

# Heat Vulnerability in DC from an Equity Perspective:

*Block and Parcel Level Strategies  
for Dealing with Urban Heat Islands*



**Ilgi Toprak**

5-12-2023  
GEOGRAPHIC INFORMATION SYSTEMS

## INTRODUCTION

This report presents an urban equity analysis aimed at addressing the needs of communities of color and communities with higher health risks that are disproportionately affected by the escalating heat associated with climate change in Washington, DC. The impact of climate change, particularly the intensifying heat waves, poses significant challenges to the well-being and resilience of vulnerable populations. In response, this study proposes a strategic implementation plan at the block and parcel level to mitigate the adverse effects of heat and foster more significant equity within the city. By examining the intersection of climate change, urban planning, and social justice, this analysis provides actionable recommendations to enhance the capacity and overall quality of life for marginalized communities in Washington, DC.

The report builds on previous work by the DOEE [1] at the census tract level to understand disparities and challenges faced by communities of color and those with higher health risks. By focusing on the block and parcel-level urban planning, the study aims to provide insights into heat vulnerability and its solutions on a more granular level. It provides detailed insights into specific neighborhoods with higher heat vulnerability: Takoma, Brightwood, and Anacostia. It utilizes diverse data sources, employs quantitative and qualitative methods, including spatial analysis and community engagement, and proposes innovative design interventions tailored to these neighborhoods' needs. The report intends to provide a holistic framework for mitigating heat-related risks and promoting equity in Washington, DC.

## HYPOTHESIS

By implementing granular parcel-level solutions to address heat vulnerability in areas previously identified as heat islands at the census tract level, it is hypothesized that targeted interventions at a smaller spatial scale will result in more effective and equitable mitigation of heat-related risks for vulnerable communities in Washington, DC.

## BACKGROUND

Equitable heat mitigation planning is crucial because lower-income individuals are disproportionately impacted by heat. Prioritizing fairness in planning efforts ensures that vulnerable communities have equal access to effective heat mitigation strategies [2].

The Department of Energy and Environment (DOEE) in Washington, DC, conducted a census tract level analysis as part of the Climate Ready Project in May 2022 [1], focusing on heat sensitivity and exposure. The study incorporated various factors to assess heat sensitivity, including the presence of people of color, elderly population, child population, low-income population, disabled population, population with limited English proficiency, population with asthma, population with obesity, and population with coronary heart disease. In addition to sensitivity factors, the study considered exposure factors such as ambient air temperature, impervious surface cover, and urban tree canopy cover. By integrating these factors into their model, DOEE created heat sensitivity and exposure maps to better understand the vulnerabilities and risk levels faced by different communities in relation to heat-related challenges in Washington, DC. This report uses the Heat Sensitivity & Exposure Index that DOEE assessed for census tracts.

## DATA SOURCES

HSEI data [3], tree canopy block level and parcel level maps [4], cooling centers placement [5] are available on the Open Data DC website. The zoning map and zoning regulations are available online at Official Zoning Map Website [6]. Elderly, disabled population [3] housing occupancy census tracts maps [7] are also available at Open Data DC.

## METHODS

The methodology employed for the spatial analysis in this study aimed to identify vulnerable areas where people are more exposed or sensitive to heat in Washington, DC. The first step involved defining a buffer zone around the current cooling centers, with a walking distance limit of 7-8 minutes. This buffer zone was established to identify areas where vulnerable populations could easily access existing cooling facilities. Next, the analysis focused on areas that were not served by cooling centers. In these areas, the methodology aimed to determine the locations that were most exposed to heat or had a higher population vulnerability to heat-related risks. Factors such as ambient air temperature, impervious surface cover, and demographic indicators from the DOEE's heat sensitivity and exposure model were considered.

For the block (Fig 1) /parcel level analysis of tree canopy, impervious surface cover, and zoning/land use, a multi-step approach will be undertaken.

- Finding the most heat-vulnerable areas with spatial analysis: The first step

involves identifying areas throughout Washington, DC, where cooling centers or tree canopy is not serving the most heat-vulnerable areas. By targeting these locations, the aim is to improve access to cooling resources and enhance the urban green infrastructure in the next phase, in a more granular level. The study uses Heat Sensitivity& Exposure Index (HSEI) in three different forms as mentioned above according to the study provided by the DOEE.

- Neighborhood Level Design and Policy Implementations: Within specific neighborhoods, the focus will shift towards neighborhood-level design implementations. Utilizing the zoning map, block and parcel level strategies will be proposed to implement tree plantation, heat-reducing surfaces, or additional transportation to cooling centers. This includes identifying suitable locations for green roofs and maximizing tree planting to enhance shade and reduce heat island effects.

By analyzing the existing zoning and land use patterns at the block and parcel level, the study will identify opportunities for incorporating heat-reducing features into the urban fabric and using the cooling centers more efficiently. This may involve recommending policy changes or incentives to encourage the adoption of green infrastructure.

## ANALYSES

- **Finding the most heat-vulnerable areas with spatial analysis:**

To determine the most vulnerable areas within Washington, DC, a merged map was created by overlaying the Heat Sensitivity and Exposure Index (HSEI) 1-2-3 maps (Fig 2,3,4,5). The analysis specifically focused on residential areas, identified by zoning codes starting with "R." Additionally, the size of the areas was considered to ensure feasibility for implementing solutions. After applying these criteria, five areas emerged as meeting the requirements: Queens Chapel/Michigan Park, Carver/Langston, Mayfair, Skyland, and Washington Highlands.

In order to further inform recommendations, additional factors were examined within these identified areas. Specifically, the analysis considered the disability and elderly population (Fig 6,7), as well as the distribution of housing occupation between renters and owners (Fig 7-8). These indicators provide valuable insights into the specific vulnerabilities and needs of these communities.

- **Neighborhood Level Design and Policy Recommendations:**
  - a. **Queens Chapel/Michigan Park:**

Within the Queens Chapel/Michigan Park area (Fig 10-11), which primarily consists of R2 zoning and semi-detached dwellings, a significant portion of the properties are owner-occupied. In these residential areas, there is a potential for encouraging tree planting by homeowners, particularly in the identified planting areas with darker green on the map. This initiative can contribute to increased tree canopy cover and provide shade, which helps mitigate heat-related challenges and enhance the overall resilience of the neighborhood.

In the southern part of the area, specifically Michigan Park, a notable presence of the elderly population is observed. To address their specific needs during periods of extreme heat, it is recommended to establish additional bus services operating on an hourly basis to nearby cooling centers. This transportation provision can ensure that the elderly population has accessible and convenient means to reach the cooling centers, providing them with a safe and comfortable environment during heatwaves.

**b. Carver/Langston:**

In the Carver/Langston area (Fig 12-13), the zoning primarily consists of RF-1 (row houses) in Carver and RA-2 (moderate-density apartment/condos) in Langston. Given the characteristics of the Langston area, there is a significant potential to create more shaded areas by planting mature trees in the locations identified as dark green in the possible planting area map. The presence of shaded areas contributes to mitigating the heat island effect and improving the overall comfort and livability of the neighborhood.

Langston area is predominantly renter-occupied. It is recommended to encourage the management of condominiums and apartments to undertake tree planting initiatives. Collaboration between the government and the condo management can provide necessary support, such as technical expertise and financial assistance if needed, to facilitate the implementation of tree planting projects.

**c. Mayfair:**

Mayfair (Fig 14-15), consisting of RA-1 low-rise apartments, provides an opportunity for tree planting in the available yard spaces. Encouraging condo management to undertake tree plantation initiatives can increase tree canopy cover and enhance the neighborhood's greenery. Given the presence of a moderate number of disabled individuals in the area, it is recommended to establish additional transportation options

to nearby cooling centers. These measures aim to improve the overall resilience and inclusivity of Mayfair, mitigating heat-related risks and enhancing the well-being of residents.

**d. Skyland:**

Skyland (Fig 16-17), a mix of R3 row houses and RA-1 low-density apartments, offers opportunities for tree planting initiatives. Encouraging condo managements to plant grown trees can enhance the greenery and tree canopy cover. Given the significant population of disabled individuals, additional transportation options are recommended to ensure their access to nearby cooling centers. These measures contribute to a more resilient and inclusive community in Skyland, mitigating heat-related risks and prioritizing the well-being of residents.

**e. Washington Highlands:**

Washington Highlands (Fig 18-19), consisting of R2 semi-detached and R3 row houses, offers opportunities for tree planting initiatives. Owners are encouraged to plant trees to increase tree canopy cover. Additionally, the area has a high number of people with asthma. Implementing cooling and air purifying systems can help provide relief for asthma patients. These measures contribute to a more resilient and healthier neighborhood in Washington Highlands.

## **CONCLUSION**

In conclusion, this report presents an urban equity analysis focused on addressing the heat-related challenges faced by vulnerable communities in Washington, DC. By implementing granular parcel-level solutions and considering the specific needs of communities of color and those with higher health risks, this study aims to promote resilience and equity within the city. The analysis identifies five vulnerable areas: Queens Chapel/Michigan Park, Carver/Langston, Mayfair, Skyland, and Washington Highlands. For each area, tailored recommendations are provided, such as encouraging tree planting by homeowners, establishing additional transportation options for the elderly and disabled populations, and implementing cooling and air purifying systems in areas with high asthma prevalence. By integrating urban planning, social justice, and climate change considerations, this report offers actionable strategies to improve the well-being and adaptive capacity of marginalized communities in Washington, DC.

