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

Why is Tree Canopy Important?

Urban tree canopy (UTC) is the layer of leaves, branches, and stems of trees that cover the ground when viewed from above. Urban tree canopy provides many benefits to communities including 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 UTC goal is crucial for those communities seeking to improve their green infrastructure. A UTC assessment that provides the amount of tree canopy currently present (Existing UTC) along with the amount of tree canopy that could be established (Possible UTC) is the first step in the UTC goal setting process.

How Much Tree Canopy Does Frederick Have?

An analysis of Frederick's urban tree canopy based on land cover (Figure 1) derived from year 2007 high resolution aerial imagery found that more than 1,804 acres of the City were covered by tree canopy (termed Existing UTC) representing 14% of all land in the city. An additional 69% (9,307 acres) of the city could theoretically be improved (termed Possible UTC) to support tree canopy (Figure 2). Of land classified as Possible UTC, 20% (2,675 acres) of the is impervious and another 49% (6,633 acres) consisted of grass and shrub land. Establishing new tree canopy is likely to be easier on the areas identified as Possible UTC Vegetation, where as establishing tree canopy on Impervious Possible UTC will have a greater impact on water quality.

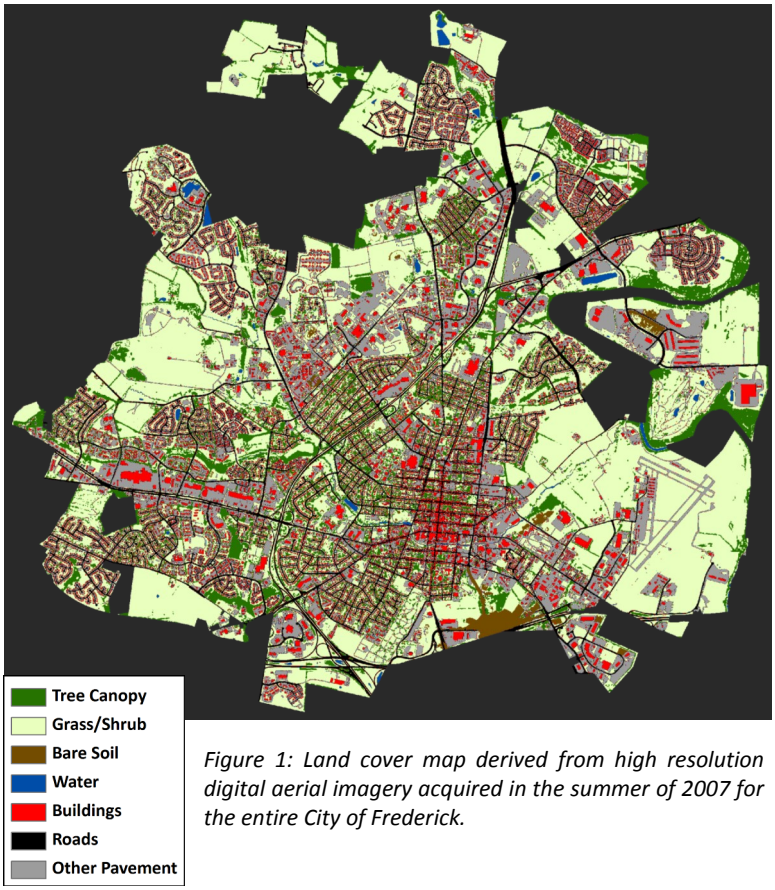

Figure 1: Land cover map derived from high resolution digital aerial imagery acquired in the summer of 2007 for the entire City of Frederick.

Project Background

The analysis of Frederick's urban tree canopy (UTC) was carried out in collaboration with the City of Frederick. The assessment was performed by the University of Vermont's Spatial Analysis Laboratory (SAL) in consultation with the USDA Forest Service's Northern Research Station. The goal of the project was to apply the USDA Forest Service's UTC assessment protocols to the City of Frederick using the best available data and methods.

Data for this project was provided by the Maryland Department of Natural Resources (MD DNR) and the City of Frederick. This analysis was conducted based on year 2007 data.

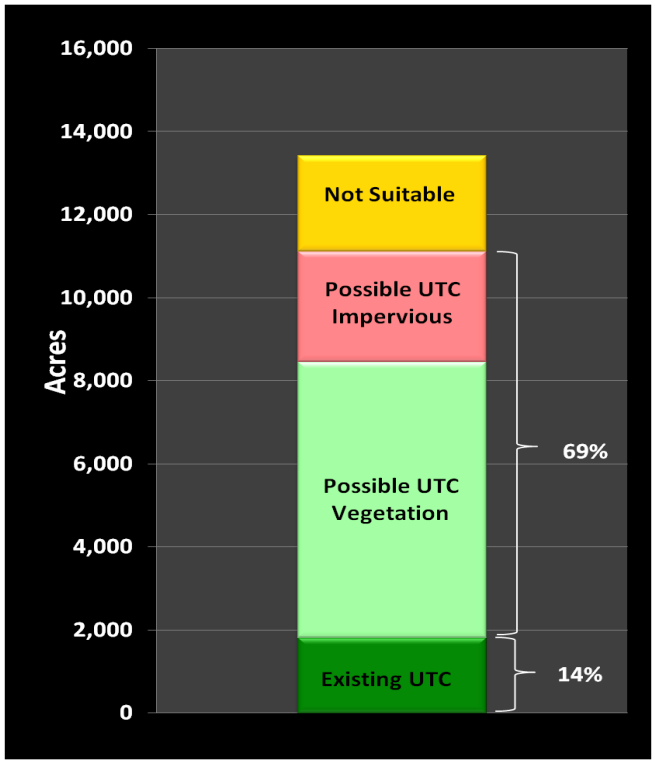

Figure 2: UTC metrics for Frederick based on % of land area covered by each UTC type.

