A Report on the City of Newark'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 summer 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 urban forest planning, 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 Newark Have?

An analysis of Newark's tree canopy based on land cover data derived from high-resolution aerial imagery (Figure 1) found that 2,352 acres of the city were covered by tree canopy (termed Existing TC), representing 15% of all land in the city. An additional 46% (7,115 acres) of the city's land area could theoretically be modified (termed Possible TC) to accommodate tree canopy (Figure 2). In the Possible TC category, 33% (5,106 acres) of the city was classified as Impervious Possible TC and another 13% was Vegetated Possible TC (2,009 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 imagery for the City of

Project Background

The goal of the project was to apply the USDA Forest Service's Tree Canopy Assessment protocols to the City of Newark. The analysis was conducted based on year 2010 data. This project was made possible through funding from the City of Newark. The Spatial Analysis Laboratory (SAL) at the University of Vermont's Rubenstein School of the Environment and Natural Resources carried out the assessment in collaboration with the City of Newark Sustainability Office and the USDA Forest Service's Northern Research Station.

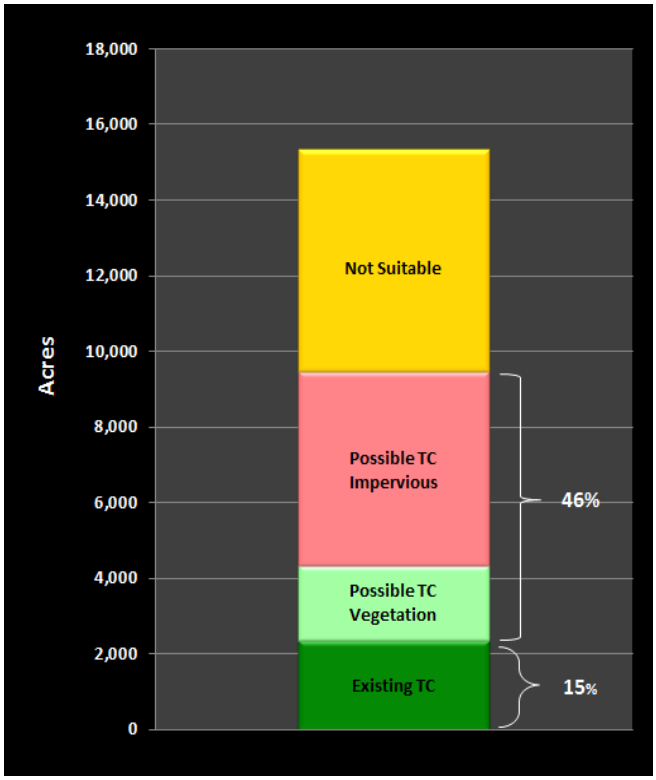


Figure 2: TC metrics for Newark based on % of land area covered by each TC type.

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.
Not Suitable: Areas where it is highly unlikely that new tree canopy could be established (primarily buildings and roads).

Mapping Newark's Trees

A prior estimate of tree canopy for the entirety of the City of Newark (including water) from the 2001 National Land Cover Database (NLCD 2001) was 8%, far lower than the 15% obtained in this study. The large difference is due to the fact that NLCD 2001 (Figure 3a) and only accounted for relatively large patches of tree canopy. The same is true for the city's vegetation layer (not shown). Using high-resolution aerial imagery (Figure 3b), in combination with advanced automated processing techniques, land cover for the city was mapped with such detail that trees as short as 8ft tall were detected (Figure 3c).

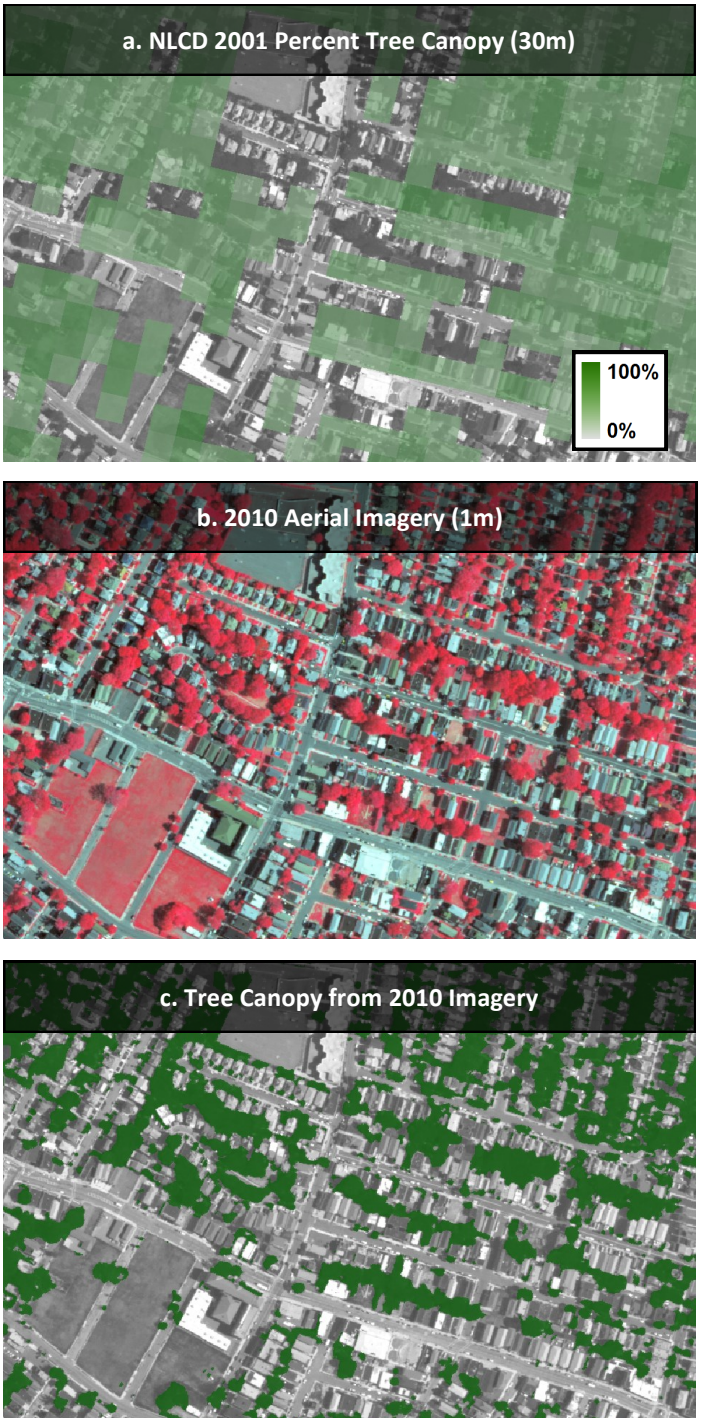


Figure 3: Comparison of NLCD 2001 (a) to high-resolution imagery (b) and tree canopy (c) derived for this study.

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 (square footage) and as a percentage of the land area within each parcel (TC area ÷ land area of the parcel).

