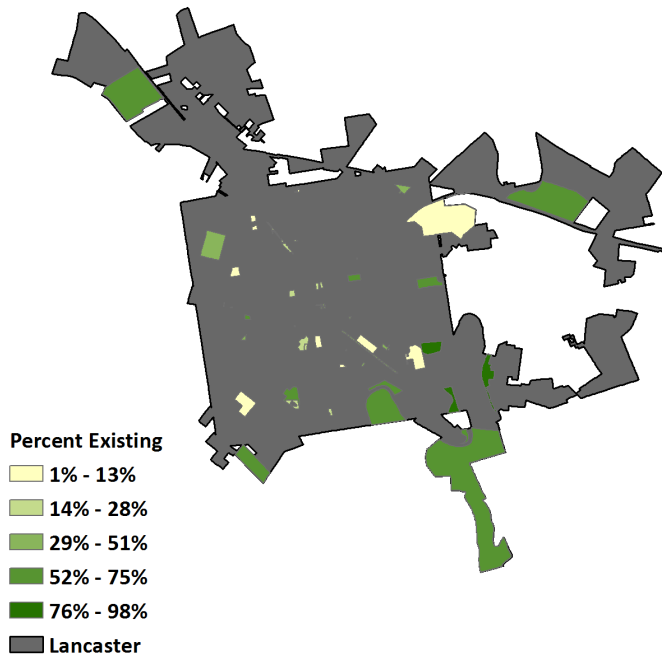
Attribute	Value
Land Use	Vacant Land
Parcel ID	141605
Address	64 Springhouse Road
Existing TC	19%
Possible TC	82%
Possible TC—Vegetation	79%
Possible TC—Impervious	3%

Figure 7: GIS-based analysis of parcel-based TC metrics for decision support. In this example, GIS is used to select an individual parcel. The attributes for that parcel, including the parcel-based TC and land cover metrics, are displayed in tabular form providing instant access to relevant information.

Parks Analysis

Cabbage Hill Veterans Memorial, Hand W.O.O.D.S., Holly Pointe Conservation Area, and Triangle Park have the highest Existing Tree Canopy (> 95%). Nine parks had 8% or less tree canopy. Edward Hand Jr. High and Washington Elementary, Ewel/Ganz Playground, George Ross Elementary, and Wharton Elementary School each had relatively high amounts of Possible TC (> 93%).

Existing Tree Canopy

Percent Existing
- 1% - 13%
- 14% - 28%
- 29% - 51%
- 52% - 75%
- 76% - 98%
- Lancaster

Possible Tree Canopy

Percent Possible
- 0% - 15%
- 16% - 39%
- 40% - 64%
- 65% - 82%
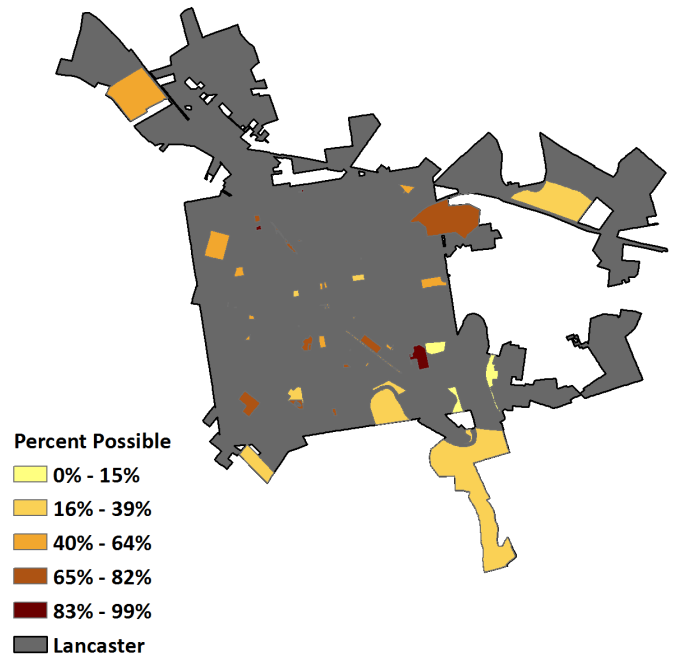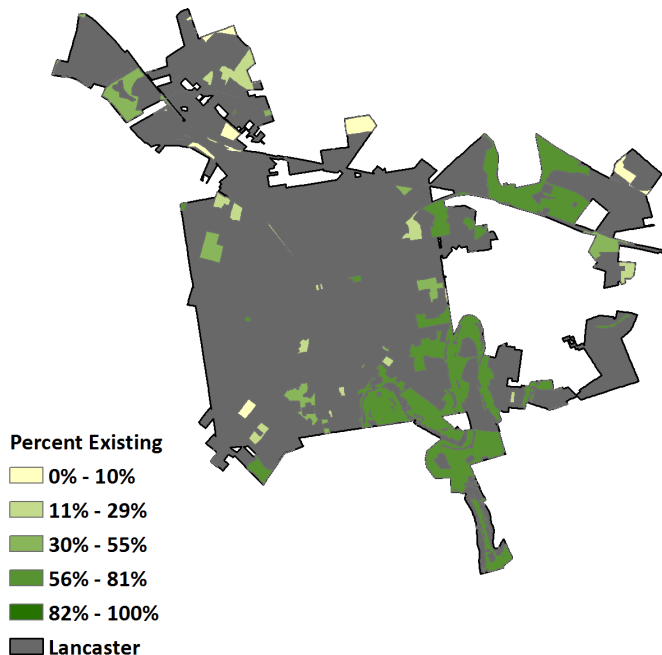- 83% - 99%
- Lancaster