## REFERENCES

- [1] Cadmus, May 2022, HEAT SENSITIVITY-EXPOSURE INDEX METHODOLOGY REPORT, CLIMATE READY DC.  
[https://doee.dc.gov/sites/default/files/dc/sites/ddoe/service\\_content/attachments/Methodology%20Report\\_Update%2005.11.22web\\_0.pdf](https://doee.dc.gov/sites/default/files/dc/sites/ddoe/service_content/attachments/Methodology%20Report_Update%2005.11.22web_0.pdf)
- [2] Marx, R & Morales-Burnett, J. (2022). Centering Equity to Address Extreme Heat Preparing Communities for Hotter Days, Urban Institute report.  
[https://www.urban.org/sites/default/files/2022-02/centering-equity-to-address-extreme-heat\\_1.pdf](https://www.urban.org/sites/default/files/2022-02/centering-equity-to-address-extreme-heat_1.pdf)
- [3] Open Data DC, HSEI Data  
<https://opendata.dc.gov/datasets/DCGIS::heat-sensitivity-exposure-index/explore>
- [4] Open Data DC, Urban Tree Canopy at Parcel Level in 2020  
<https://opendata.dc.gov/datasets/urban-tree-canopy-at-parcel-level-in-2020/explore>
- [5] Open Data Dc, Cooling Centers - District of Columbia  
[https://opendata.dc.gov/datasets/bd51c0c373d844fa9654a7a02da23d6f\\_0/explore](https://opendata.dc.gov/datasets/bd51c0c373d844fa9654a7a02da23d6f_0/explore)
- [6 ] DC Summary of Zone Districts - ZR58,  
<https://dcocz.dc.gov/page/summary-zone-districts-zr58>
- [7 ] ACS Housing Characteristics DC  
<https://opendata.dc.gov/datasets/DCGIS::acs-housing-characteristics-dc-census-tract/about>