Key Terms

UTC: Urban tree canopy (UTC) 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.
UTC Metrics: UTC summaries (see below) based on various geographies such the community boundary, neighborhoods, and parcels.
Existing UTC: The amount of urban tree canopy present when viewed from above using aerial or satellite imagery.
Impervious Possible UTC: Asphalt or concrete surfaces, excluding roads and buildings, that are theoretically available for the establishment of tree canopy.
Vegetated Possible UTC: Grass or shrub area that is theoretically available for the establishment of tree canopy.

Mapping Frederick's Trees

The original UTC assessment for Frederick, based on MD DNR's 2002 Strategic Urban Forest Assessment (SUFA) land cover dataset (Figure 3a), estimated that 12% of the city was covered by tree canopy. This updated study of Frederick's tree canopy employed higher resolution imagery (Figure 3b), a more accurate methodology for mapping land cover, and robust quality assurance and quality control plan. This resulted in a more accurate accounting of tree canopy, particularly with respect to smaller forest patches and individual trees (Figure 3c), increasing the Existing UTC estimate to 14%.

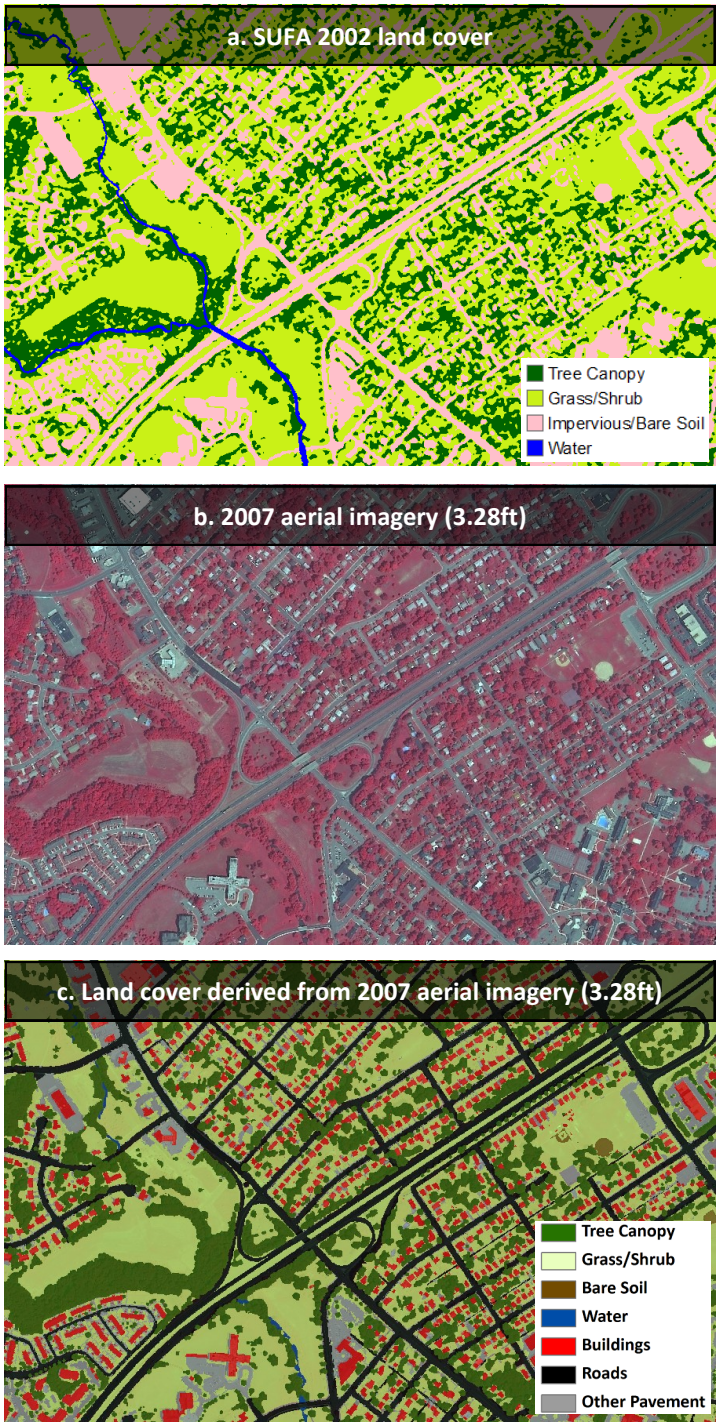

Figure 3: Comparison of SUFA 2002 to 2007 high-resolution imagery and land cover. The 2007 land cover is more accurate and includes more classes

Parcel & Land Use Summary

UTC metrics were calculated for each property in the city's parcel database (Figure 4). For each parcel the absolute area of Existing and Possible UTC was computed along with the percent of Existing UTC and Possible UTC (UTC area / area of the parcel).