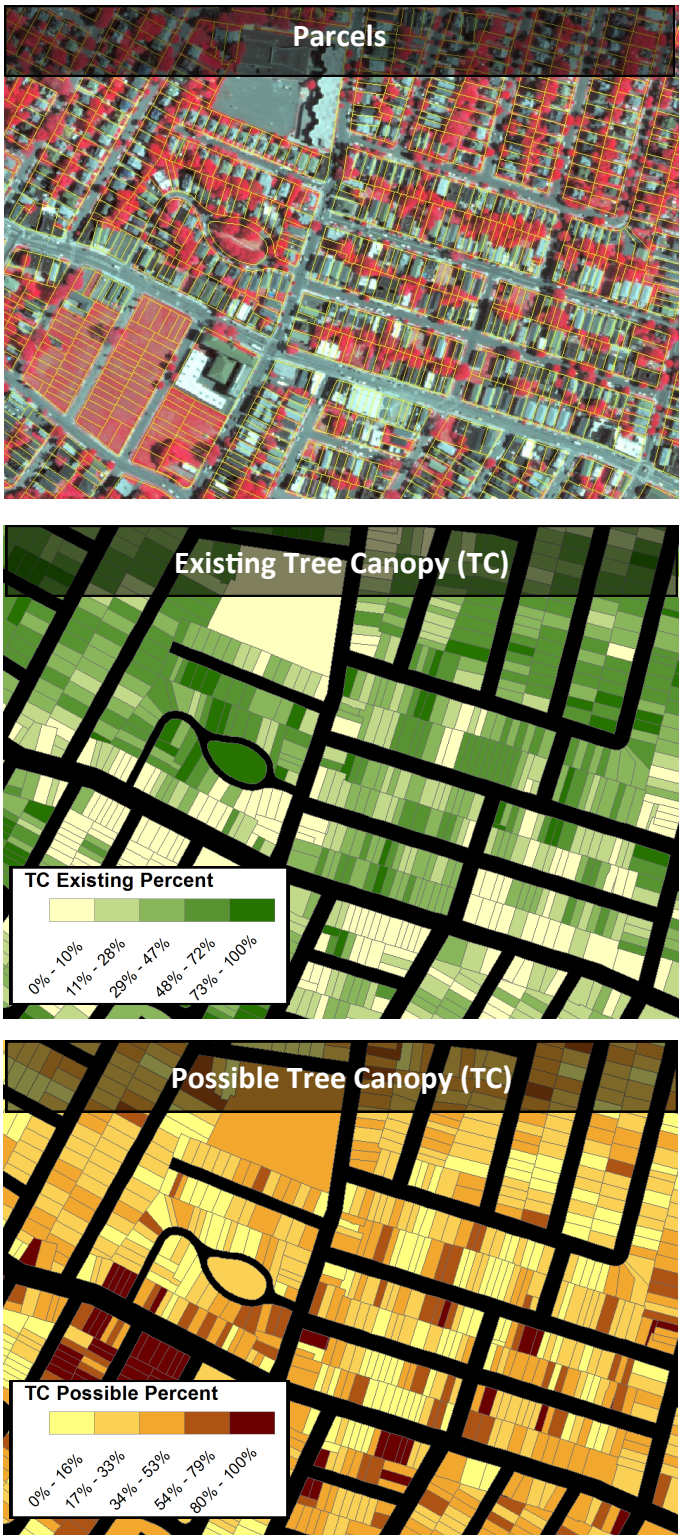


Figure 4a, 4b, 4c: Parcel-based TC metrics. TC metrics are generated at the parcel level, allowing each property to be evaluated according to its Existing TC and Possible TC.

Rights-Of-Way

Land within Newark can be broadly split into two categories (Figure 5), parcel land and rights-of-way. Parcel land refers to all land contained within the city's parcel database. Rights-of-Way (ROW) refers to "non-parcel" land, essentially street rights-of-way and water. The vast majority of the city's land base (77%) exists within parcels, with 23% of the city's land base within the ROW (Figure 6). Within the parcels, 13% of the land is covered by tree canopy. Within the ROW the percent of land covered by tree canopy is much lower (4%). Additional tree canopy (Possible TC) could theoretically be established on 41% of all the parcel land area, but only 5% of the ROW, largely due to the presence of roads and other transportation infrastructure. Establishing new tree canopy within the parcel land will likely be easier as much of the Possible TC falls into the Vegetation category whereas in the ROW most of the Possible TC is in the Impervious category. Nevertheless, the city could substantially improve its tree canopy through an "all lands" approach that includes both street tree plantings (within the ROW) and plantings on parcel land.

Figure 5: Parcels and ROW land division in Newark.

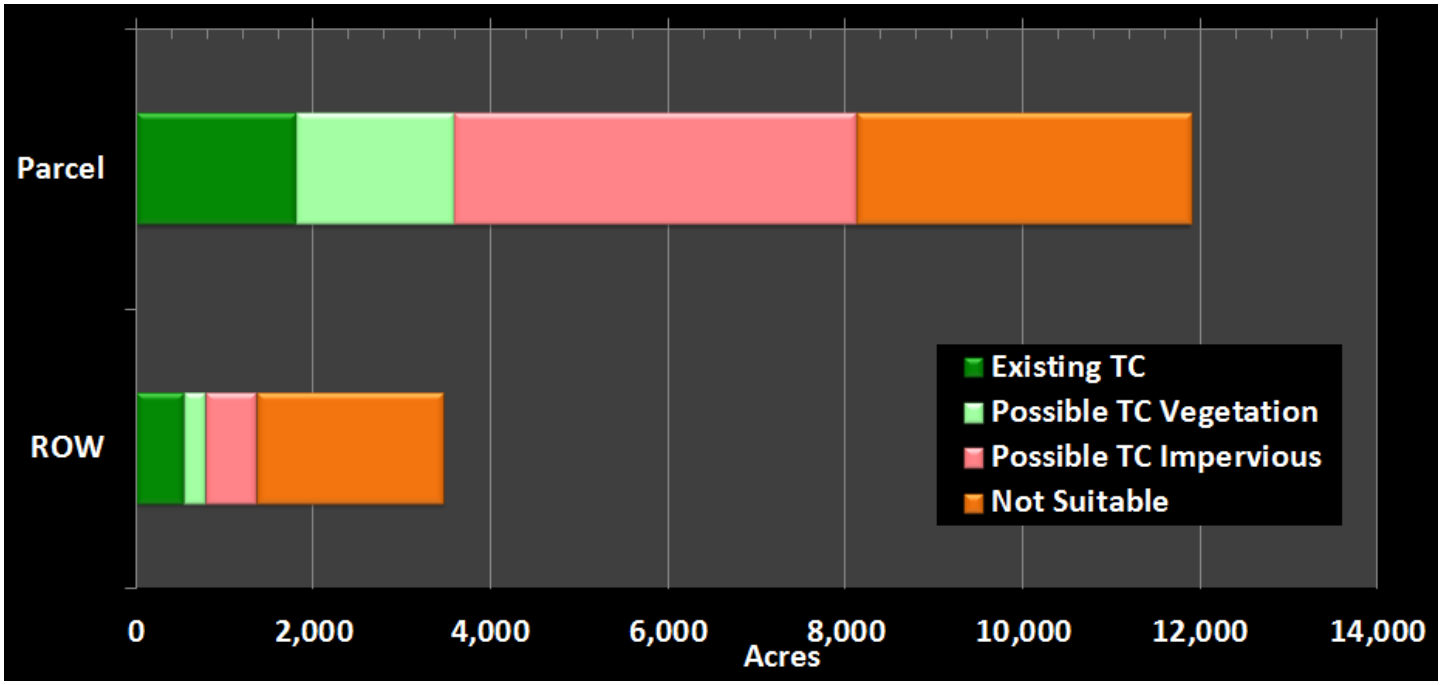


Figure 6: Tree Canopy (TC) metrics were summarized by parcels and ROW.

Land Use

An analysis of Existing and Possible TC by land use category was conducted using the city's land use data (Figure 7, Table 1). For each land use category, 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), and as a percentage of the area for TC type (% TC Type). The majority of the city is industrial land, but a large portion of this is the airport and seaport. Outside of the airport/seaport, the majority of Newark is in residential land use, and thus it comes as no surprise that the residential areas have not only the majority of the cities tree canopy, but also the most room to plant new trees. The Governmental — Other and Open Space categories present opportunities for tree planting. There remains considerable room for establishing new tree canopy in industrial areas, but this will be challenging due to the amount of impervious surfaces.

