Anne Arundel County:
Transportation Mobility and Accessibility

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Executive Summary

This report examines where jobs and workforce participants are located in Anne Arundel County, and what transit options connect them. Special attention is paid to low-income workforce participants and low-income job sites. The goal is to determine if there is a spatial mismatch between where workforce participants live and where jobs are located in Anne Arundel County, and to assess whether or not transit options address that mismatch.

To this end, we have produced maps that identify transit coverage, major clusters of low-income workers' residences and job locations, and transit captivity, which is a measure of households that have no private transportation option and are reliant on public transportation. What we found was that transit within the county is connected to most residential neighborhoods and employment centers, though it doesn't comprehensively serve each neighborhood or employment area it touches. Some residential communities, such as Cape St. Claire and job centers including a cluster around the I-97/Crain Highway intersection, completely lack transit services.

The report also identifies communities that may contain transit dependent individuals.

Based on our findings, we recommend further study of transit dependent populations and feasibility studies to expand transit services to underserved areas. The findings come with caveats; we did not have origin-destination data, so analysis of transit patterns cannot pinpoint actual behaviors. Also, the employment data used excluded federal employees, meaning Ft. Meade, an area of signficiant employment in the county, was not included in the dataset.

Background

Anne Arundel County is a geographically diverse area in the heart of Maryland. Its northern edge touches Baltimore City and Baltimore County, its western edge reaches the Washington D.C. suburbs, and its southern half is sparsely populated and rural in character. It contains the Baltimore-Washington International Airport and Fort Meade, home of the National Security Agency (NSA), which is the largest employer in the County with over 53,000 workers.

The county seat is Annapolis, which is also the Maryland state capitol. The population of Anne Arundel County was 537,656 as of the 2010 Census. The unemployment rate was 4.3% as of April 2015. The County's total workforce is 253,104 and the low-income workforce, defined by Census Longitudinal Employer-Household Dynamics database as those making less than $1,250 a month, is 53,104.

The county is served by three different organizations providing public transportation:

1) Regional Transportation Agency (RTA): RTA provides the main connections between Anne Arundel and Howard and Prince George's Counties. It mainly serves the northwestern section of Anne Arundel, with five bus lines.

2) Maryland Transportation Authority (MTA): MTA manages three modes of transit that cross the county: the MARC, light rail, and bus lines. MARC trains connect Washington D.C. to Baltimore City, making a few stops in Anne Arundel County. MTA runs nine bus lines that serve or cross the county, connecting Baltimore City and Washington D.C. with points within Anne Arundel such as the BWI Airport and the City of Annapolis. Two more lines connect D.C. with Queen Anne and Calvert Counties, making stops in Anne Arundel.

3) City of Annapolis: Annapolis's bus system is made up of seven lines and managed by the City.

Research Question

The central question of this report is "can low-income workers get to low-income jobs in Anne Arundel County?" Or, in other words, do public transit options adequately connect the areas where low-income workers live to job sites? Breaking this question into its constituent parts, first we must answer the question of where low-income workers live, and then the question of where low-income employment is

located. Next we must find who depends on public transit, and where transit is located in the county, and what areas are connected by it. Finally, we ask what the gaps are between workers, jobs, and transit.

Methodology

Our data is drawn from Longitudinal Employer-Household Dynamics (LEHD), the American Community Survey (ACS), the Maryland Department of Business and Economic Development (November 2014 data), and Anne Arundel County. From the LEHD, we used the 2014 "Residence Area Characteristics" and the "Workplace Area Characteristics" data files. From ACS, we used the measures of households with no cars, households in poverty, and commuting times.

We took three approaches to identify levels of transit mobility and access. First, we identified transit coverage in Anne Arundel County. Then we used kernel density mapping (heatmaps) to identify clusters of jobs and workforce participants residences. Finally, we identified areas that are transit captive, or in other words, have no transportation accessibility beyond that afforded by public transit. We aggregated these three approaches to assess transit mobility and jobs access.