A City-wide land use layer was used to summarize UTC by land use category (Figure 5). For each land use category UTC metrics were computed as a percentage of all land in the city (% Land), as a percent of land area by land use category (% Category) and as a percent of the area for the respective UTC type (% UTC Type) (Table 1). For example, land designated as "Residential—Moderate Density" has the most Existing UTC of any land use category. 4% of all land in the city is covered by tree canopy in this land use type, and 27% of all of the tree canopy in the city is in "Residential—Moderate Density" properties. As a percentage of land within the land use category it is "Parks and Public Open Space" category that is the leader, with 28% tree canopy compared to 20% for "Residential—Moderate Density."

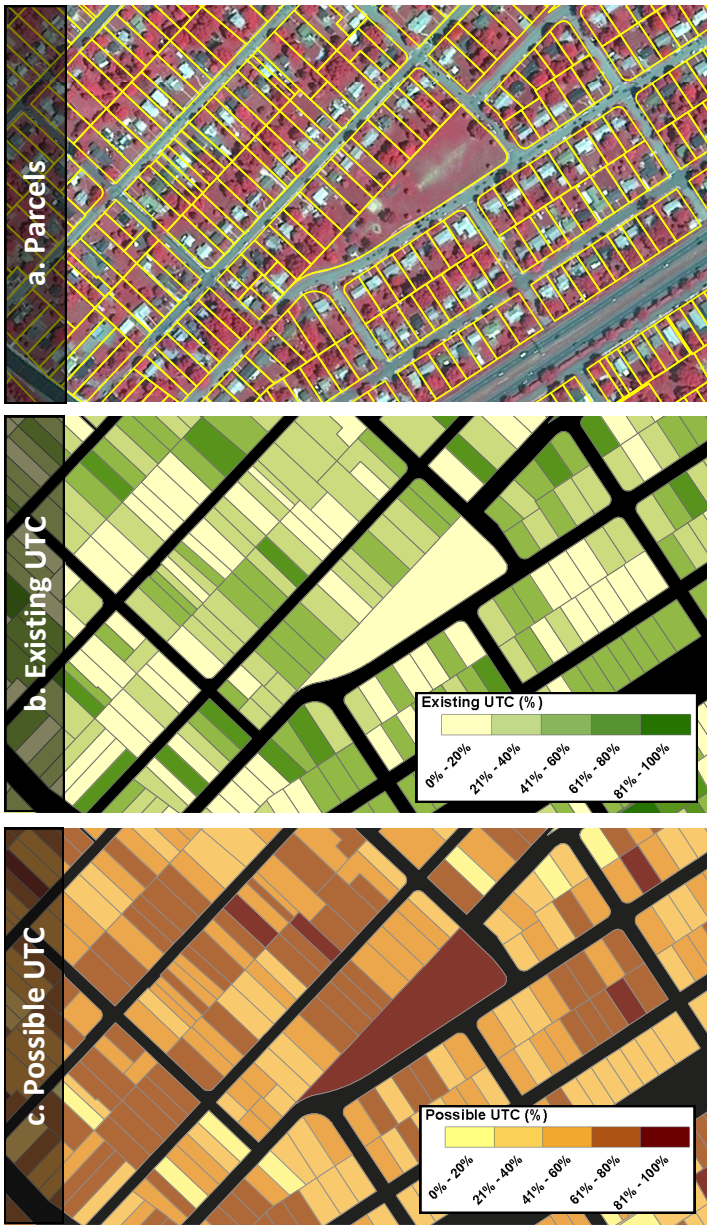

Figure 4: Parcel-based UTC metrics. UTC metrics are generated at the parcel level, allowing each property to be evaluated with respect to its Existing UTC and Possible UTC.