## MAPS

Fig 1- Percentage of Tree Canopy on Block Level

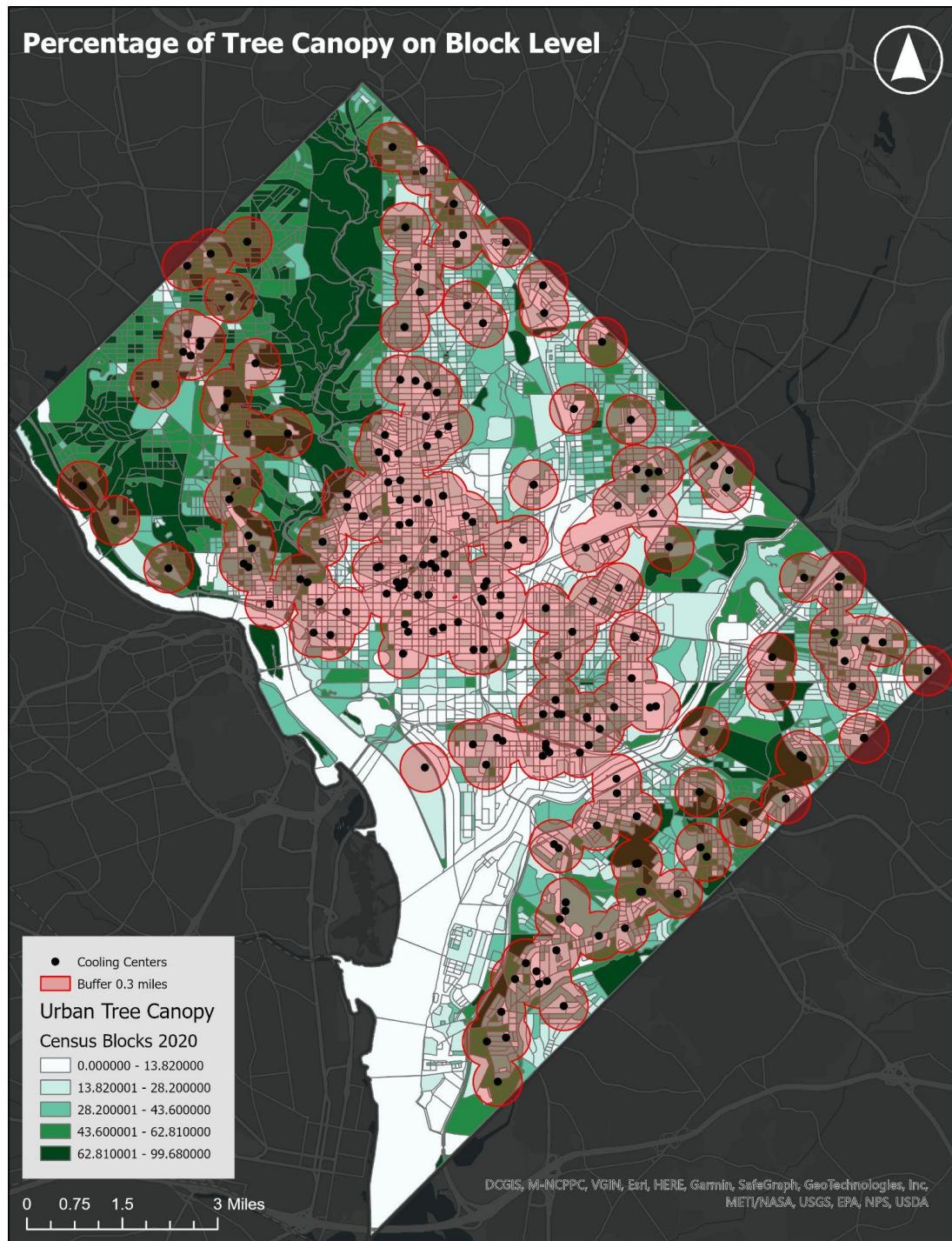


Fig 2- Most Heat- Vulnerable areas According to HSEI1

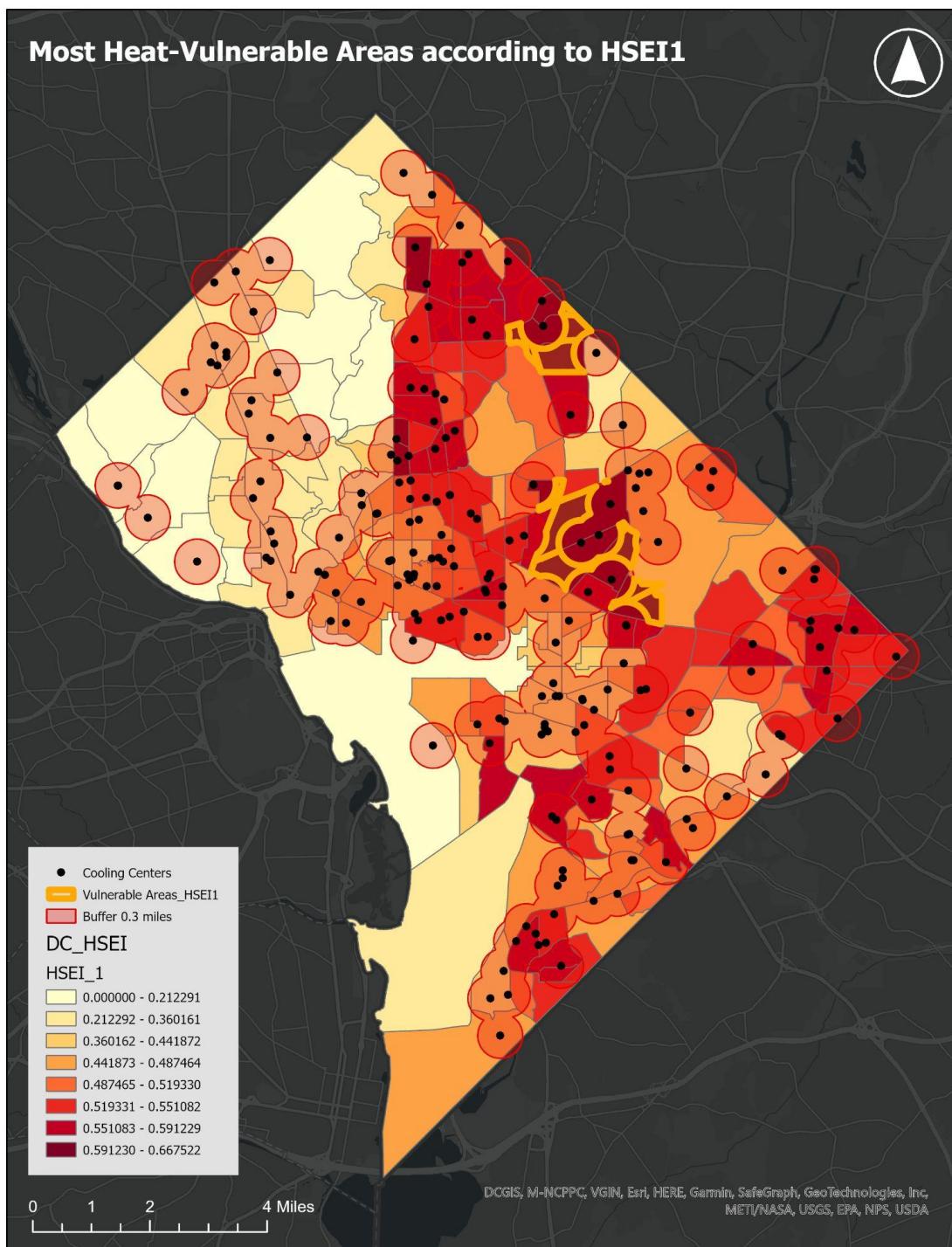


Fig 3 - Most Heat- Vulnerable areas According to HSEI2

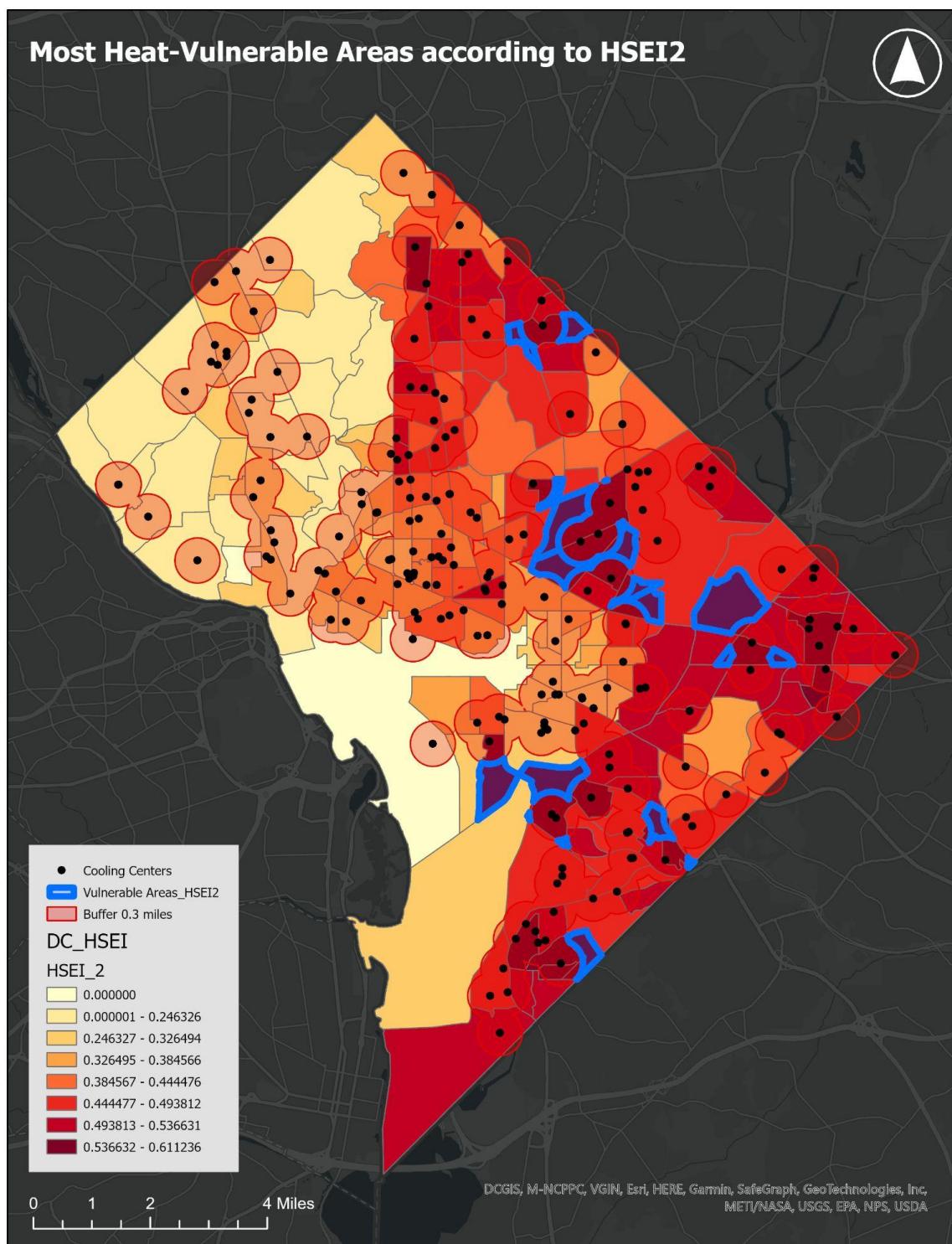


Fig 4- Most Heat- Vulnerable areas According to HSEI3