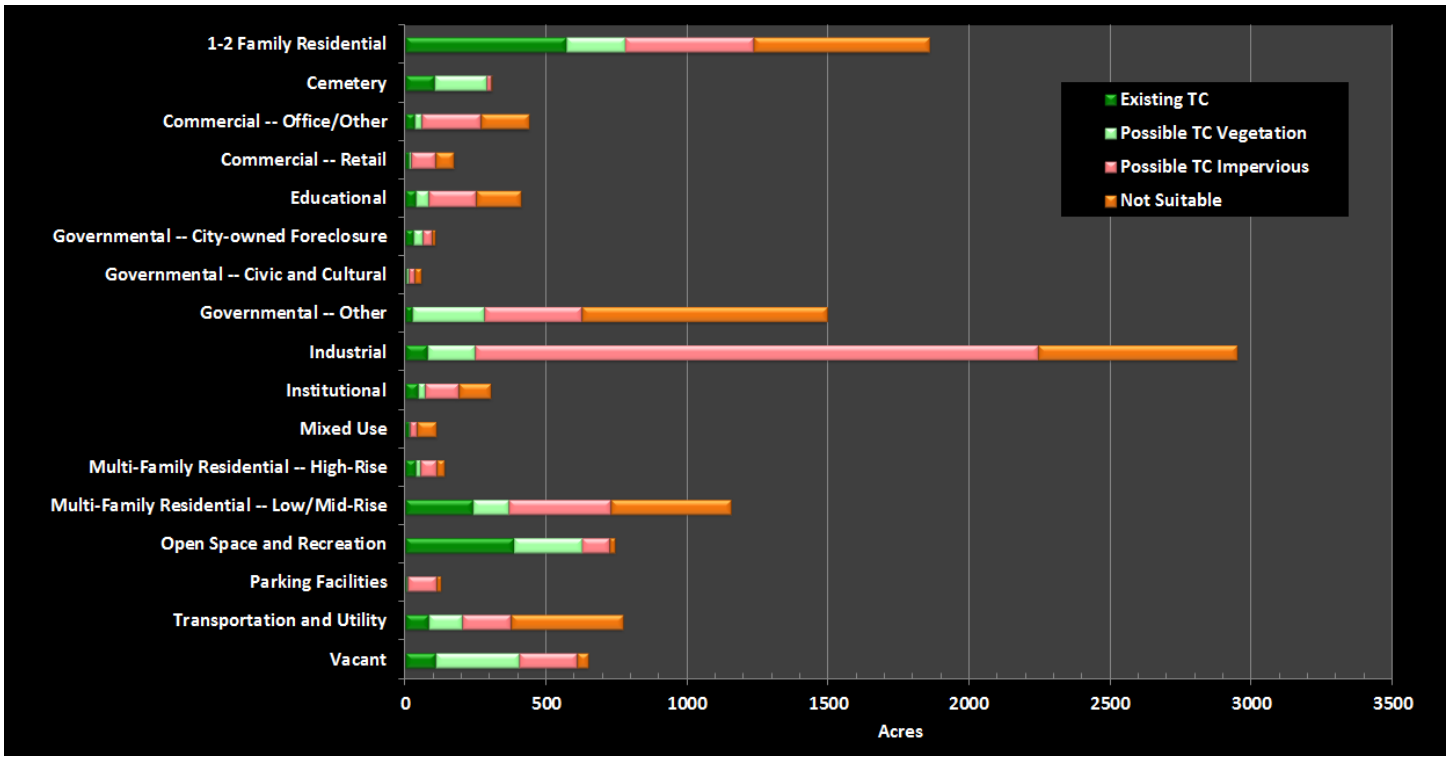


Figure 7: Tree Canopy (TC) metrics summarized for each zoning district.

Land Use	Existing TC			Possible TC Vegetation			Possible TC Impervious		
	% Land	% Category	% TC Type	% Land	% Category	% TC Type	% Land	% Category	% TC Type
1-2 Family Residential	6%	31%	46%	2%	11%	19%	5%	25%	12%
Cemetery	1%	34%	8%	2%	60%	17%	0%	5%	0%
Commercial -- Office/Other	0%	8%	3%	0%	5%	2%	2%	48%	5%
Commercial -- Retail	0%	7%	1%	0%	5%	1%	1%	49%	2%
Educational	0%	9%	3%	0%	11%	4%	2%	41%	4%
Governmental -- City-owned Foreclosure	0%	27%	2%	0%	30%	3%	0%	30%	1%
Governmental -- Civic and Cultural	0%	9%	0%	0%	10%	1%	0%	41%	1%
Governmental -- Other	0%	2%	2%	3%	17%	23%	4%	23%	9%
Industrial	1%	3%	7%	2%	6%	15%	21%	68%	51%
Institutional	0%	15%	4%	0%	9%	2%	1%	38%	3%
Mixed Use	0%	11%	1%	0%	3%	0%	0%	23%	1%
Multi-Family Residential -- High-Rise	0%	25%	3%	0%	14%	2%	1%	39%	1%
Multi-Family Residential -- Low/Mid-Rise	3%	21%	20%	1%	11%	11%	4%	31%	9%
Open Space and Recreation	4%	51%	31%	3%	32%	22%	1%	13%	3%
Parking Facilities	0%	4%	0%	0%	3%	0%	1%	81%	3%
Transportation and Utility	1%	11%	7%	1%	15%	11%	2%	22%	4%
Vacant	1%	16%	9%	3%	45%	27%	2%	32%	5%

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

The % Land Area value of 3% indicates that 3% of Newark's land area is covered by tree canopy in the Multi-Family Residential — Low/Mid-Rise category.

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

The % Land value of 21% indicates that 21% of land in the Multi-Family Residential — Low/Mid-Rise category is covered by tree canopy.

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

The % TC Type value of 20% indicates that 20% of all tree canopy is in land classified as Multi-Family Residential — Low/Mid-Rise .

Table 1: Tree Canopy (TC) metrics were summarized by land use. 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 category (% Category), and as a percentage of the area for TC type (% TC Type).

Socio-Demographic Analysis

US Census Block Groups contain a wealth of socio-demographic information that, when combined with TC metrics, provide new insights into the relationship between the citizens of Newark and their tree canopy. An inverse relationship between existing tree canopy and renter occupancy rates is evident when comparing block groups (Figure 8b). Evidence from other cities shows that tree survival tends to be lower in areas with higher renter occupancies. Tree canopy per capita is lowest in those sections of the city where the population density is highest (Figure 8c). The Priority Planting Index (PPI) incorporates census data and TC metrics to score block groups based on the need for tree plantings. The Priority Planting Index, which factors in population density, tree stocking levels, and per capita tree cover helps to identify areas where tree planting efforts can be targeted to address issues of environmental justice (Figure 8d). Interestingly, the areas with high PPI values also have relatively high amounts of Possible TC.