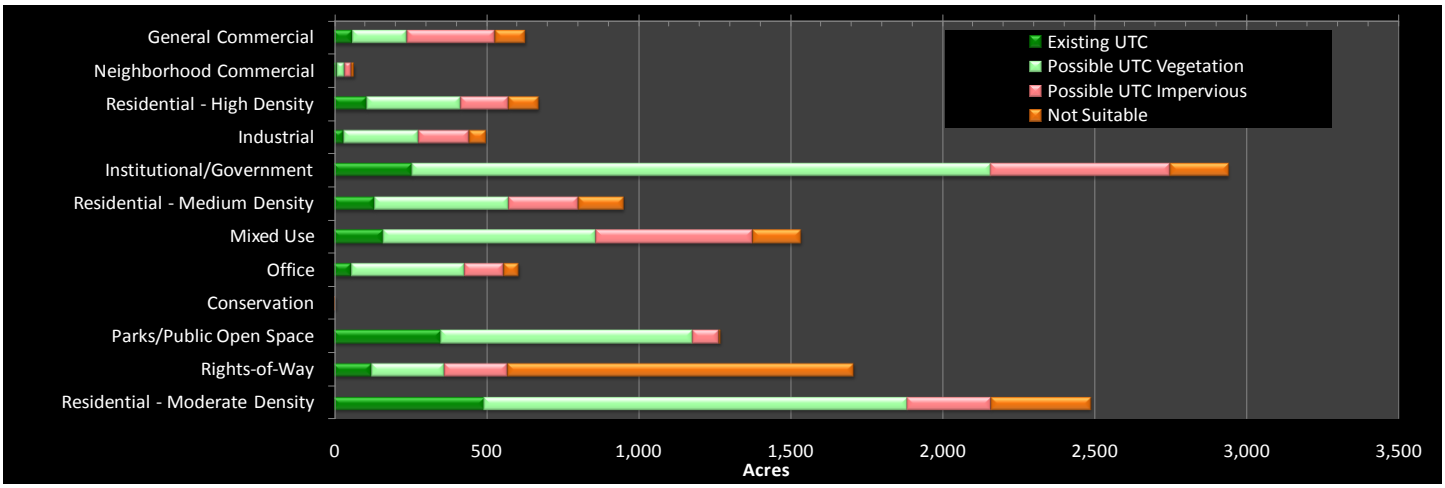

Figure 5: UTC metrics summarized by land use.

Land Use	Existing UTC			Possible UTC Vegetation			Possible UTC Impervious		
	% Land	% Category	% UTC Type	% Land	% Category	% UTC Type	% Land	% Category	% UTC Type
General Commercial	0%	10%	3%	1%	29%	3%	2%	45%	4%
Neighborhood Commercial	0%	17%	1%	0%	38%	0%	0%	33%	0%
Residential - High Density	1%	16%	6%	2%	46%	5%	1%	23%	2%
Industrial	0%	7%	2%	2%	49%	4%	1%	33%	3%
Institutional/Government	2%	9%	14%	14%	65%	29%	4%	20%	9%
Residential - Medium Density	1%	14%	8%	3%	46%	7%	2%	24%	3%
Mixed Use	1%	11%	9%	5%	45%	11%	4%	34%	8%
Office	0%	10%	3%	3%	61%	6%	1%	21%	2%
Conservation	0%	18%	0%	0%	72%	0%	0%	9%	0%
Parks/Public Open Space	3%	28%	19%	6%	65%	12%	1%	7%	1%
Rights-of-Way	1%	7%	7%	2%	14%	4%	2%	12%	3%
Residential - Moderate Density	4%	20%	27%	10%	56%	21%	2%	11%	4%

Table 1: UTC metrics by type, summarized by land use. For each land use category UTC metrics were computed as a percent of land in the city (% Land), as a percent of land area by land use category (% Category) and as a percent of the area for the UTC type (% UTC Type).

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

The % Land Area value of 4% indicates that 4% of Frederick's land area is tree canopy in areas where the land use is "Residential - Moderate Density."

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

The % Category value of 20% indicates that 20% of "Residential - Moderate Density" land is covered by tree canopy.

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

The % UTC Type value of 27% indicates that 27% of all Existing UTC lies in areas of "Residential - Moderate Density" land use.

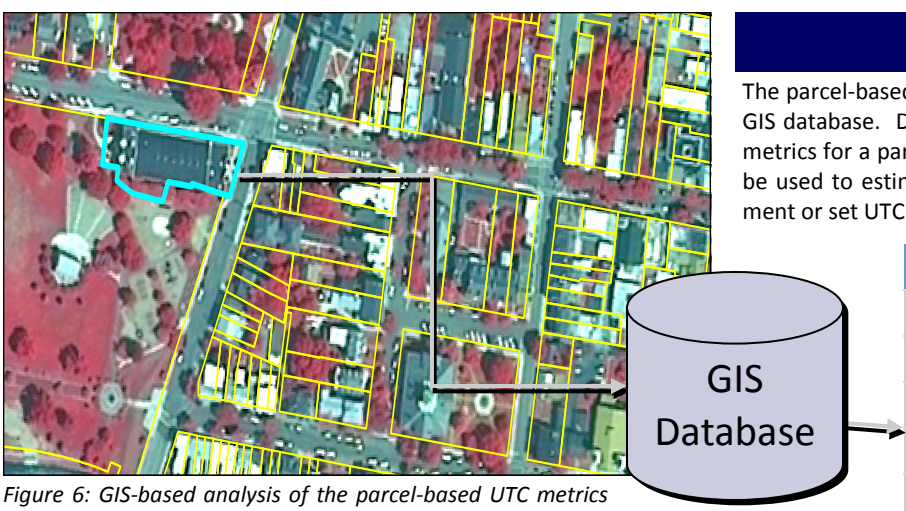

Figure 6: GIS-based analysis of the parcel-based UTC metrics for decision support. In this example GIS is used to select an individual parcel. The attributes for that parcel, including the parcel-based UTC metrics, are displayed in tabular form providing instant access to relevant information.

Decision Support

The parcel-based UTC metrics were integrated into the city's existing GIS database. Decision makers can use GIS to find out specific UTC metrics for a parcel or set of parcels (Figure 6). This information can be used to estimate the amount of tree loss in a planned development or set UTC improvement goals for an individual property.