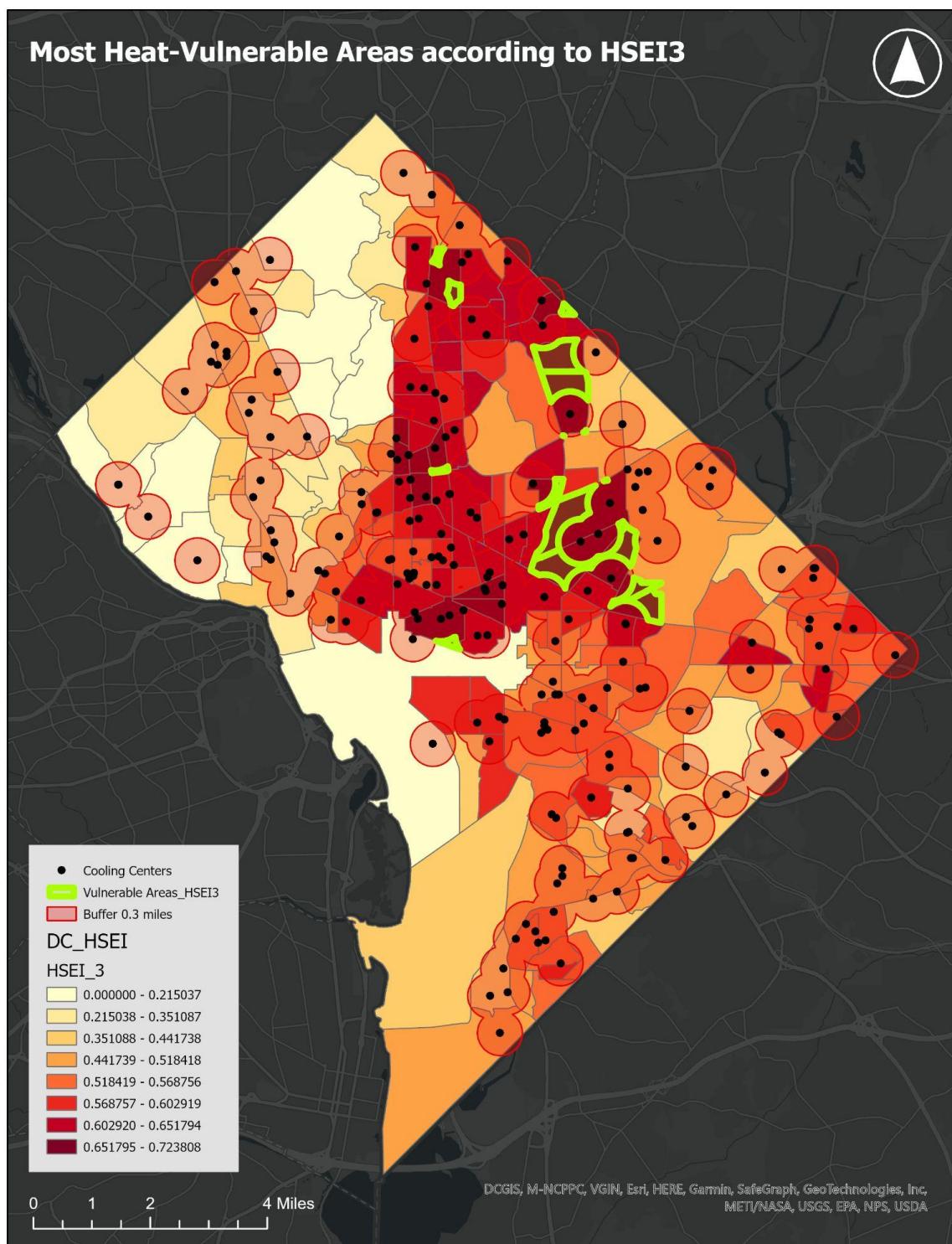


Fig 5- Most Heat- Vulnerable areas - Merged

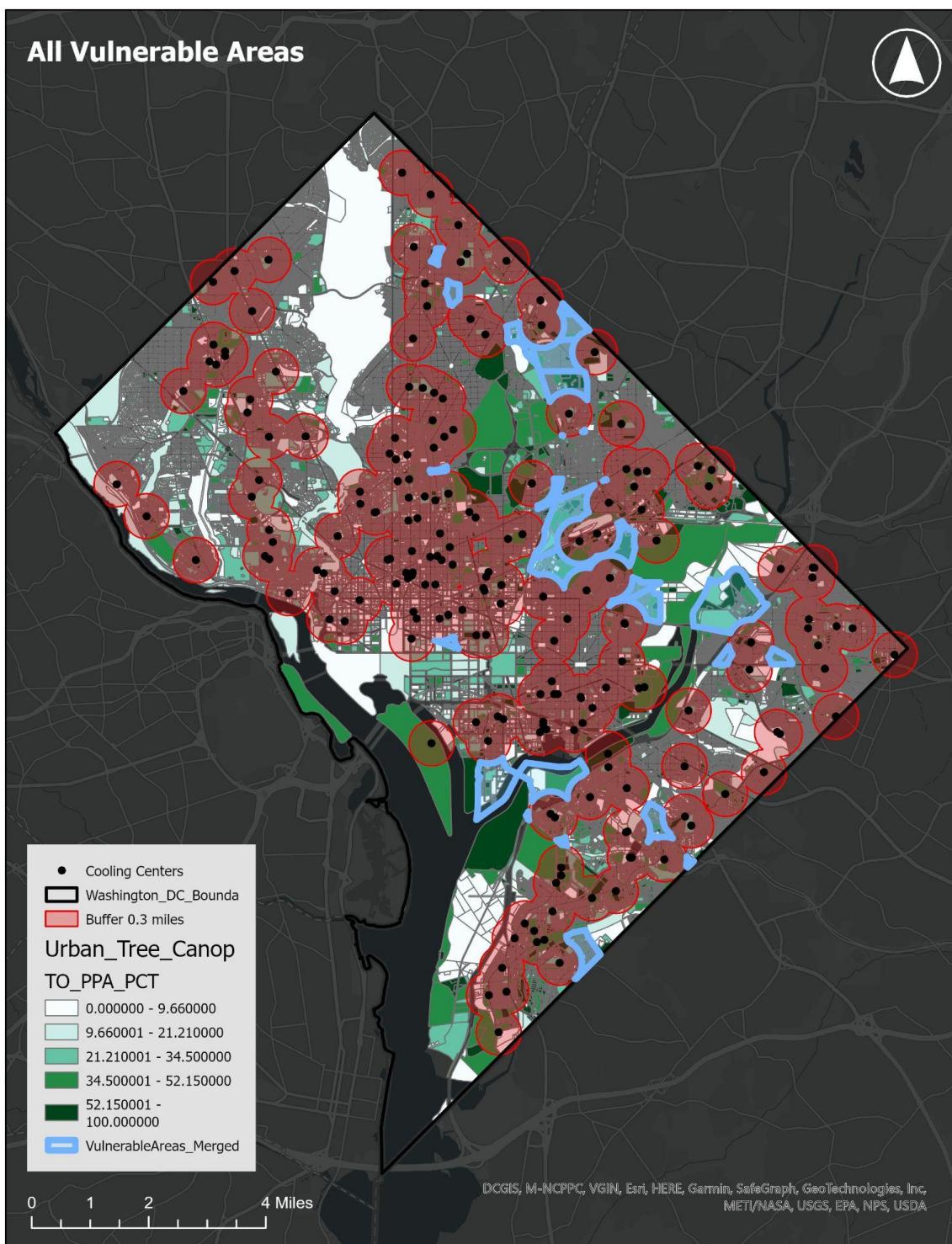


Fig 6 - Disabled Population with Vulnerable Areas

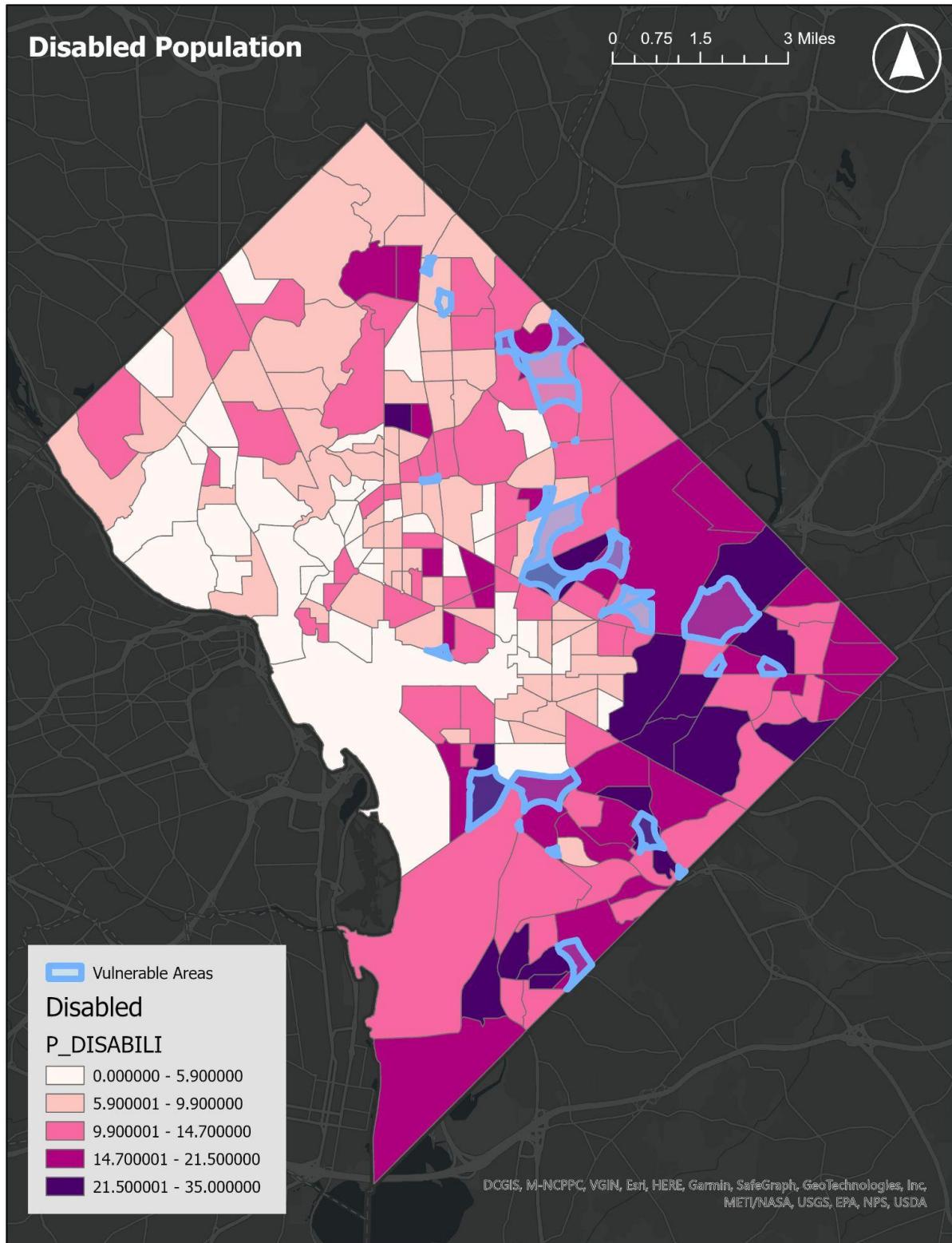


Fig 7 - Elderly Population with Vulnerable Areas

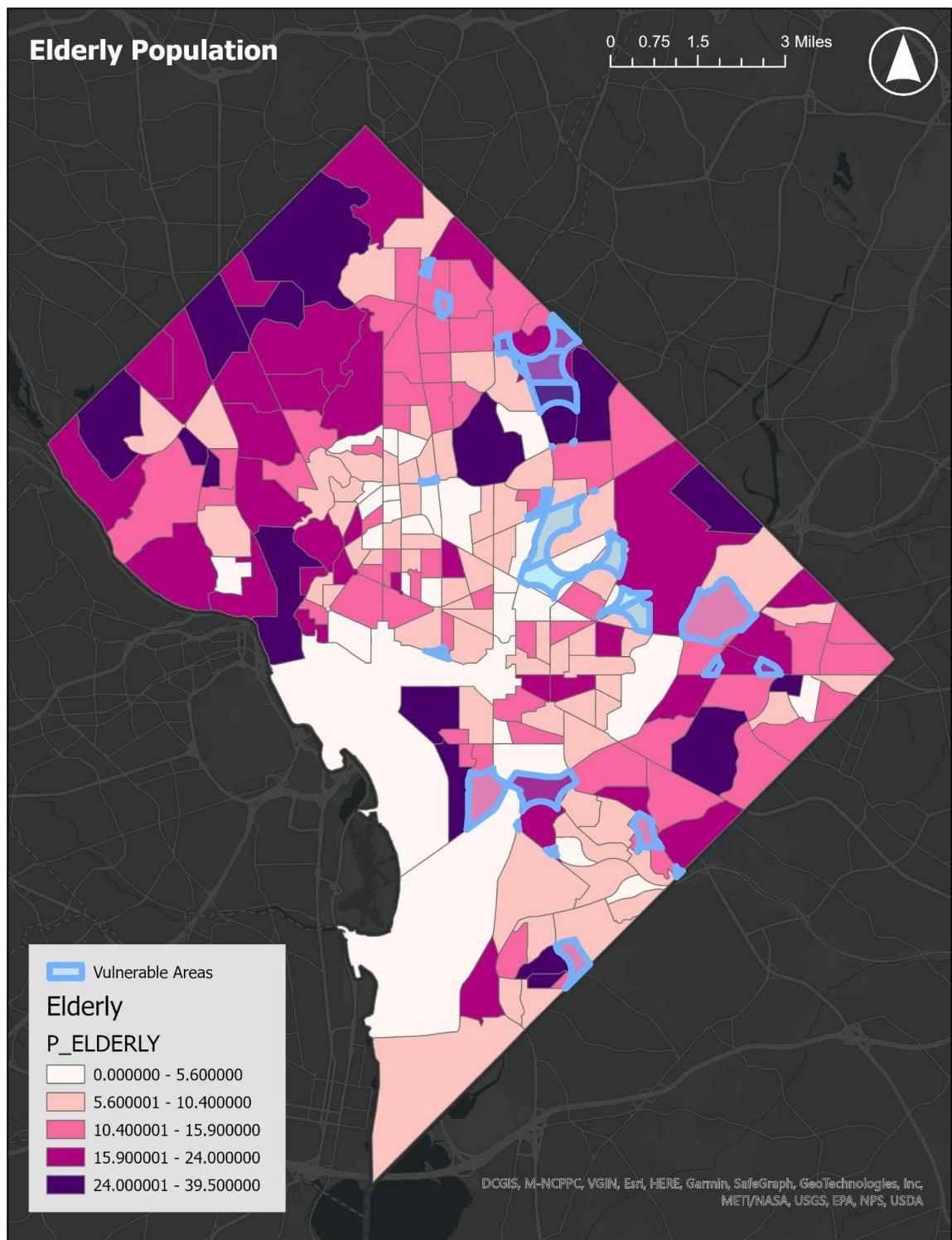


Fig 8 - Renter Occupied Housing in Vulnerable Areas