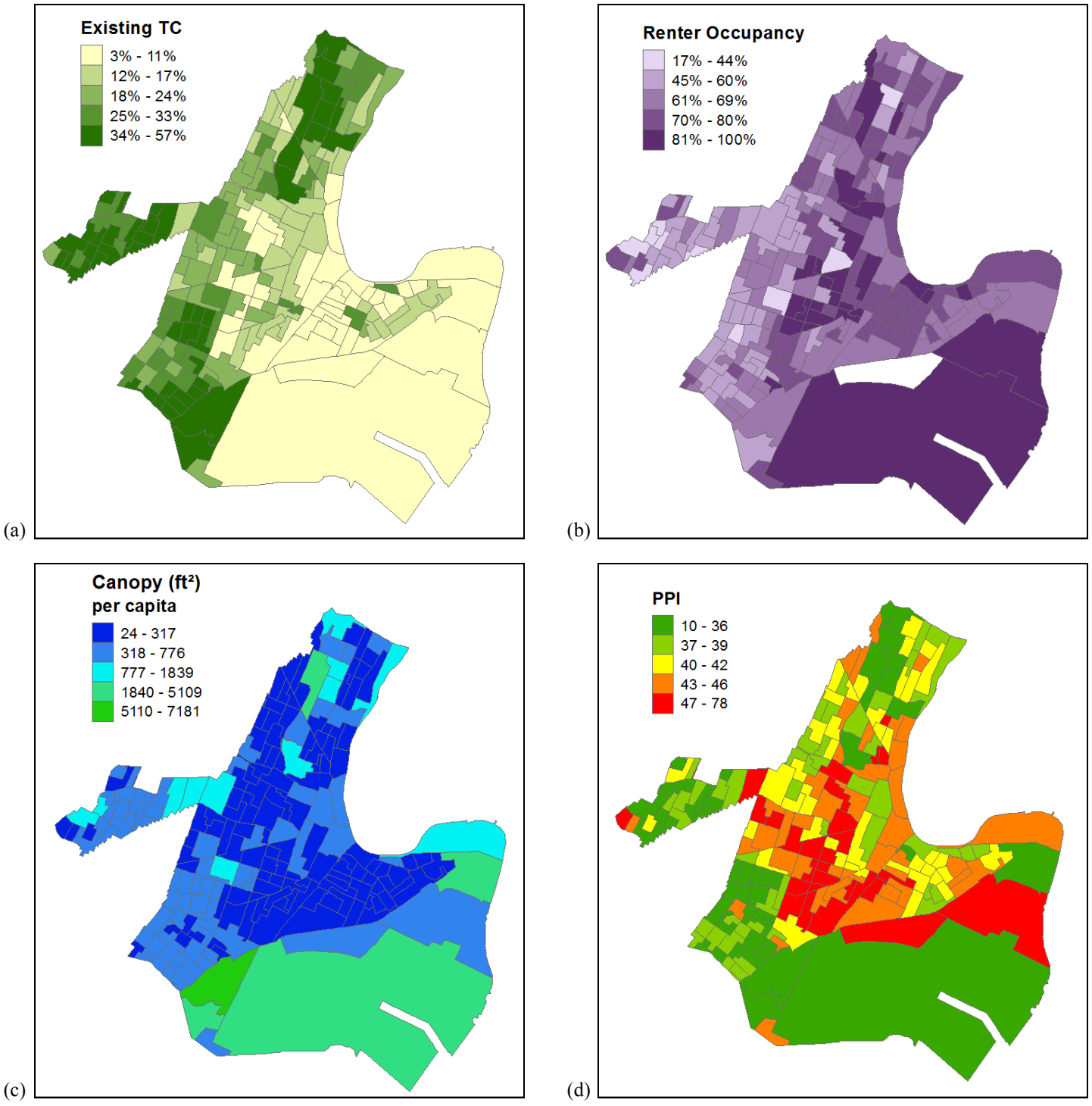


Figure 8: (a) Percent Existing TC; (b) proportion of housing units occupied by renters; (c) tree canopy per capita; and (d) Priority Planting Index.

Socio-Demographic Analysis

Socio-demographic information also provides insight into income and population distribution with respect to tree canopy. North, west and southwest areas of the city where existing tree canopy coverage is greater also tend to have higher per capita incomes (Figure 9a). Population data indicate that 16.5% of Newark's residents live in block groups with less than 10% tree canopy; 2.4% live in block groups with less than 5% tree canopy. Areas with a higher density of children (Age 0-19) and relatively low amounts of tree canopy are evident in some block groups in the Ironbound, Fairmount, Springfield, and Seventh Avenue neighborhoods (Figure 9b). Similarly, low tree canopy block groups with higher density of retirees and seniors (Age 65+) occur in Ironbound as well as the Central Business District (Figure 9c). Several of these block groups have at least one third of their area in Possible Tree Canopy and thus might provide opportunities for strategic tree planting to benefit these more vulnerable age groups (Figure 9d).

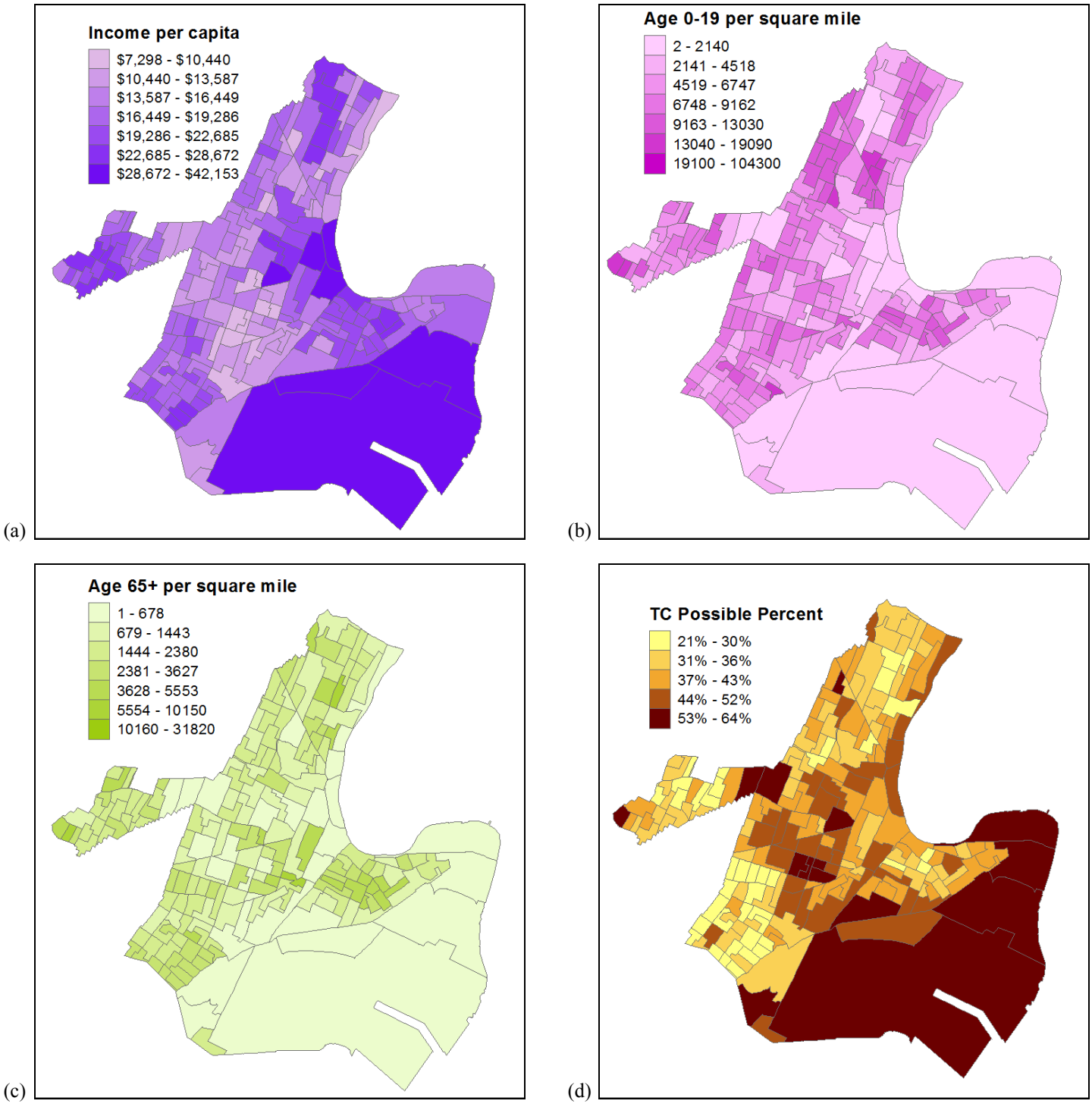


Figure 9: (a) Per capita income; (b) Age 65+ population density; (c) Age 0-19 population density; and (d) Percent Possible TC.

Neighborhoods

Tree canopy metrics were summarized for each neighborhood (Figure 10). TC metrics for neighborhoods are displayed in Figure 11. Forrest Hill is the second largest neighborhood in Newark and has 21% of existing tree canopy. Three neighborhoods — Forrest Hill, Dayton, and Weequahic have 50% of the city's total tree canopy. Upper Clinton Hill and the Vailsburg neighborhoods are also important, each having at least 10% of the city's overall tree canopy. In terms of establishing new tree canopy (Possible TC), Fairmount, Springfield and South Ironbound each have nearly 50% of their land area available, with several other neighborhoods at 40% or greater. Fairmount and Dayton have the largest proportion of currently vegetated land, where tree canopy opportunities are generally better than on impervious land.