Attribute	Value
Address	121 North Bentz Street
Land Use	Parks/Public Open Space
NAC	9
Existing UTC	8%
Possible UTC	25%
Possible UTC—Vegetation	9%
Possible UTC—Impervious	16%

Fort Detrick and City Airport Exclusion Analysis

The potential for establishing tree canopy within Fort Detrick and the airport is limited by the activities inherent to those areas. The UTC metrics for the city , with Fort Detrick and the airport excluded, were recalculated in order to gain a more practical picture of the current tree canopy and planting opportunities. As the excluded areas have relatively few trees, Existing UTC for the city increased by one percentage point in the (Figure 8). With these open lands removed from consideration as available planting areas, the Possible UTC for the city as a whole decreased by two percentage points to 67%. The prominent role of the "industrial/government" land in the UTC metrics (Figure 5) is substantially decreased (Figure 9). This revised analysis emphasizes the significance of the city's residents, particularly those in the "residential-moderate density" land use category, in controlling the city's tree canopy (Figure 9).

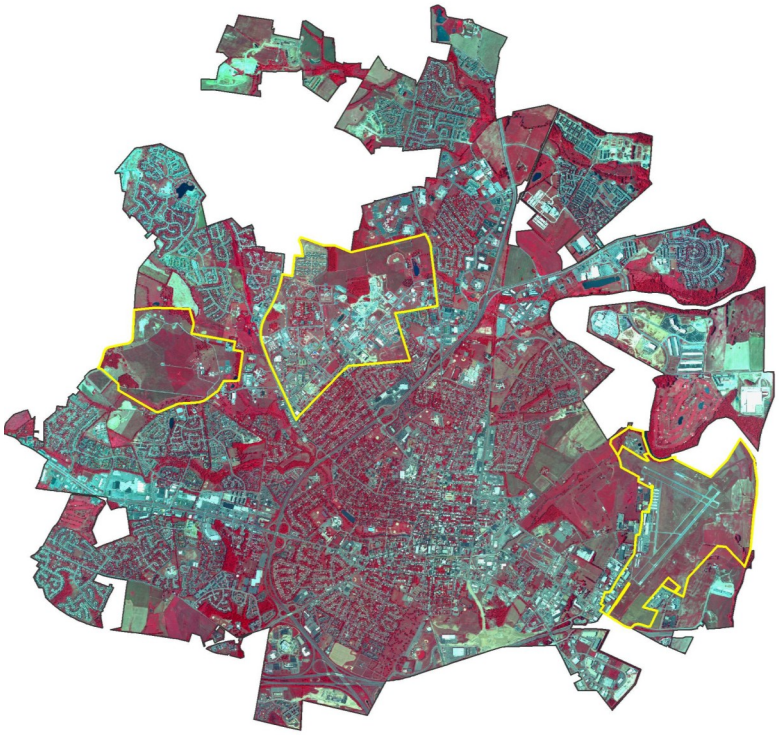

Figure 7: City of Frederick with Fort Detrick and the airport delineated.

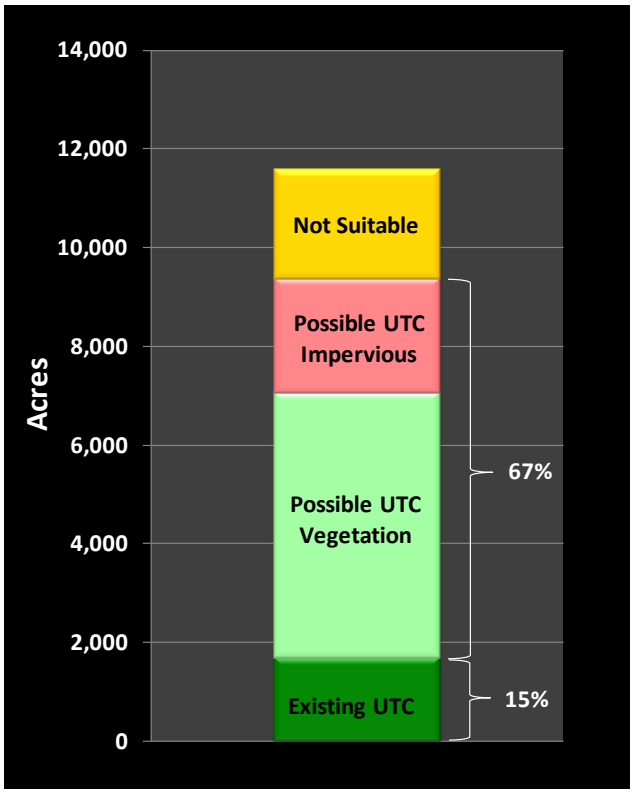

Figure 8: UTC metrics for Frederick with Fort Detrick and the City Airport excluded from analysis.