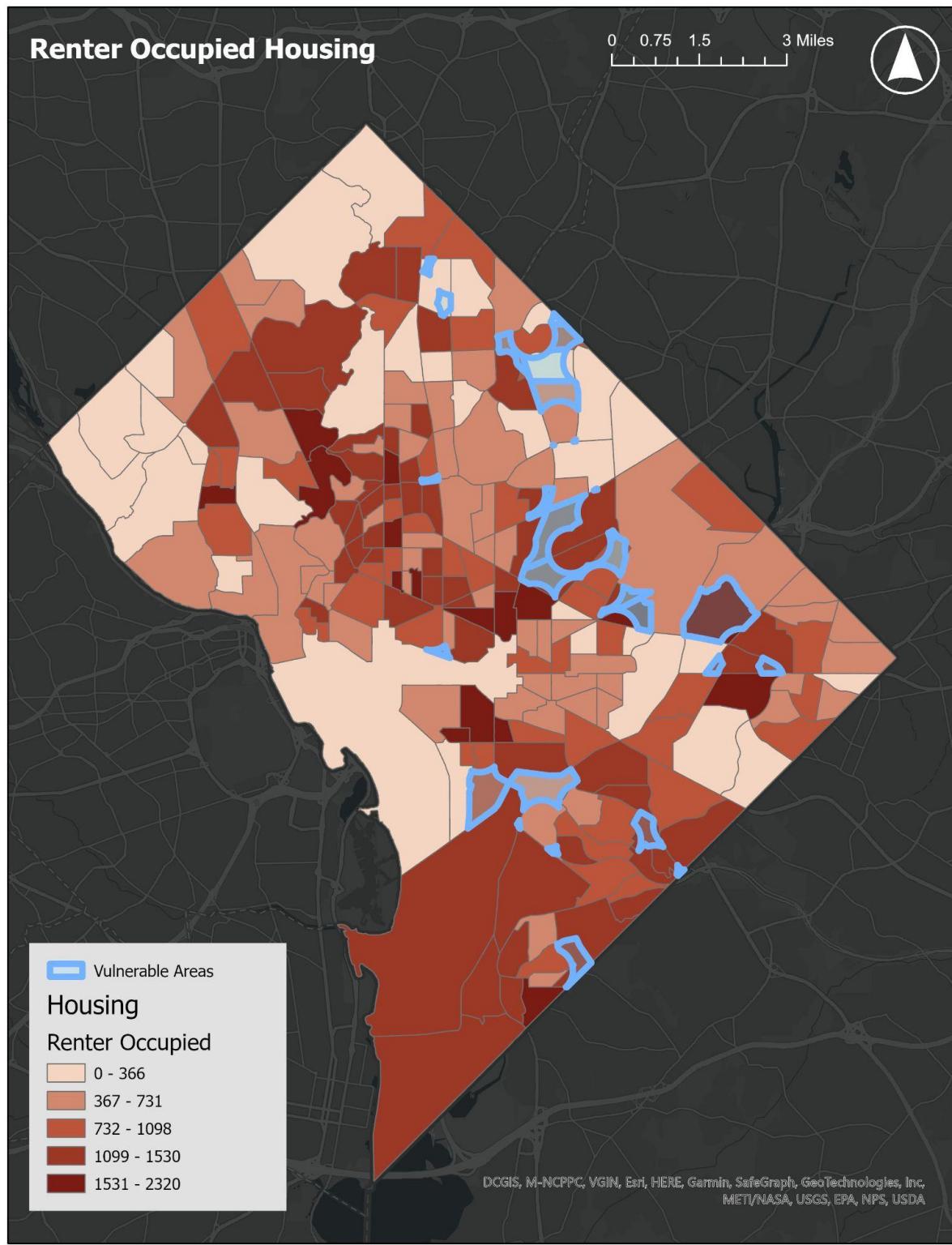


Fig 9 - Owner occupied Housing in Vulnerable Areas

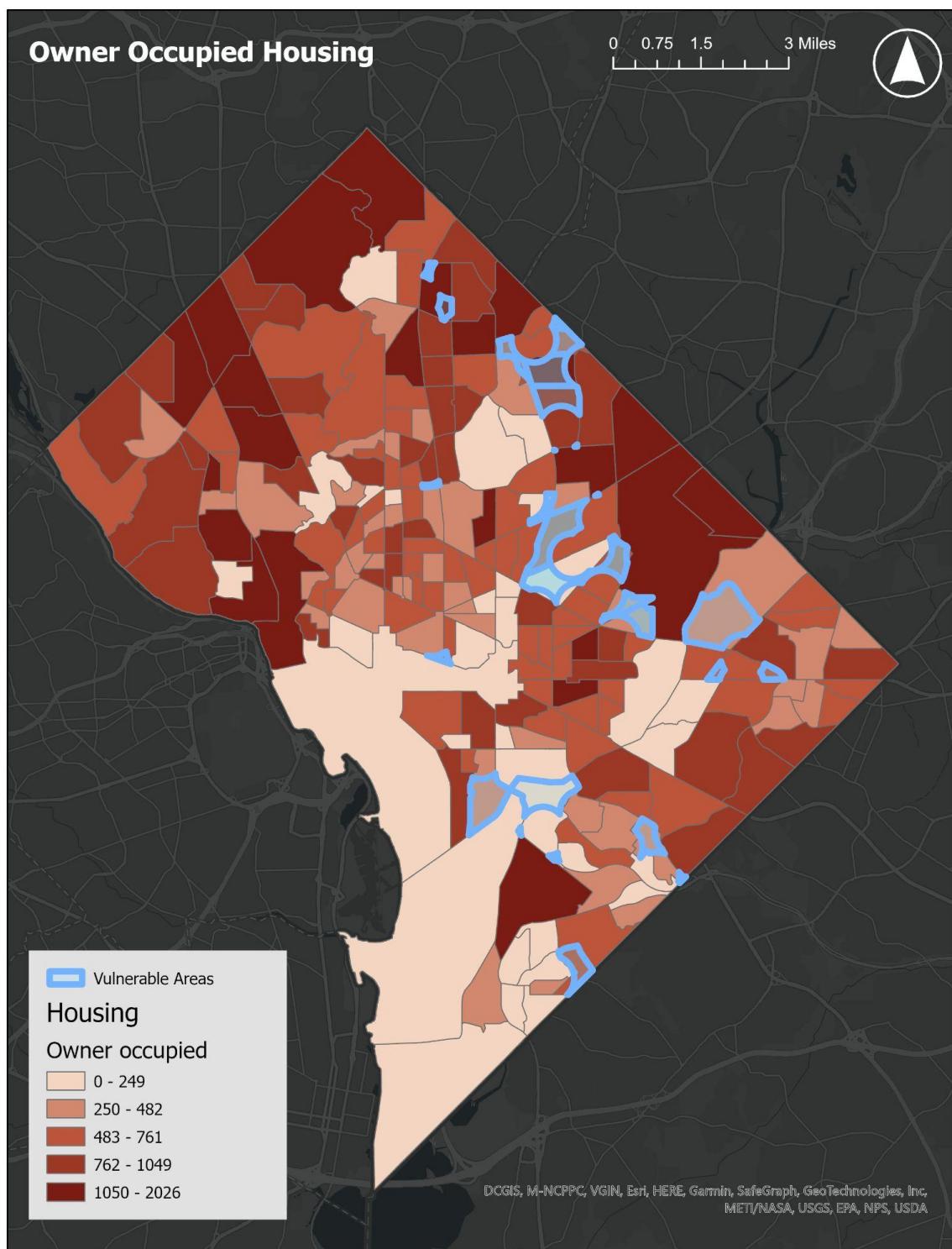


Fig 10 - Queens Chapel/Michigan Park Zoning and Satellite Image

## Queens Chapel - Michigan Park

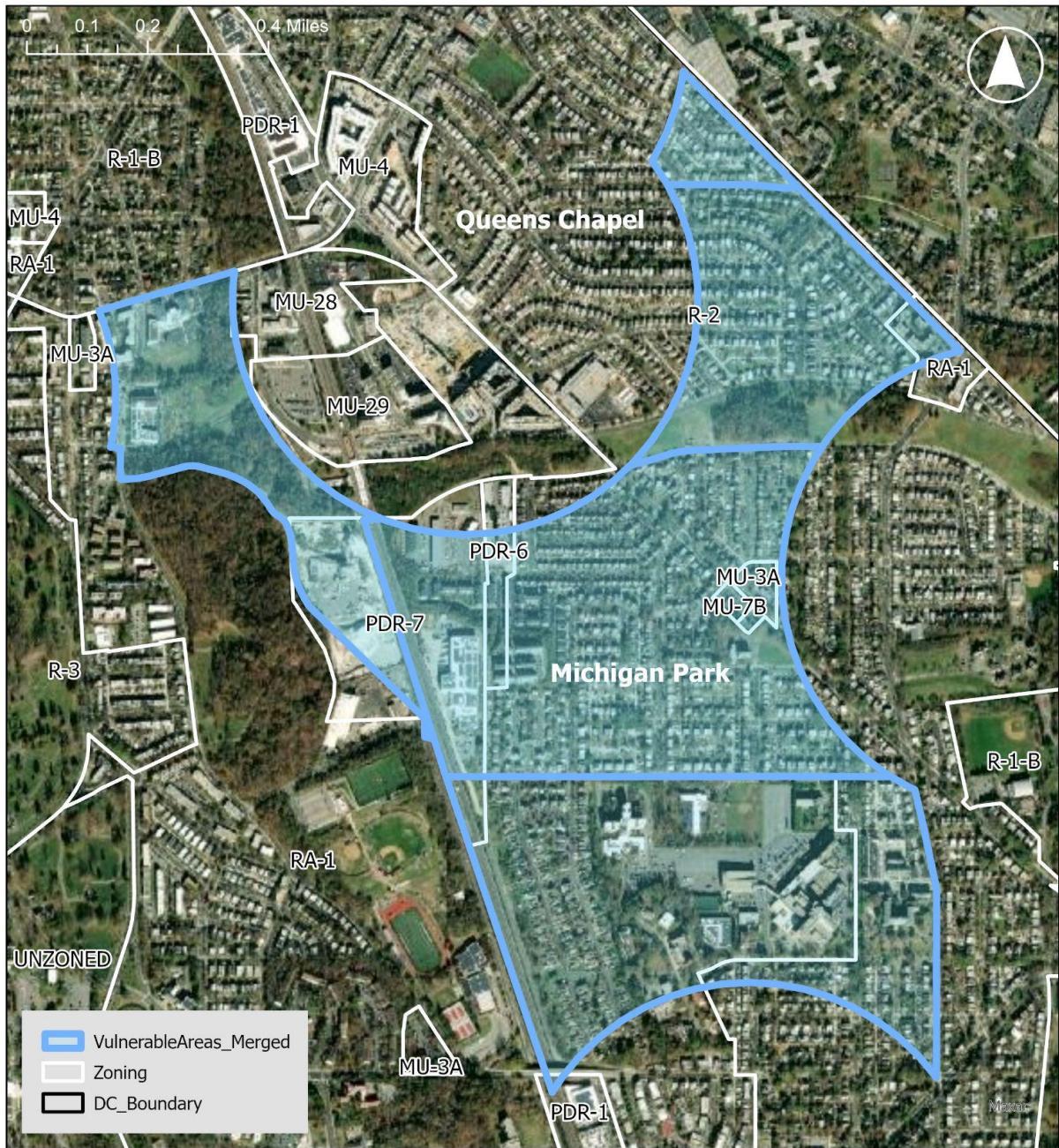


Fig 11 - Queens Chapel/Michigan Park Possible Planting Areas