Existing Tree Canopy

Possible Tree Canopy

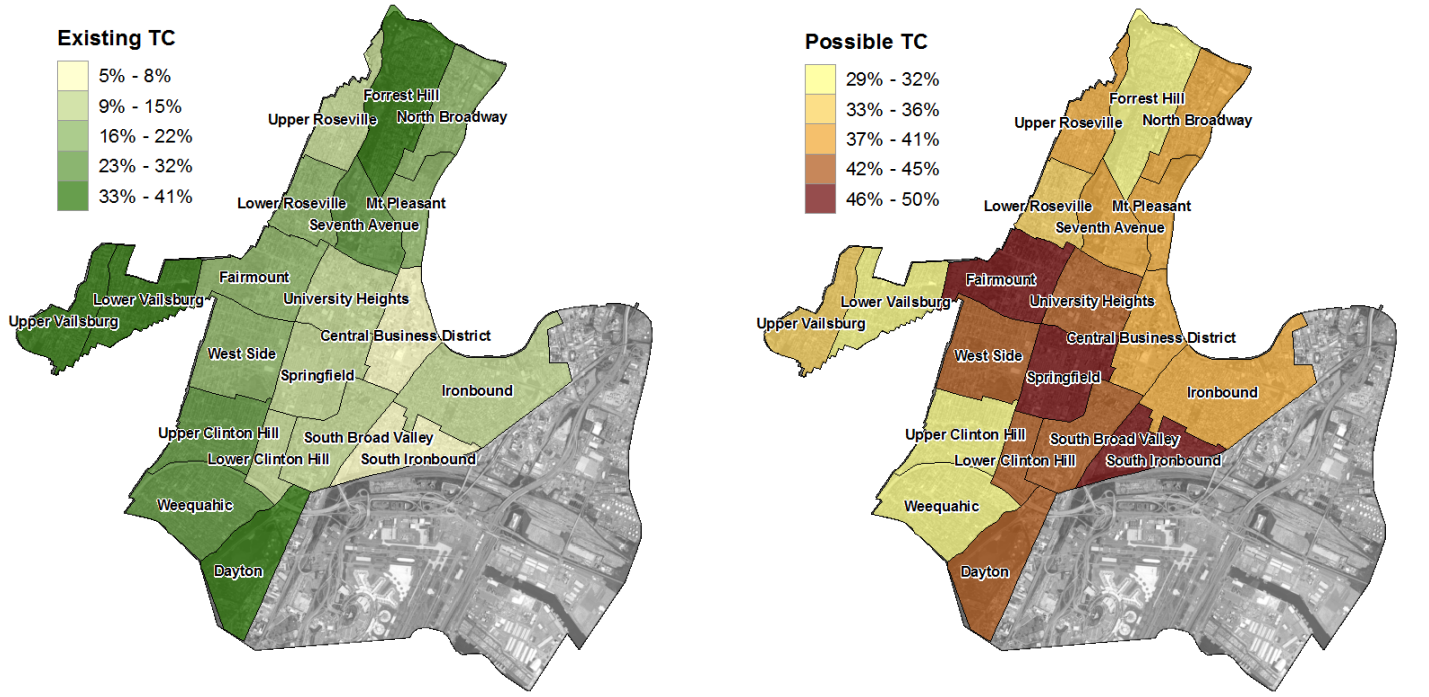


Figure 10. Existing TC (left) and Possible TC (right) as a percentage of land area.

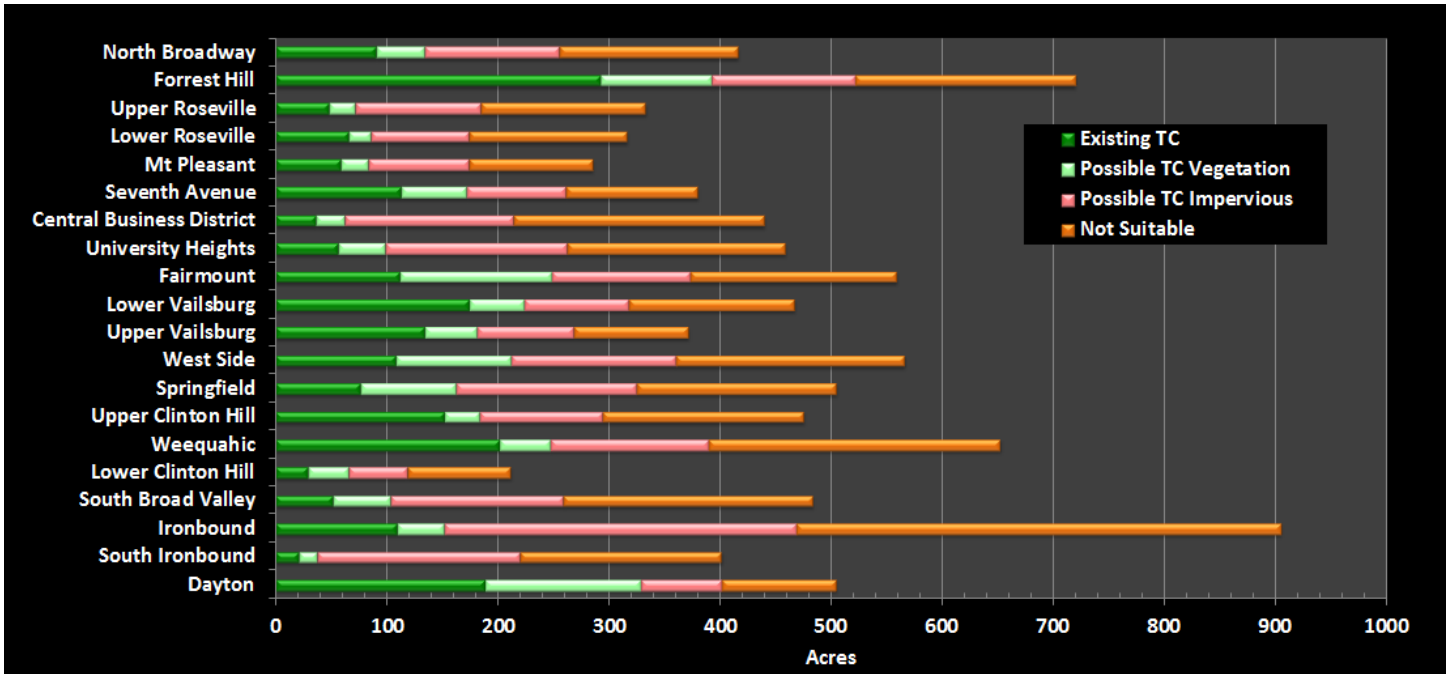


Figure 11: TC metrics summarized by Neighborhood.

Priority Neighborhoods

Neighborhoods could be prioritized for efficient planting efforts by examining the distribution of Existing and Possible Tree Canopy on a finer scale within neighborhoods. Figure 12 highlights census block groups that have Existing Tree Canopy below the city average of 15%. In the neighborhoods of Ironbound, South Broad Valley, Lower Clinton Hill and Upper Roseville, the majority of block groups have less than 15% tree canopy. The Central Business District and South Ironbound neighborhoods are entirely below the 15% threshold.

Tree canopy metrics were also summarized for the Rights-of-Way (ROW) in each of four neighborhoods identified by the City of Newark as high priority neighborhoods for tree planting (Figure 13). The ROW is the area in which street tree plantings occur. Although street trees constitute a small percentage of a neighborhoods overall tree canopy they yield numerous ecosystem services. Of the four neighborhoods, Upper Clinton Hill has the most Existing Tree Canopy in the ROW, both in terms of area and percent. Lower Broadway has the second highest percentage but has less overall tree canopy area than Fairmount, which is a larger neighborhood. East Ferry has the highest percentage of ROW area identified as Possible Tree Canopy, although nearly all of it is in the impervious surface category. Establishing street trees in the ROW in these neighborhoods will require the use of either vacant tree pits or the establishment of new tree pits. A field assessment would help to determine optimal locations.