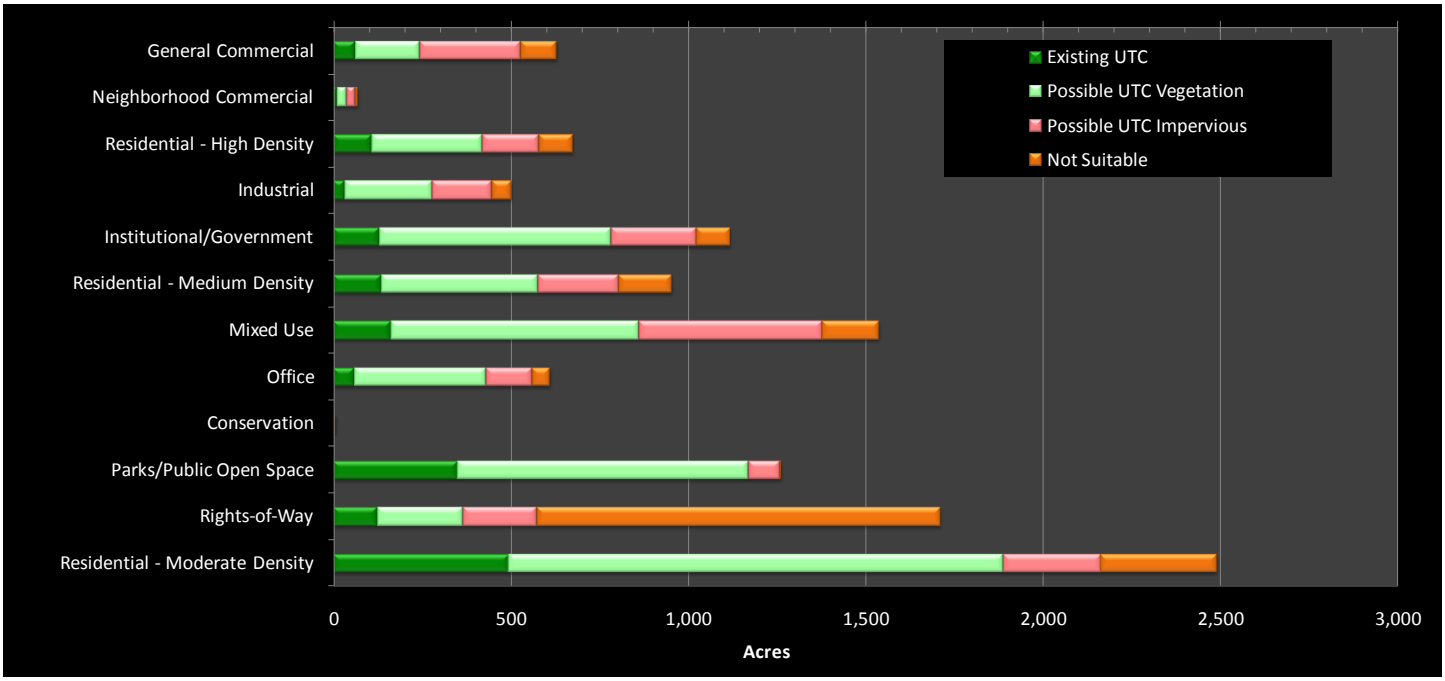

Figure 9: UTC metrics for city with Fort Detrick and City Airport excluded, summarized by land use.

Neighborhood Advisory Councils

To better understand the distribution of tree canopy within the city, UTC metrics were generated for the twelve Neighborhood Advisory Councils (NAC). Land use and zoning clearly influence Existing UTC and Possible UTC metrics for the NACs. NACs 6 and 9, both heavily residential areas, have Existing UTC in excess of 20%, clearly above the city average. These two NACs also have the least room to plant trees in the city, with Possible UTC values under 60%. NACs 1, 2, and 3 have a high percentage of land managed by the government and institutions. As institutional and government land in Frederick contains below average tree canopy, these NACs have the lowest Existing UTC values in the city. NACs 1, 2, and 12 have the highest Possible UTC percentages, but as it will not be desirable or feasible to plant trees on playing fields and on grassy areas in and around the airfield, these values are not indicative of planting opportunities. NAC 10 has a relatively low percentage of Existing UTC, on par with NACs 1, 2, and 12, but due to the amount of land occupied by buildings and roads it does not have a corresponding high Possible UTC percentage.