## Queens Chapel - Michigan Park

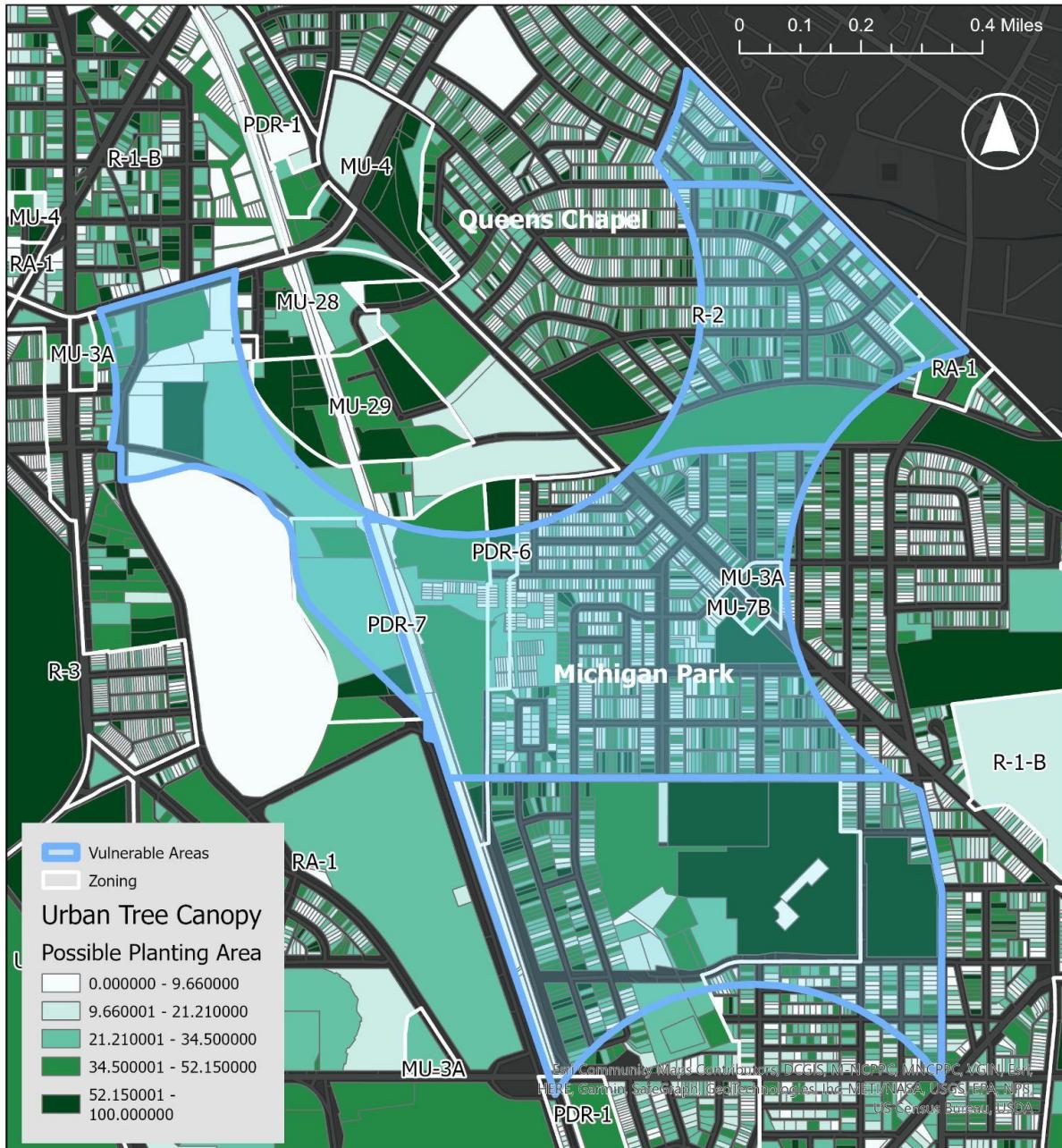


Fig 12 - Carver/Langston Zoning and Satellite Image

## Carver/Langston

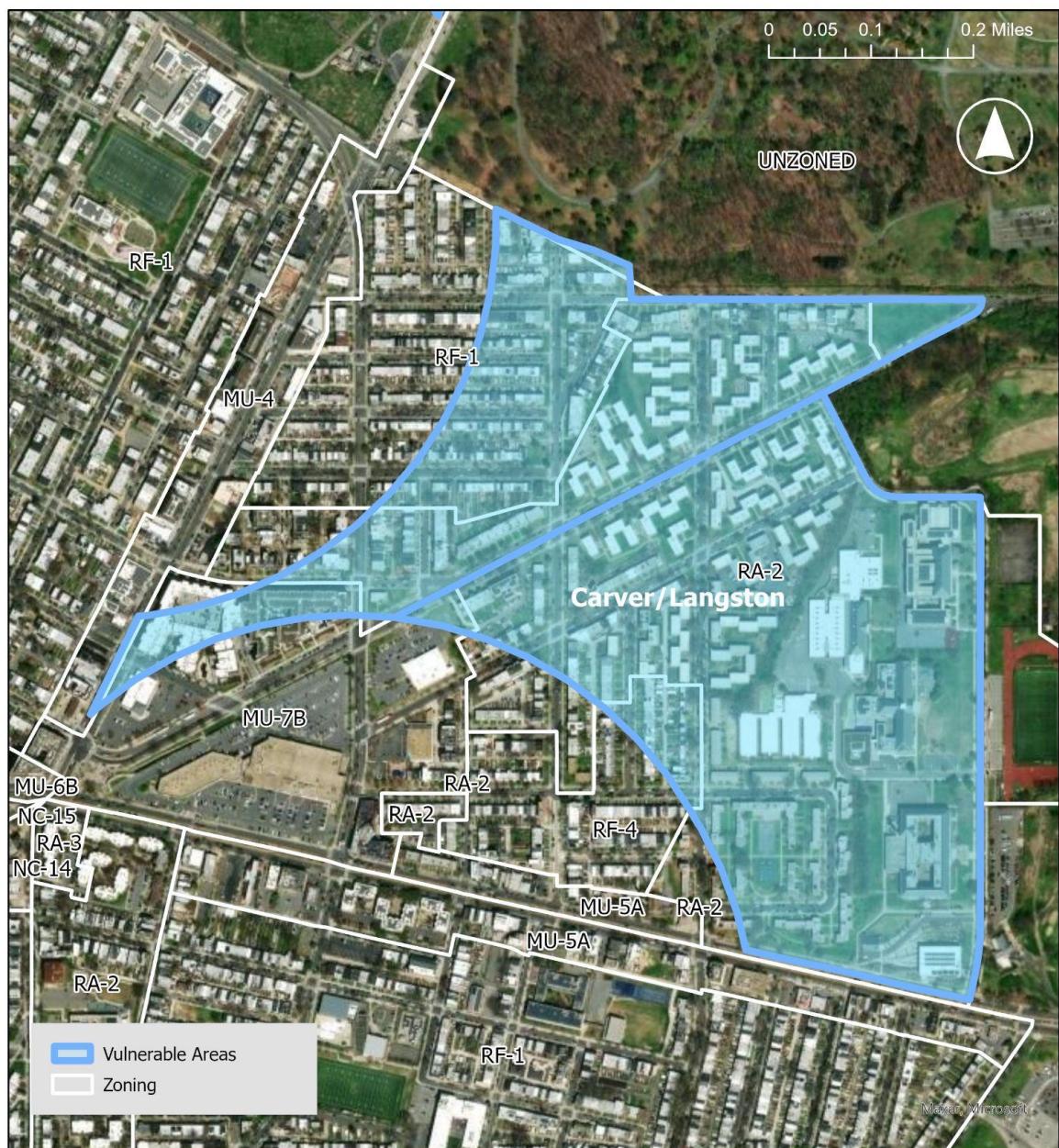


Fig 13 - Carver/Langston Possible Planting Areas

### Carver/Langston Possible Planting Area

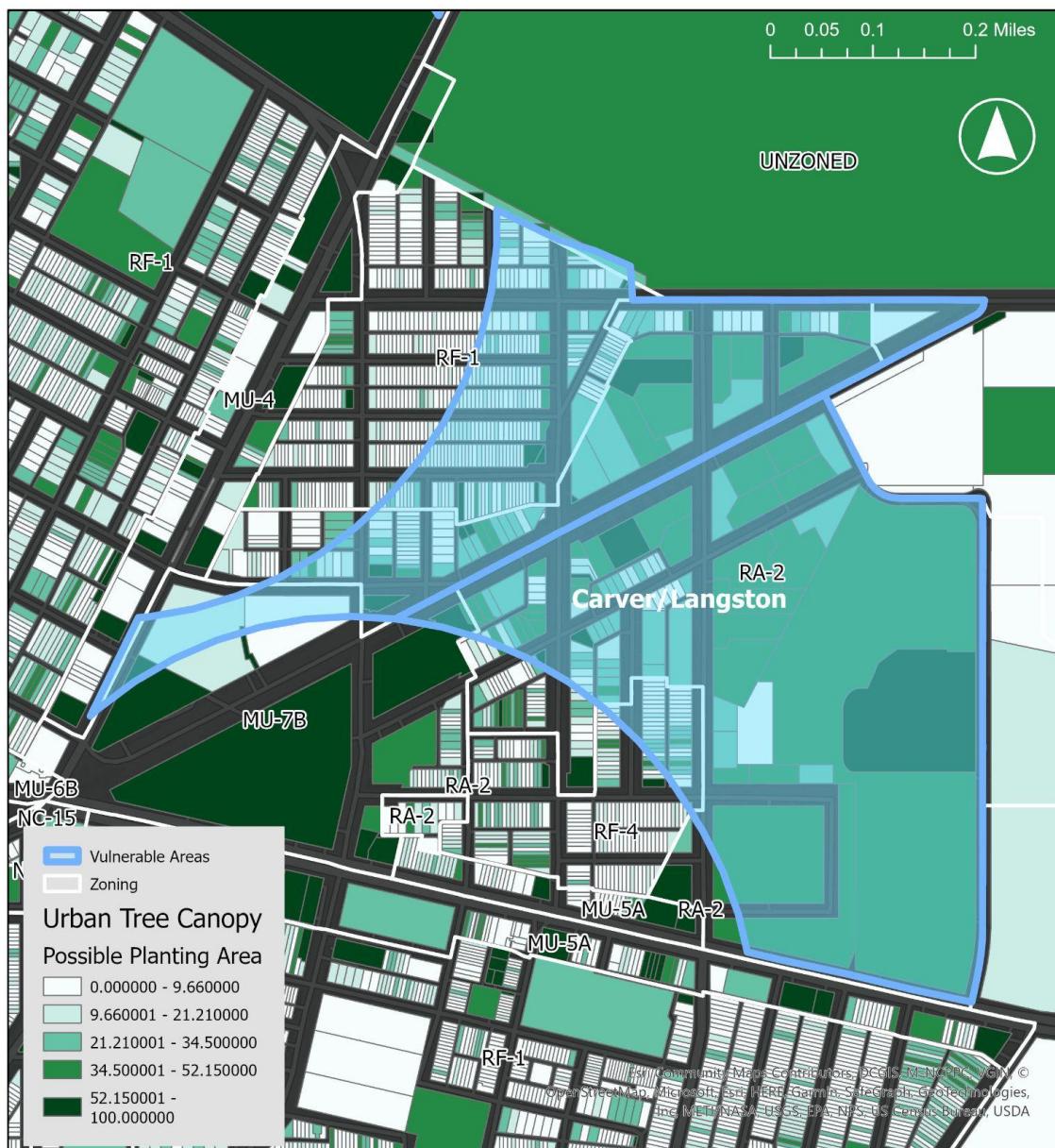