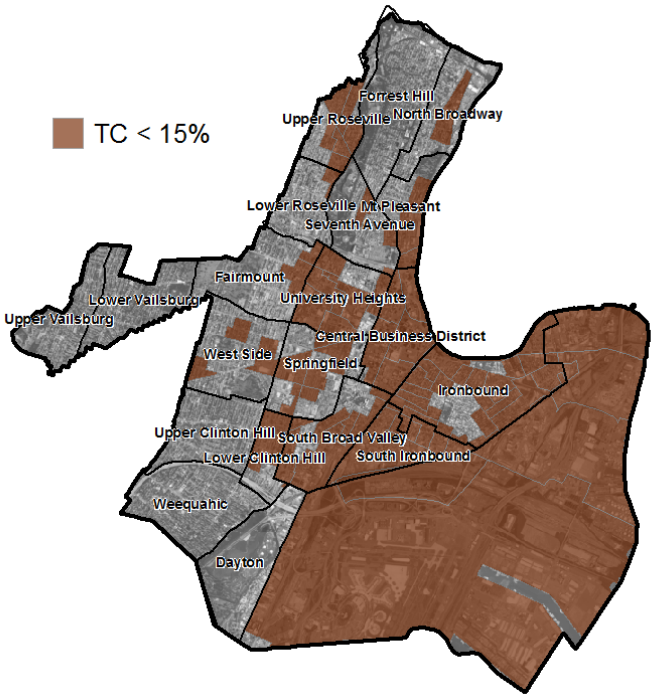


Figure 12. Census Block Groups with less than 15% Existing TC .

Existing Tree Canopy

Possible Tree Canopy

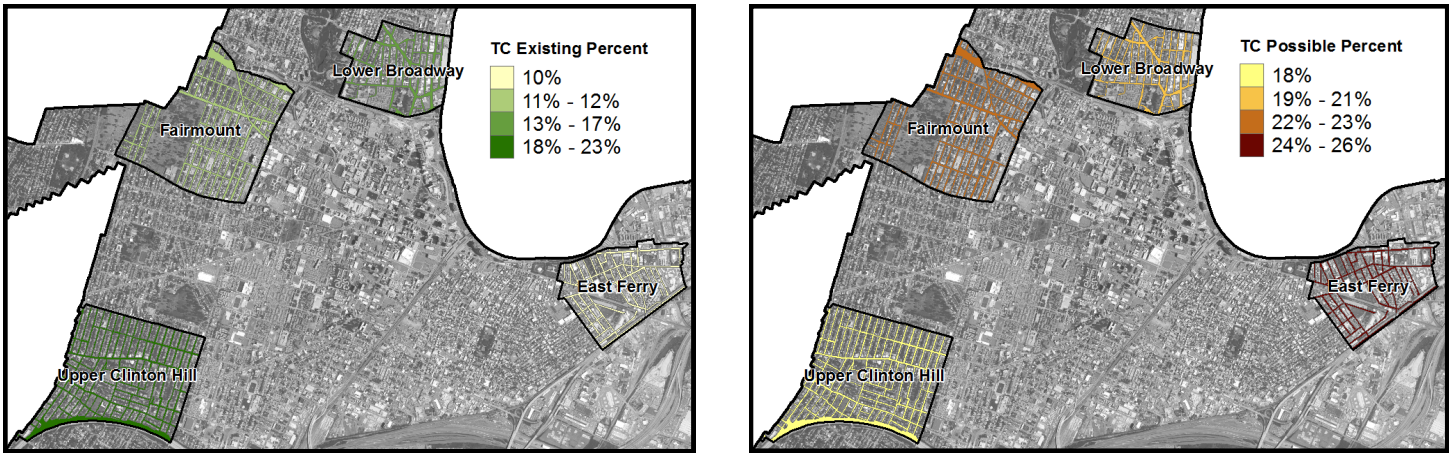


Figure 13. Existing TC (left) and Possible TC (right) as a percentage of land within the right-of-way (ROW)

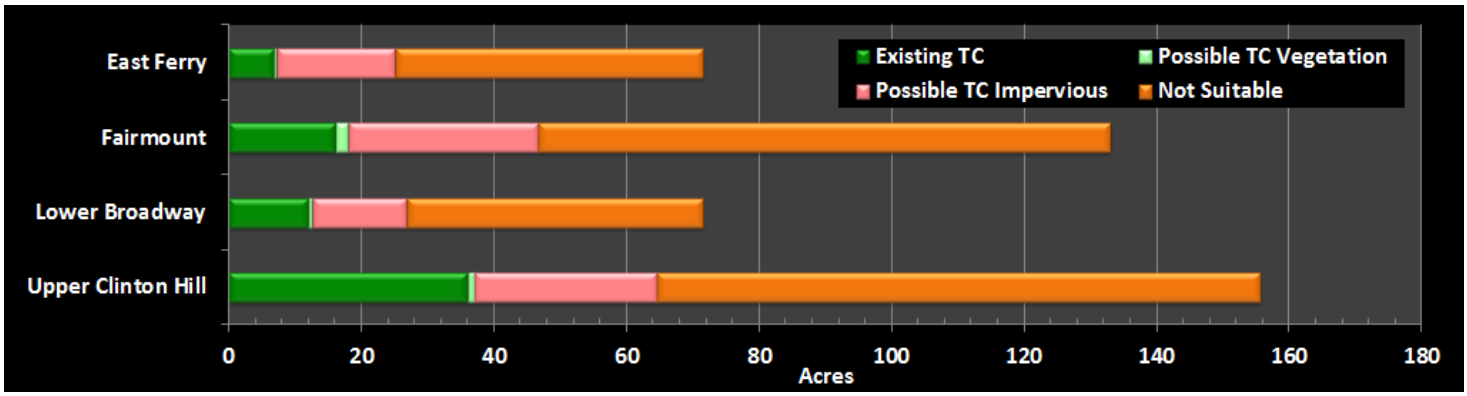


Figure 14: TC metrics summarized by ROW for Priority Neighborhoods.

Wards

The heavily-industrialized East Ward has the lowest Existing tree canopy as a percentage of Ward area (Figures 15, 16), followed by the Central Ward. The North and West Wards have the highest Existing TC (30% and 28%, respectively). All Wards present opportunities as each has well over one-third of its area classified as possible tree canopy.