Figure 8: Existing TC (left) and Possible TC (right) as a percentage by Park.

Priority Habitat Restoration Area Analysis

The Priority Habitat Restoration Area layer was used to summarize Existing and Possible TC within Lancaster. Twenty-four of the restoration areas (27%) had Existing TC exceeding 93%. Over 35% of the restoration areas had greater than 50% Possible TC.

Existing Tree Canopy

Percent Existing
- 0% - 10%
- 11% - 29%
- 30% - 55%
- 56% - 81%
- 82% - 100%
- Lancaster

Possible Tree Canopy

Percent Possible
- 0% - 10%
- 11% - 35%
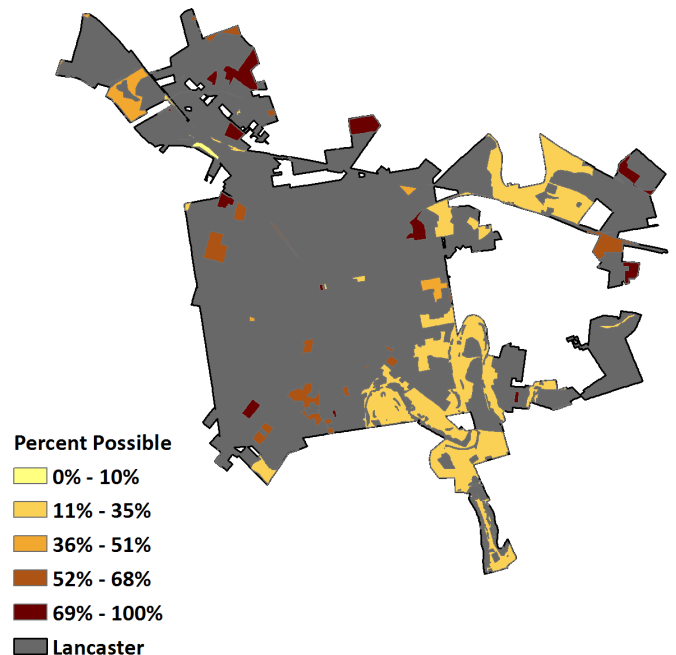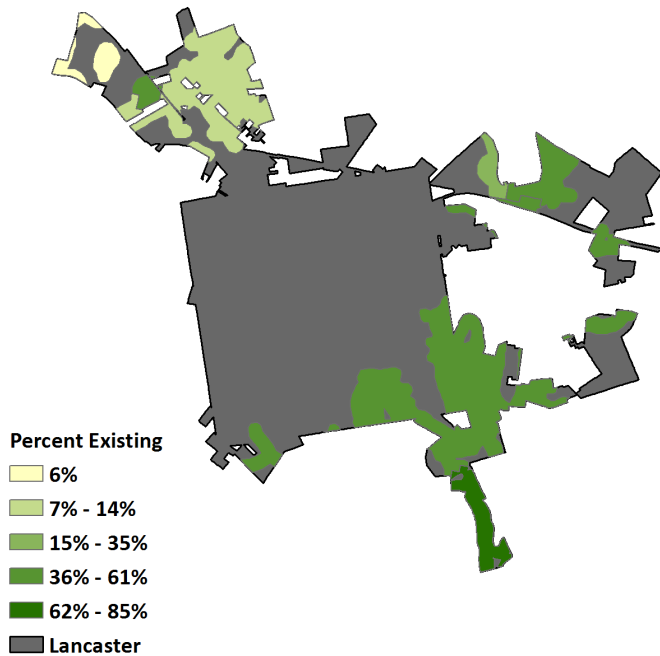- 36% - 51%
- 52% - 68%
- 69% - 100%
- Lancaster