Transit Coverage

We used the LEHD data low-income workers' residences by block for this section. We then created a quarter mile buffer around every transit stop in the County, and intersected the buffer area with the census blocks. For each block, we consider its area, the count of low-income workers, and its density, to finally obtain the total number of low-income workers in each quarter-mile buffer. Then, we compared this value with the total number of low-income residents in Anne Arundel to obtain the share of the working population covered by the transit system. We compared calculations for all of Anne Arundel County, for Annapolis, and for the rest of the County without Annapolis. In addition, we followed the same procedure for half-mile buffers and one-mile buffers around the transit stops.

Spatial Mismatch

Spatial mismatches were identified by joining the LEHD data to a census block map of Anne Arundel County. The LEHD data includes Residence Area Characteristic (RAC) data, including the number of jobs for workers at the residence census block level sorted by demographic markers like educational attainment,

sex, and race. We also used LEHD Workplace Area Characteristic (WAC) data with the same information but sorted by workplace census block rather than by residence census block. This allowed us to pinpoint the census block location of both the workers and jobs. However, origins and destinations were not part of the LEHD data, so these maps should not be considered a definitive measure of commuting trips.

Once the data was associated with the correct census block, kernel density estimation was used to produce the heatmaps. Using cartographic analysis we determined the spatial gaps between jobs and workers' residences. Over the heatmap we layered public transit route and stops. This allowed us to measure the straight-line walksheds of each transit stop to determine gaps in transit coverage, and then, using cartographic analysis, to identify where coverage could be productively extended.

Transit Dependent

Transit dependence is when residents of a particular area have no alternative travel options and rely on public transit. For this research, maps were created using ACS block group level data of income, zero car households, and average commute times to identify and characterize potential transit dependent communities. Because the number of residents varies by block group size, density maps were created, which show the concentrations of residents in each block group for the different analyzed factors. All three maps were divided into five levels of concentration, in the quantile method. Quantile divisions assign the same number of data, for each data value to each class. So there are no empty classes seen in this classification option.

Results

Transit Coverage

Table 1 shows the transit coverage within a quarter-mile of transit stops for Anne Arundel, Annapolis, and the County without Annapolis. For the County as a whole, 10,193 low-income workers live within a quarter-mile of a transit station. This represents a transit coverage of 19% (from the total 53,104 low-income workers residing in the County). This means that in the County there are approximately 40,000 low-income workers living more than a quarter-mile from the closest transit station.

When compared with Annapolis, the number of low-income workers served is significantly higher: 3,441 workers of the 4,064 low-income workers living in Annapolis, for a coverage of 85%. This result is expected given the urban characteristics of Annapolis and the City's robust transit system. In addition, when the County's coverage is assessed without the City of Annapolis, the number of low-income workers covered decreases to 6,752 out of the 40,000 total, leaving just 14% of the County's low-income workers with transit coverage.

Table 1: Transit Coverage for Low-income Workers in Anne Arundel County, ¼-mile Buffer