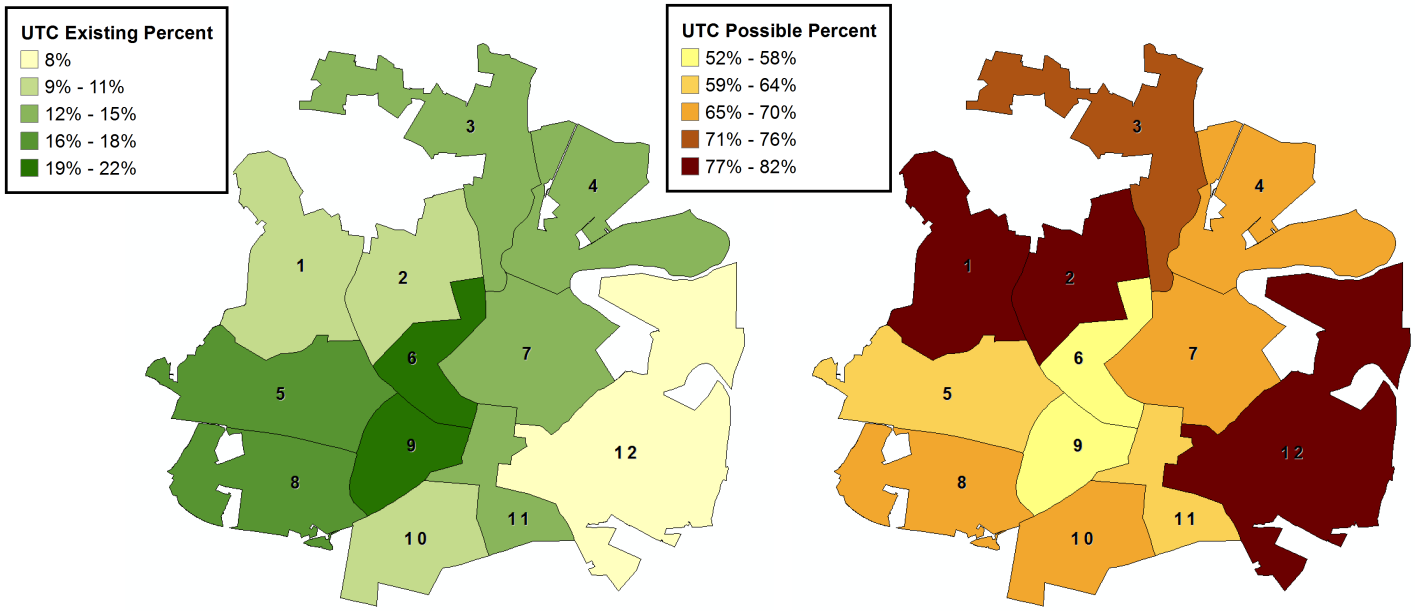

Figure 10: Existing UTC and Possible UTC for the nine NACs.

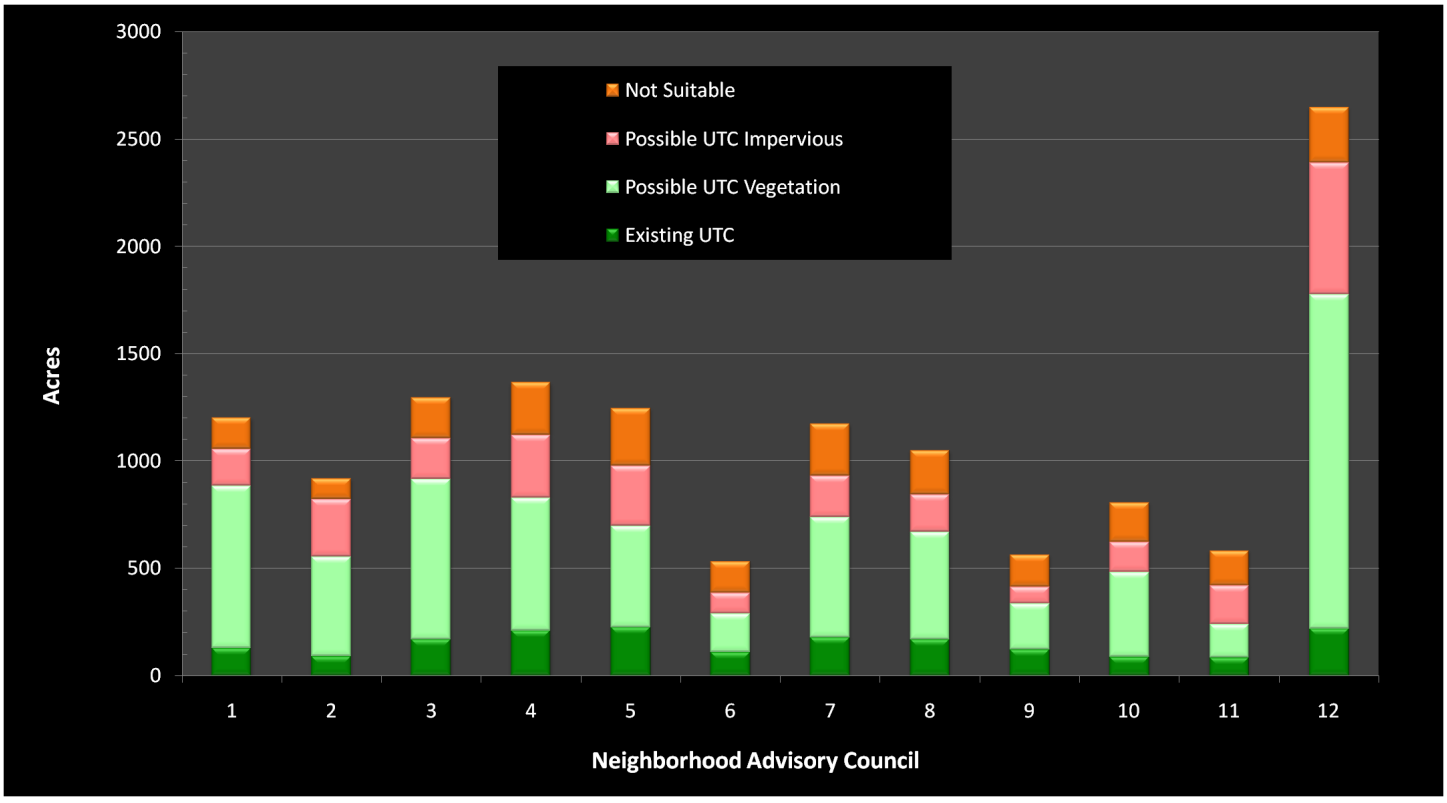

Figure 11: UTC metrics for the NACs.