Figure 9: Existing TC (left) and Possible TC (right) as a percentage by Priority Restoration Habitat Area.

Riparian Buffer Analysis

Tree canopy metrics were calculated for riparian buffers within Lancaster. Higher amounts of Existing Tree Canopy are clustered in both the southern and eastern parts of the city along Conestoga and Mill Creek. Riparian buffers located in the northern portions of the city along Little Conestoga Creek had the highest amounts of Possible TC.

Existing Tree Canopy

Possible Tree Canopy

Percent Existing
- 6%
- 7% - 14%
- 15% - 35%
- 36% - 61%
- 62% - 85%
- Lancaster

Percent Possible
- 14%
- 15% - 33%
- 34% - 38%
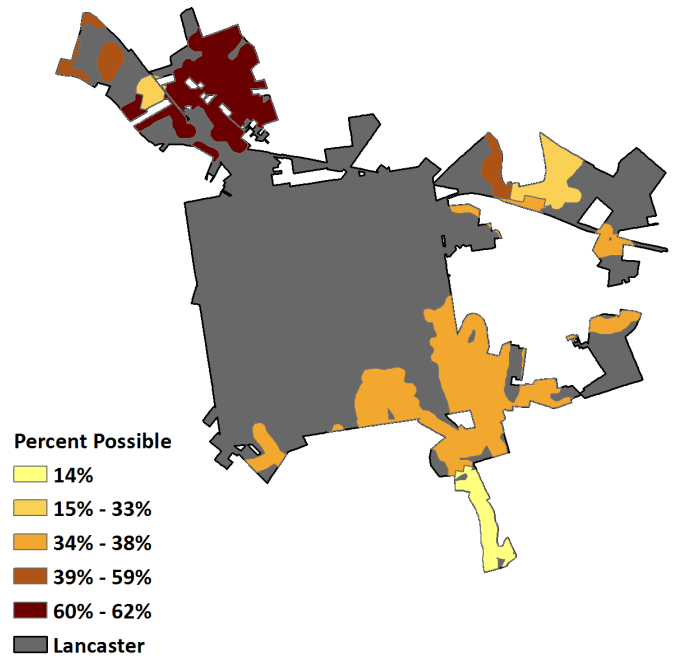- 39% - 59%
- 60% - 62%
- Lancaster

Figure 10. Existing TC (left) and Possible TC (right) as a percentage by riparian buffer.