	Anne Arundel		Annapolis		County without Annapolis	
	Total	%	Total	%	Total	%
Low-income Workers	10,193	19%	3,441	85%	6,752	14%
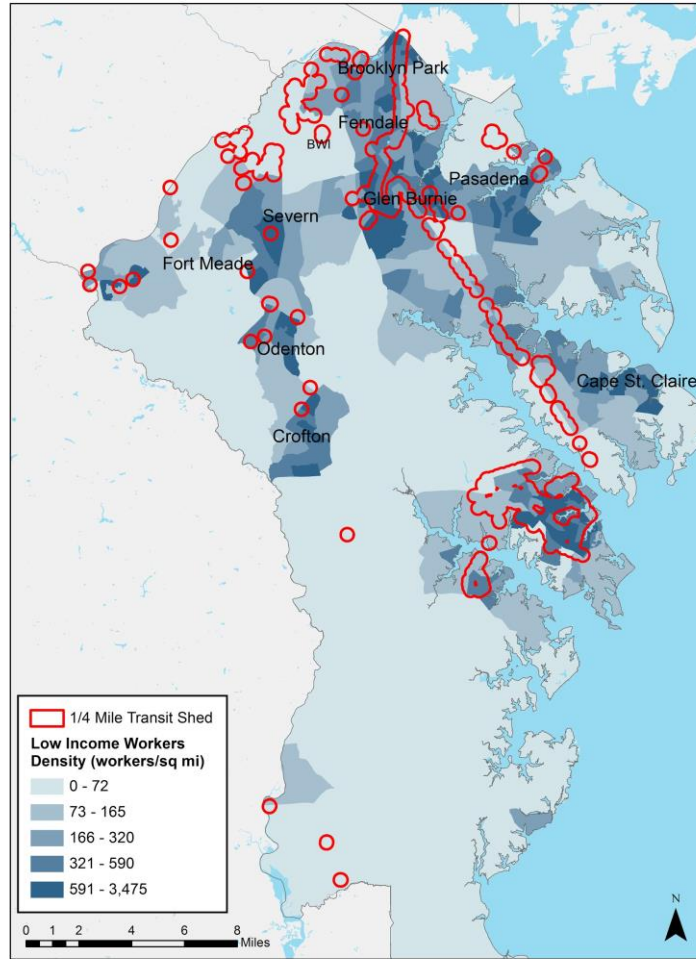
Figure 1: Low-income Workers' Residences and Quarter-Mile Transit Stop Buffer

Figure 1 shows the concentration of low-income workers, (density of workers per square mile), and the quarter-mile buffer around transit stops. It maps county areas with a significant concentration of low-income workers who are not covered by transit options. In particular, parts of Odenton and Crofton show concentrations of more than 590 workers per square mile, the higher concentration category. However, both are almost totally outside the quarter-mile buffer. Glen Burnie and the southern part of Brooklyn Park show a similar pattern: high concentrations of low-income workers who reside more than a quarter-mile away from the closest bus or rail station. Finally, while Cape St. Claire also shows similar concentrations of low-income workers, the closest transit station is the farther for its residents than for residents from other county communities.

The transit coverage results for a half-mile buffer around transit stops is shown in Table 2. Increasing the buffer area, the number of workers covered increased considerably. For the whole county, the half-mile buffer covers 20,206 low-income workers, doubling the 10,193 workers covered by the quarter-mile buffer. This means that 38% of the County's low-income workers live within a half-mile of the closest transit station.

Table 2: Transit Coverage for Low-income Workers in Anne Arundel County, 1/2 mile buffer

	Anne Arundel		Annapolis		County without Annapolis	
	Total	%	Total	%	Total	%
Low-income Workers	20,206	38%	3,941	97%	16,265	33%

In addition, Figure 2 shows the density of low-income workers along with the half-mile and one-mile transit stops buffers. The main finding here is that even after increasing the buffers around the stops, the same communities identified in Figure 1 are not reached by transit: south of Crofton, south of Pasadena, and particularly Cape St. Claire.