Conclusions

- Frederick's urban tree canopy is a vital city asset; reducing stormwater runoff, improving air quality, reducing the city's carbon footprint, enhancing quality of life, contributing to savings on energy bills, and serving as habitat for wildlife.
- This study represents the most accurate accounting of Frederick's tree canopy to date, and indicates that 14% of the city is covered by tree canopy as of 2007. Differences to the 12% estimate presented in the previous study, based on 2002 data, are most likely the result of differences in accuracy and should not be interpreted that tree canopy has increased 2%.
- Frederick should continue working toward its UTC goal. This goal should not be limited to increasing the city's overall tree canopy, it should focus on increasing tree canopy in those parcels or blocks that have the least Existing UTC and highest Possible UTC.
- With Existing UTC and Possible UTC summarized at the parcel level and integrated with the City's GIS database, individual parcels and subdivisions can be examined and targeted for UTC improvement.
- Of particular focus for UTC improvement should be parcels within the city that have large contiguous impervious surfaces, such as those in the various commercial and industrial land use categories that have disproportionally low amounts of tree canopy. These parcels contribute high amounts of runoff, degrading water quality. The establishment of tree canopy on these parcels will help to reduce runoff during periods of peak overland flow. Incentive or regulatory measures could be employed to encourage property owners to increase tree canopy on these parcels.
- By ownership type, it is Frederick's residents that control the largest percentage of the city's tree canopy (Fort Detrick and the airport excluded). Programs that educate residents on tree stewardship and incentives provided to residents that plant trees are crucial if Frederick is going to sustain its tree canopy in the long term.
- Increases in UTC will be most easily achieved on government and institutional lands. These land uses have a relatively high percentage of Possible UTC and these are lands where the City can most readily implement policy.
- Existing tree canopy is relatively low in transportation rights-of-way (1%). A "street trees" initiative could be employed to increase tree canopy in the ROW.
- Neighborhood- and zoning-level summaries could be used for targeting tree planting and preservation efforts within different regions of the City.

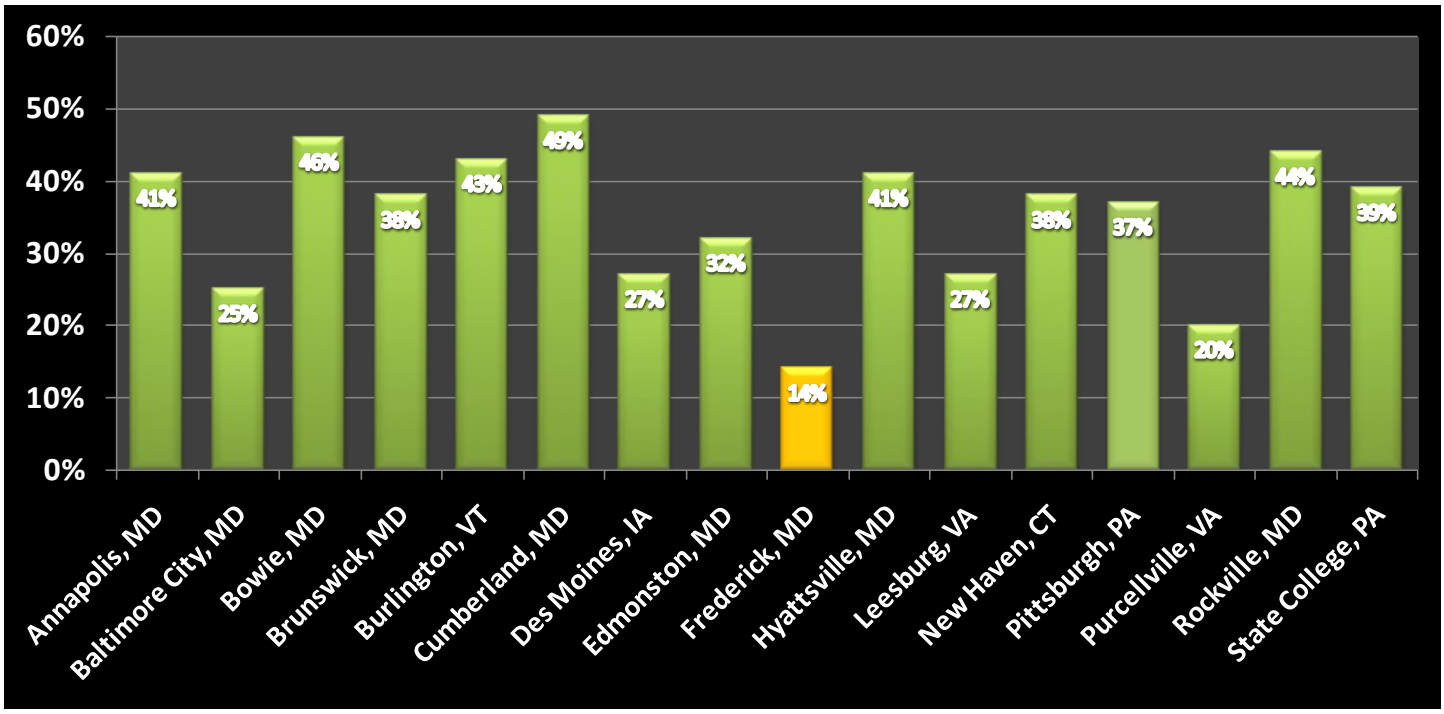

Figure 12: Comparison of Existing UTC with other selected cities that have completed UTC assessments.

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Additional Information

The study was conducted with funding from the City of Frederick and USDA Forest Service. More information on the UTC assessment project can be found at the following web site: **http://nrs.fs.fed.us/urban/utc/**