Existing Tree Canopy

Possible Tree Canopy

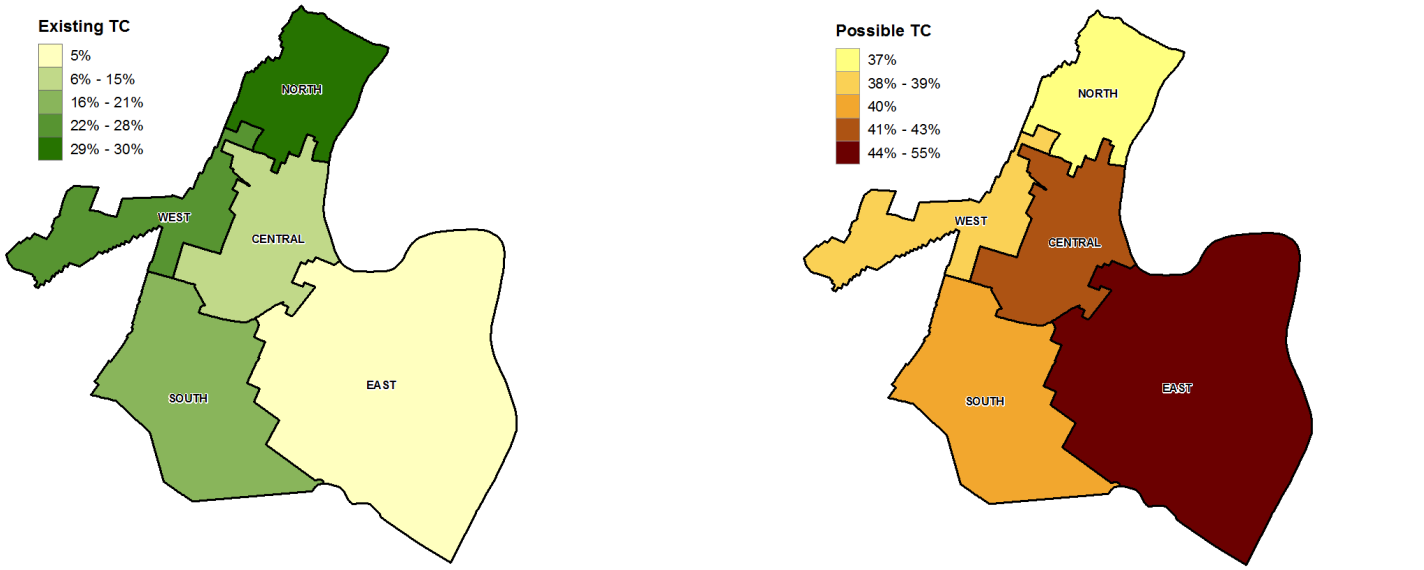


Figure 15. Existing TC (left) and Possible TC (right) as a percentage of Ward land area.

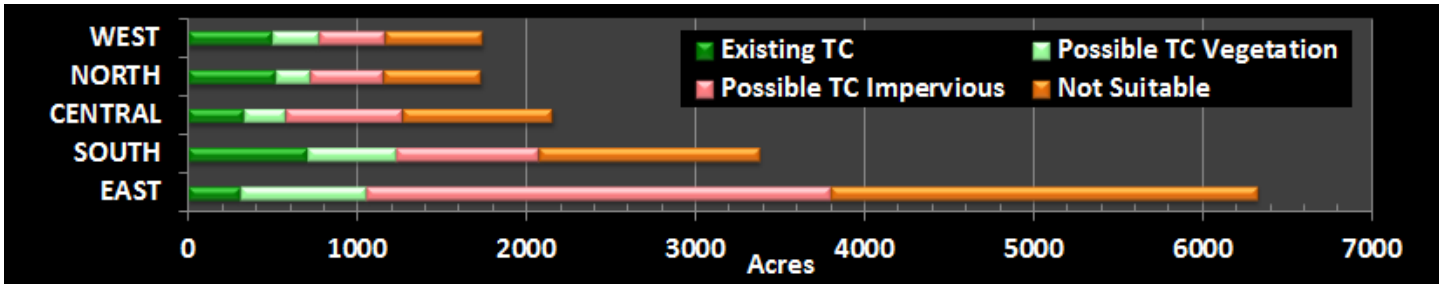
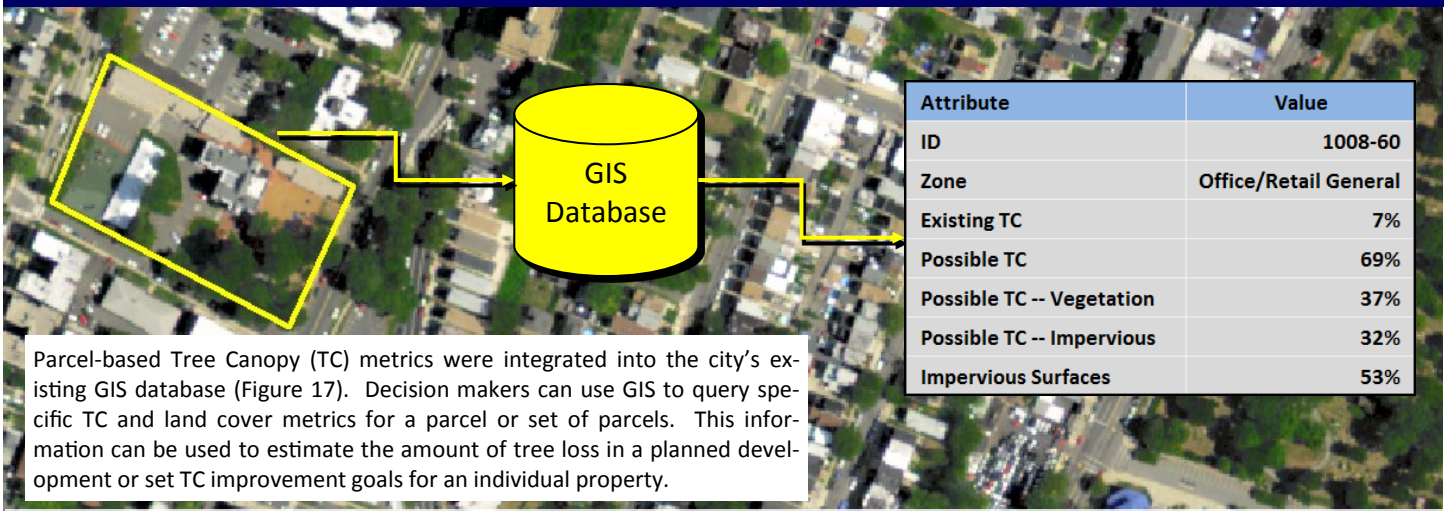


Figure 16: TC metrics summarized by Ward.

Decision Support



Parcel-based Tree Canopy (TC) metrics were integrated into the city's existing GIS database (Figure 17). Decision makers can use GIS to query specific TC and land cover metrics for a parcel or set of parcels. 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.

Figure 17: 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.

Tree Canopy Opportunity Index

In addition to simple descriptive statistics, more sophisticated techniques can help identify areas of the city where tree-planting and stewardship programs would be most effective. One approach is to focus on spatial clusters of Existing and Possible TC. When a 300-foot grid network is superimposed on the land-cover map (Figure 18a), it is possible to map regions of the study area where high values of Existing TC are tightly clustered (Figure 18b). A similar map was constructed for Possible TC (Figure 18c). A single index was created by subtracting the percentage of Existing TC per grid cell from Possible TC, which produced a range of values from –1 to 1. When clustered, this tree canopy opportunity (TCO) index highlights areas with high Possible TC and low Existing TC (Figure 18d); these areas theoretically offer the best places to strategically expand Newark's tree canopy and to increase its many attendant benefits. Unlike PPI (Figure 8d), TCO does not take into account population information. As such, the areas with the highest TCO are the largely industrial and commercial sections of the city that have low Existing and high Possible TC. As with all such analyses, however, landscape context must be evaluated before setting priorities.