These communities should be candidates for extensions of current transit services so that they are better served. For example, an additional stop south to Crofton, or an additional bus line connecting Cape St. Claire, could reach considerable concentrations of low-income workers.
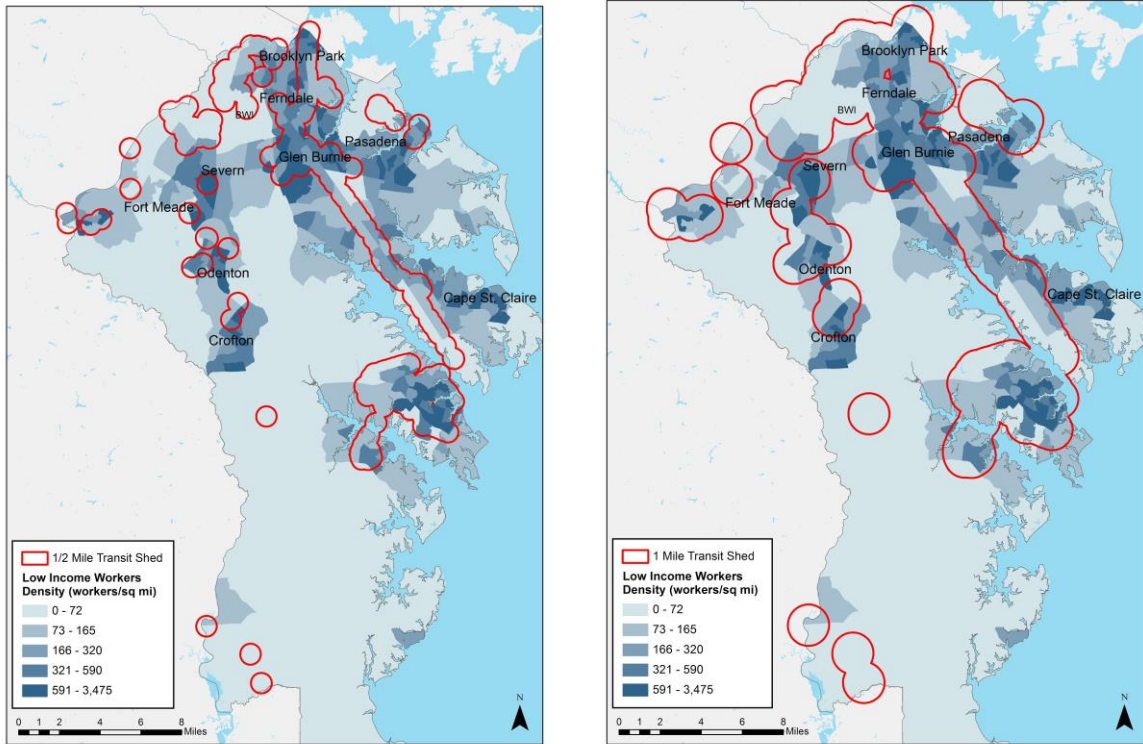
Figure 2: Low-Income Workers' Residences and Half- and One-Mile Transit Stop Buffers