Fig 14 - Mayfair Zoning and Satellite Image

## Mayfair

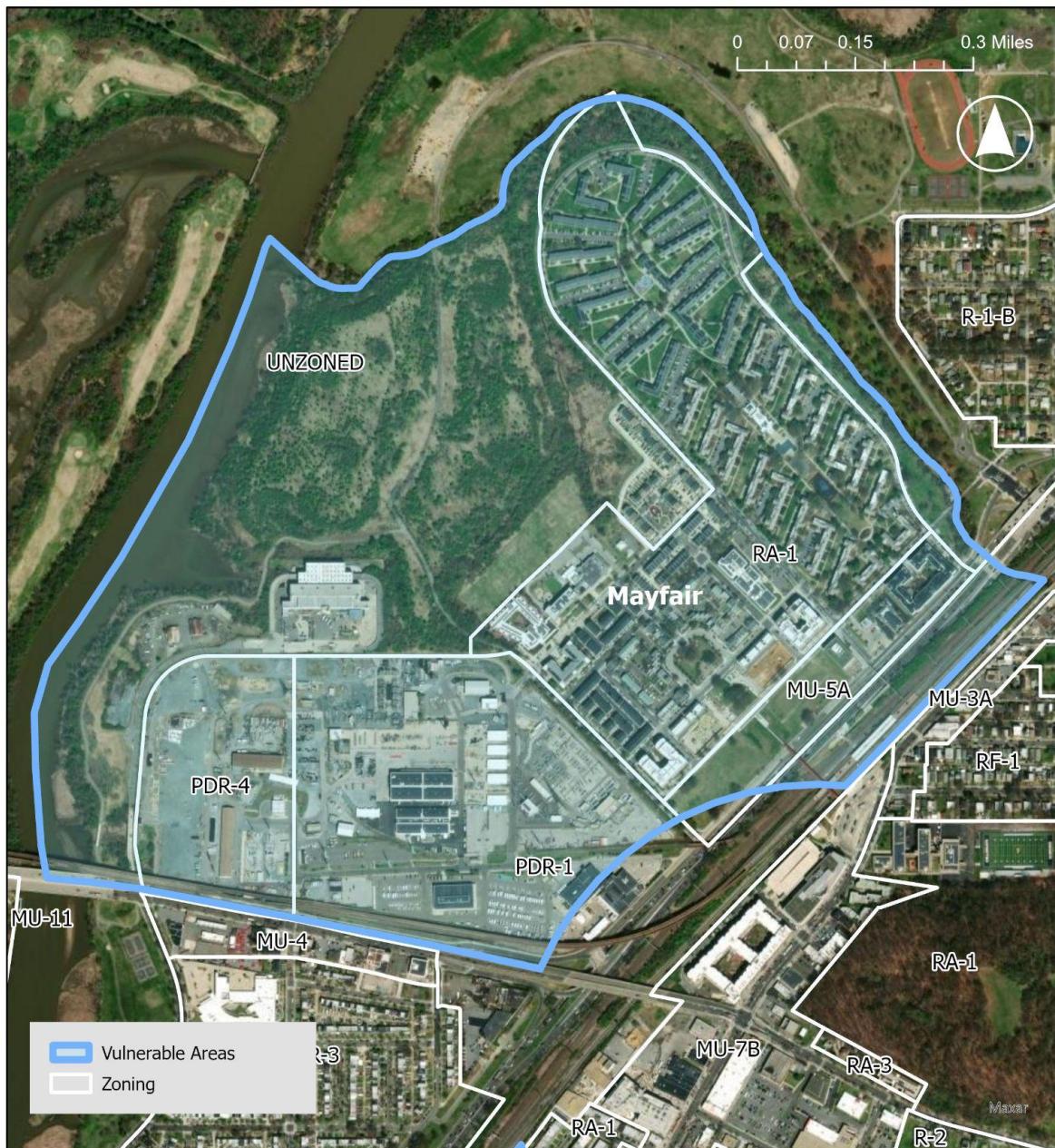


Fig 15 - Mayfair Possible Planting Area

## Mayfair Possible Planting Areas

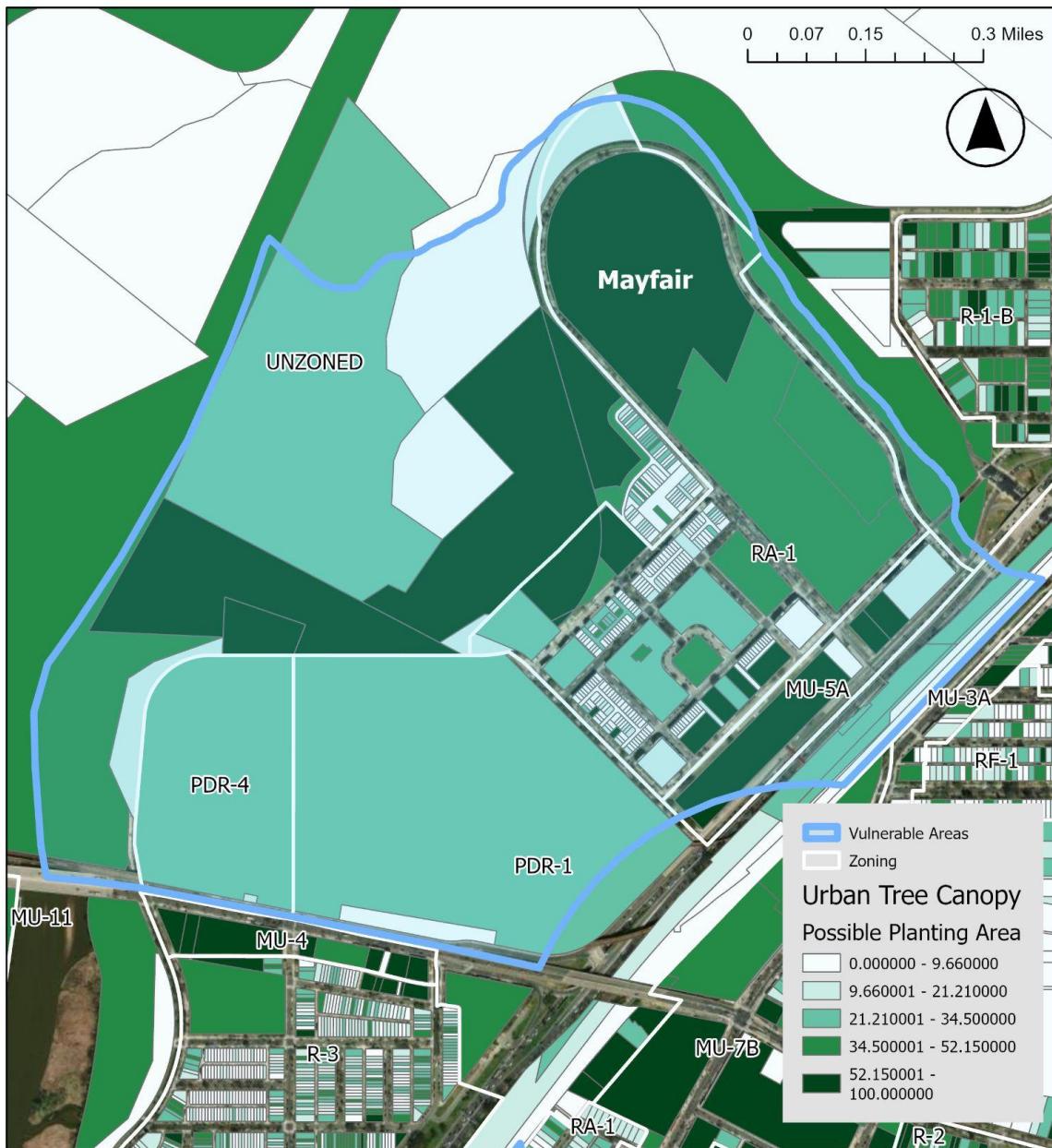


Fig 16 - Skyland Zoning and Satellite Image

### Skyland Possible Planting Areas

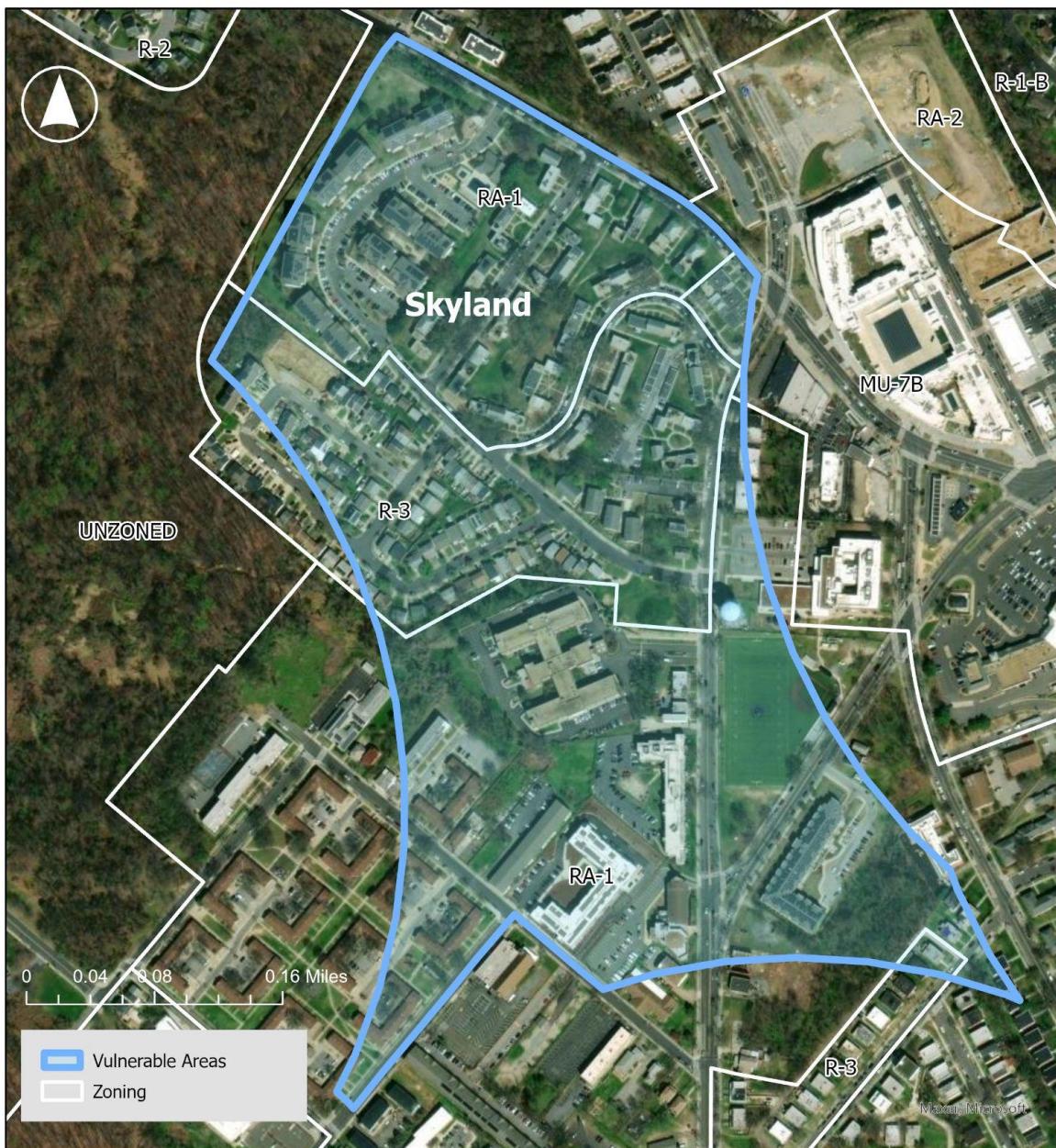


Fig 17 - Skyland Possible Planting Areas