Roads and Rights-of-Ways Analysis

Tree Canopy (TC) metrics were summarized by roads and rights-of-ways (ROW) as a surrogate analysis of street trees in Lancaster. Tree canopy overhanging roads accounts for 96 acres of tree canopy or 20% of all road areas while 24% of ROW are covered by tree canopy (24%). Within ROW, 24% of the land was mapped as Possible TC suggesting there are opportunities for adding street trees in the city.
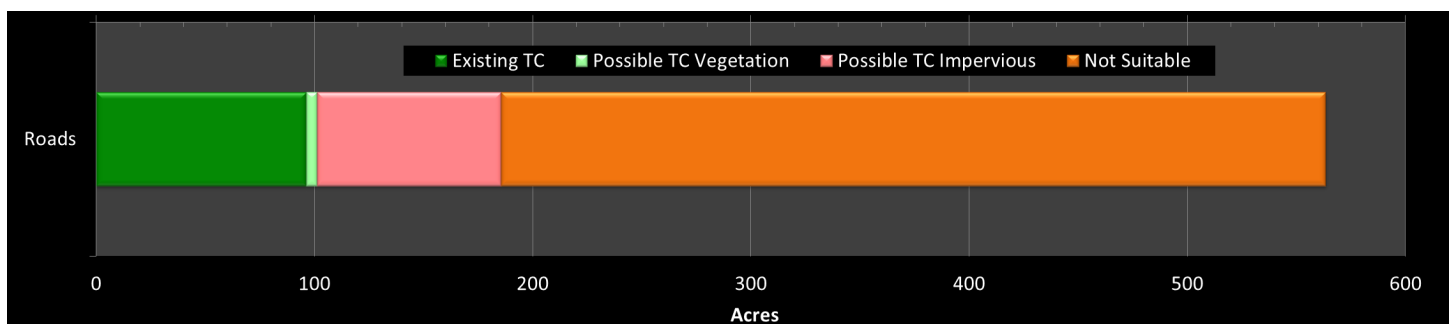

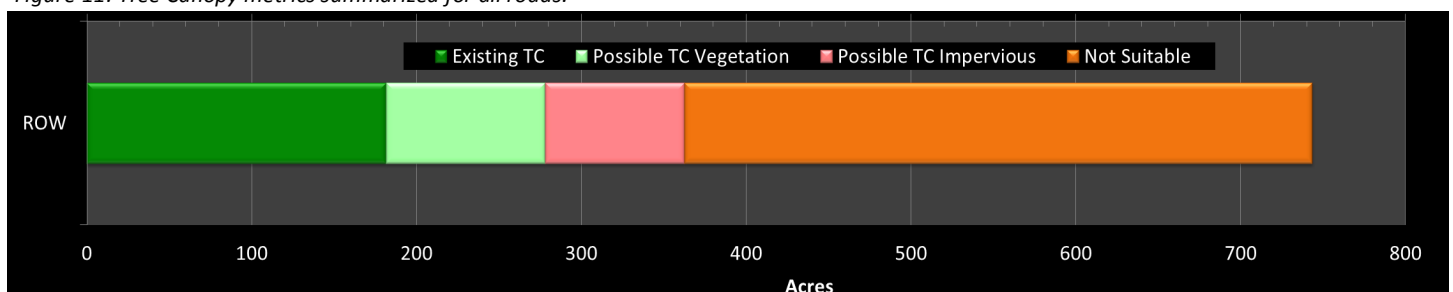*Figure 11: Tree Canopy metrics summarized for all roads.*

Figure 12: Tree Canopy metrics summarized for all rights-of-ways.

Conclusions

- City of Lancaster's urban tree canopy is a vital city asset that reduces stormwater runoff, improves air quality, reduces the city's carbon footprint, enhances quality of life, contributes to savings on energy bills, and serves as habitat for wildlife.

- Although this assessment indicates that 45% of the land in Lancaster could theoretically support tree canopy, planting new trees on much of this land may not be social desirable (e.g. recreation fields) or financially feasible (e.g. parking lots). Setting a realistic goal requires a detailed feasibility assessment using the geospatial datasets generated as part of this assessment.

- With Existing and Possible TC summarized at the parcel level and integrated into the city's GIS database, individual parcels and subdivisions can be examined and targeted for TC improvement. Of particular focus for TC improvement should be parcels in the city that have large, contiguous impervious surfaces. These parcels contribute high amounts of runoff, which degrades water quality. The establishment of tree canopy on these parcels will help reduce runoff during periods of peak overland flow.

- Lancaster's residents control the majority of the City's tree canopy and have most of the land to plant tees. Programs that educate residents on tree stewardship and provide incentives for tree planting are crucial if City of Lancaster is going to sustain its tree canopy in the long term.

- Commercial and Retail Trade land use has high amounts of Possible TC therefore incentive programs could be used to encourage business owners to maintain or plant additional tree canopy on their property.

- Park and Priority Habitat Restoration Area summaries can be used for targeting tree planting and preservation efforts in different parts of the city.

- With TC metrics summarized by riparian buffers, individual streams can be examined and targeted for TC improvement and establishing or maintaining tree canopy along streams for reducing surface runoff, controlling streambank erosion, and providing wildlife habitat.