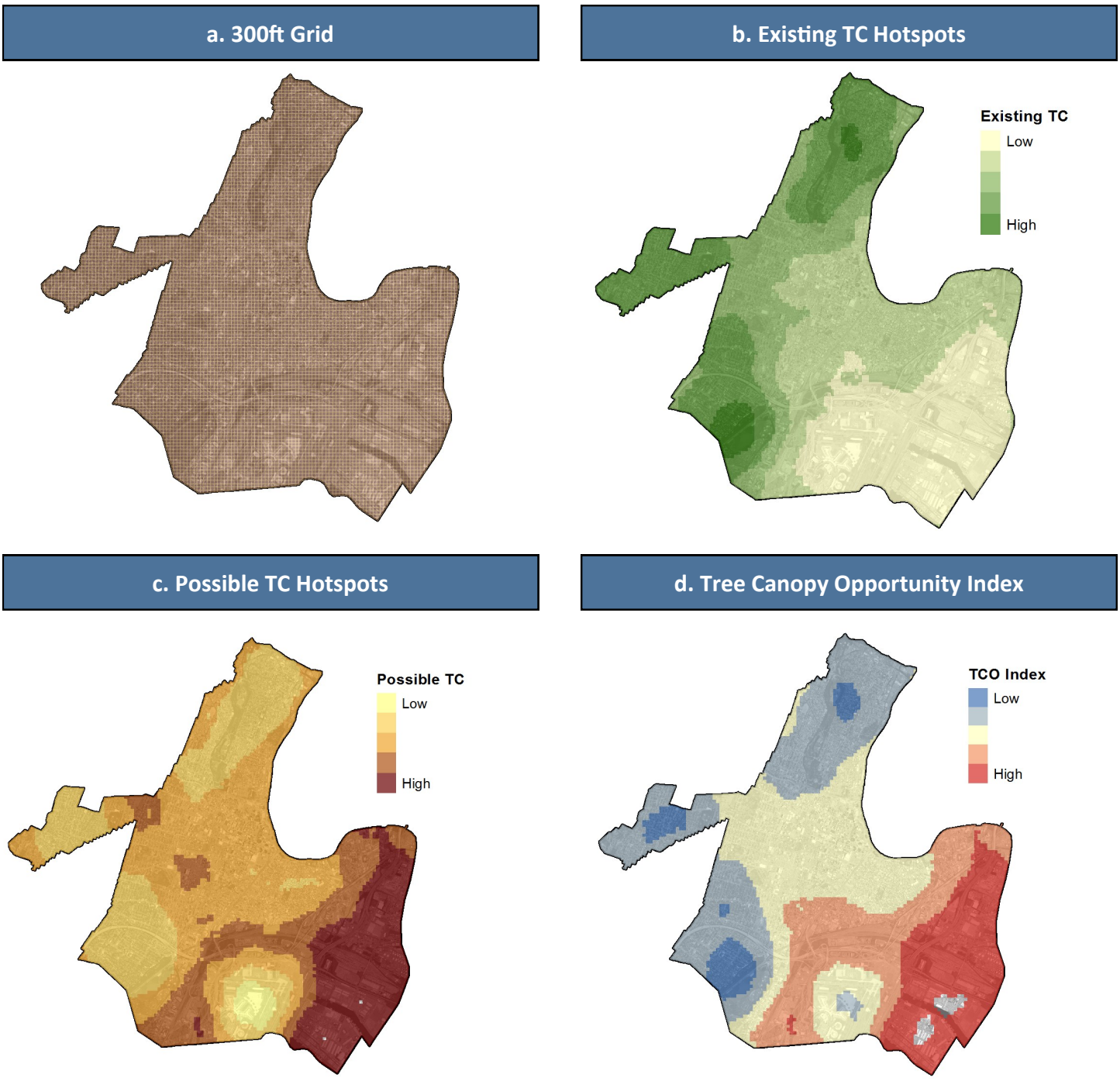


Figure 18: (a) Grid network (300-foot cells) superimposed on land-cover map for Newark and then used in spatial cluster analyses; (b) Spatial clustering of Existing TC in Newark; dark green areas are highly clustered and have high Existing TC values; (c) Spatial clustering of Possible TC in Newark; dark red areas are highly clustered and have high Possible TC values.; and (d) Spatial clustering of a combined index of Existing and Possible TC; red areas theoretically provide the best opportunities for expanding tree canopy.

Conclusions

- Newark'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 Newark could theoretically support tree canopy, planting new trees on much of this land may not be socially desirable (e.g. recreation fields) or financially feasible (e.g. industrial land). 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 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 and reduce the urban heat island.
- Newark's residents are the largest "owner" of tree canopy by land use type. Programs that educate residents on tree stewardship and provide incentives for tree planting are crucial if Newark is going to sustain its tree canopy in the long term.
- Geographically, the greatest opportunities for increasing tree canopy lies in the central, southeast, and southwest sections of the city, but these are areas dominated by the airport and seaport with a relatively low number of persons.
- Census Block Group summaries can be used to target the expansion of new tree canopy in areas of the city to meet the needs of underserved populations. The Priority Planting Index (PPI) can help to guide these efforts.
- 35% of Newark's population live in areas that have tree canopy below the city's average.

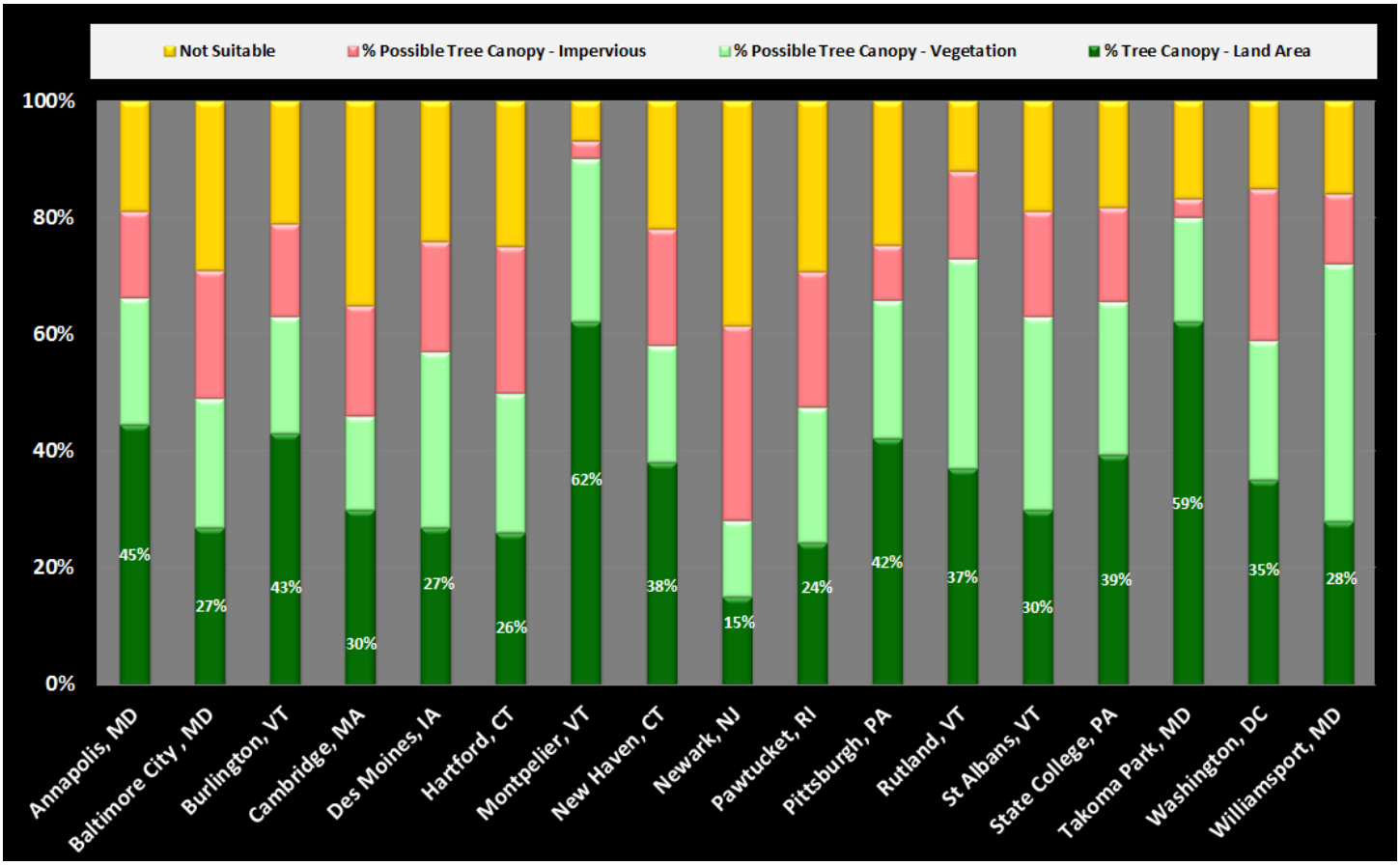


Figure 19: Comparison of Existing and Possible Tree Canopy with other similar cities that have completed Tree Canopy Assessments.

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Additional Information

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