## Skyland Possible Planting Areas

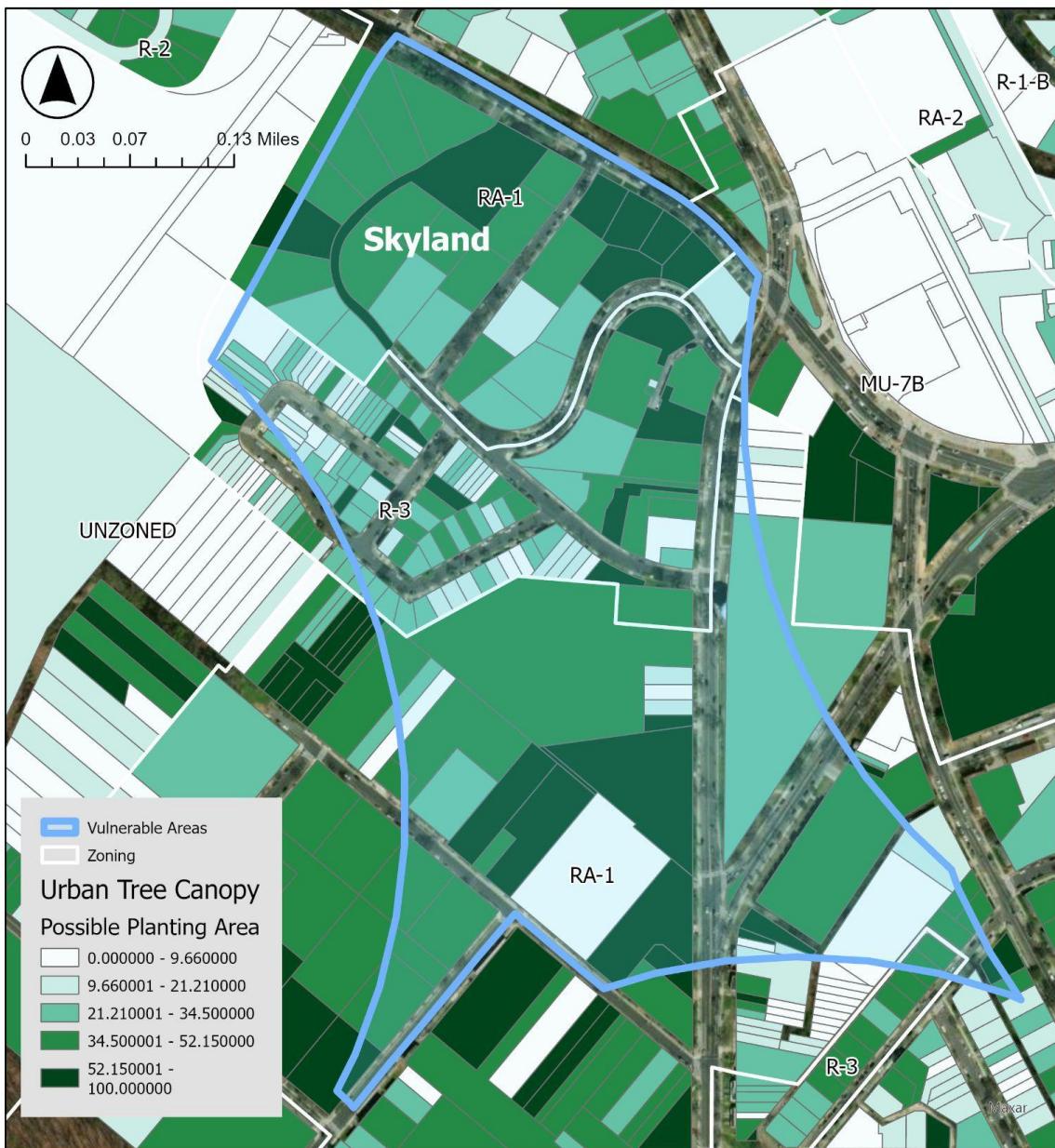


Fig 18 - Washington Highlands Zoning and Satellite Image

## Washington Highlands Possible Planting Areas

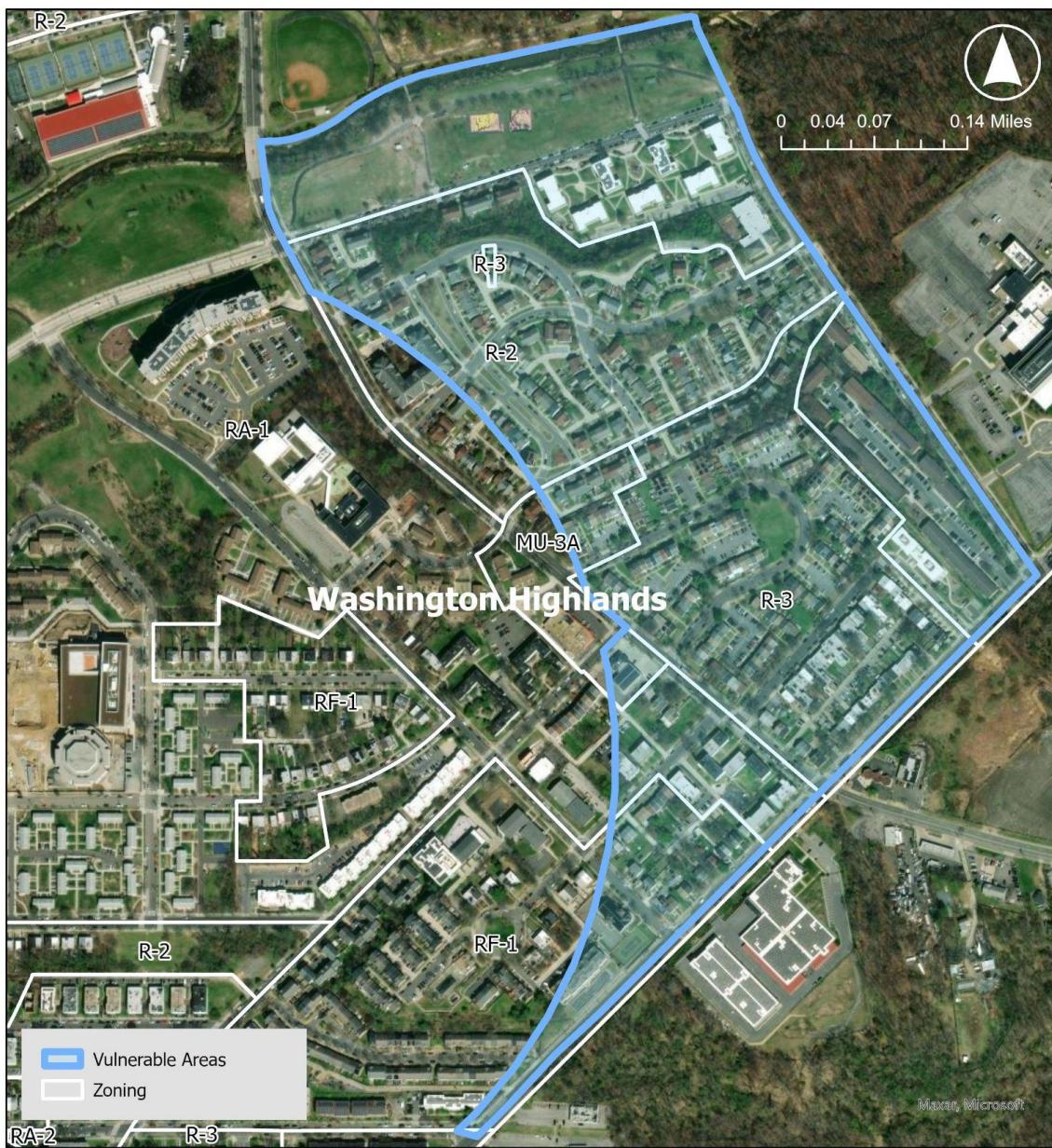


Fig 19 - Washington Highlands Possible Planting Areas

## Washington Highlands Possible Planting Areas