- The city's rights-of-way (ROW) contain 24% Existing TC and 24% Possible TC, suggesting that opportunities exist for increasing the number of street trees.
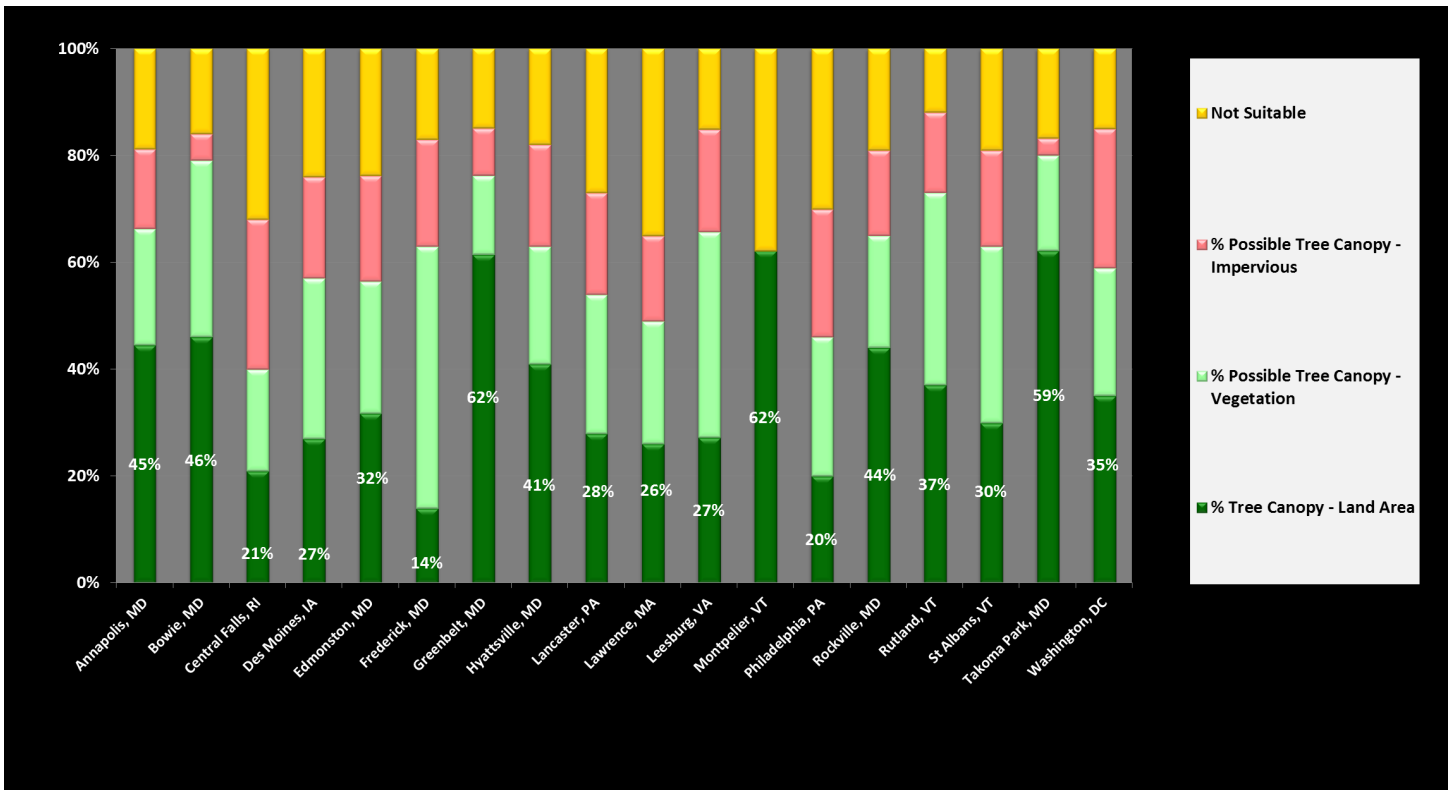

Figure 13: Comparison of Existing and Possible Tree Canopy with other selected cities that have completed Tree Canopy Assessments.

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Additional Information

Funding for the project was provided by PA Department of Conservation and Natural Resources Bureau of Forestry. More information on the TC assessment project can be found at the following web site: **http://nrs.fs.fed.us/urban/utc/**