Spatial Mismatch

The heatmaps in Figure 3 show concentrations of employment centers in red, with darker red representing denser clusters. The map on the left shows total workers' job concentrations, while the map on the right shows only low-income workers' job concentrations. Blue areas represent residential clusters of low-income workers for both maps. Cartographic analysis shows that along the I-97/Crain Highway corridor south of Glen Burnie there are multiple areas of dense employment for both low-income jobs and total jobs that are either not served by transit or have very little connection to transit (see Appendixes A and B for road locations). The most highly concentrated employment areas for low-income workers are accessible within a half-mile of transit stops (see Appendixes C and D).
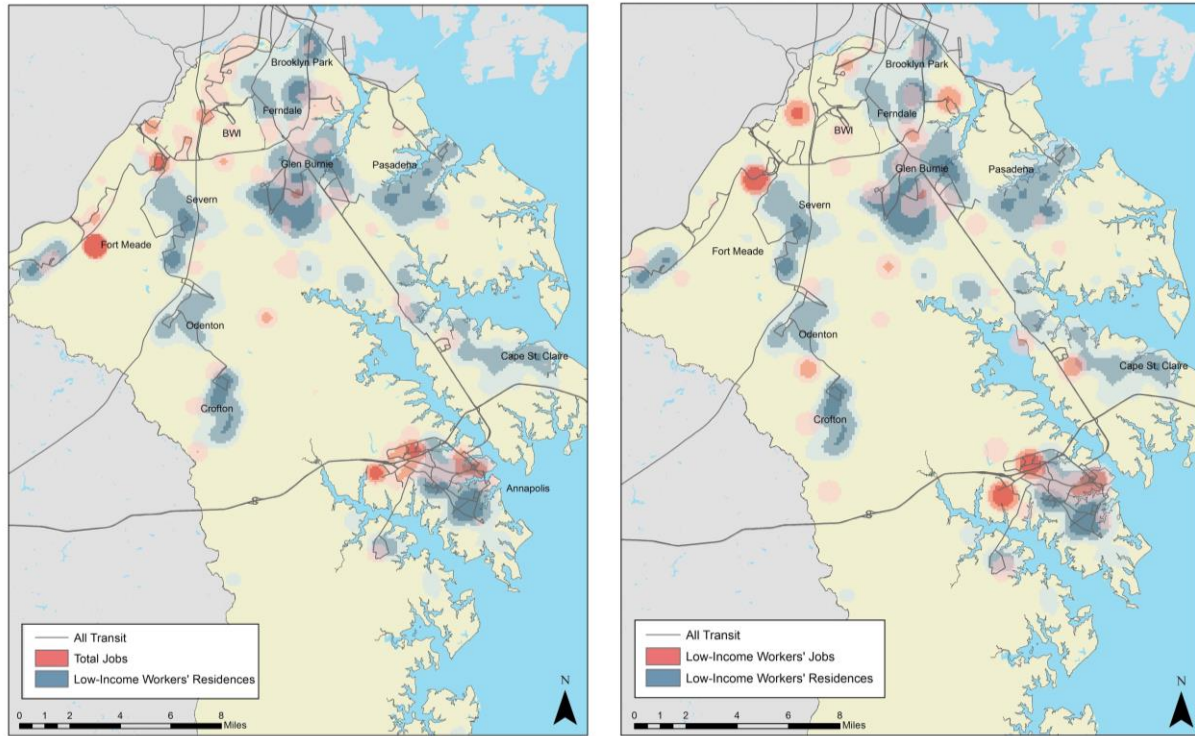
**Figure 3: Heatmap of Total Jobs and Low-Income Workers' Residences (left),
Heatmap of Low-Income Workers' Jobs and Residences (right)**

There is variation in the levels of spatial overlap between employment and residential areas. Heavy employment areas surrounding the I-295 corridor and BWI lack dense residential areas. Communities such as Severn, Odenton, Crofton, Pasadena, and Cape St. Claire either have no jobs overlapping or only jobs on the outskirts. There is a stream of employment that coincides with the county's most populous area following I-97 through Glen Burnie. Annapolis is also an area of convergence, but it too has major employment (west side) and residential areas (east side) that do not overlap.

Overall, this map shows opportunities for low-income workers to live and work in the same areas, but the map also indicates that some form of transportation will likely be needed by the total and low-income workforce to reach employment areas. Notably, the southern half of the county (south of Annapolis) does not appear to have any highly concentrated areas of low-income residences or employment centers. This does not mean that there are no low-income workers living or working in these areas, but rather that the concentrations of low-income residences and jobs were not large enough to be included.

The maps also indicate that while most of the dense low-income residential communities appear to be served by transit, in many instances transit is only available in parts of those areas. The trends seen here are very similar to those seen in the transit coverage maps. Examples of underserved areas include: Pasadena (only in the northeast), Glen Burnie (lacking in the south), North Ferndale/South Brooklyn Park (lacking in the center), Severn (lacking in the center), Crofton (only in the north). Transit is completely absent in neighborhoods north of Severna Park and in all of Cape St. Claire.

The total employment map shows that Ft. Meade lacks public transit options, although this does not take alternative transit options into account. Ft. Meade has its own transit service, "Meade Ride" that connects to the Odenton and Savage MARC Stations, the ICC Commuter Bus, and the CMRT Connect-a-ride service. "Meade Ride" is not shown on the above maps, as only public transit was analyzed in this study. Additionally, the Total Employment Map doesn't accurately portray Ft. Meade employment because of the lack of federal data provided in the LEHD dataset. To compensate for the omission of Ft. Meade data, the county's largest employer, we manually added its 53,733 jobs into our dataset, placing them in a single location (near NSA) rather than dispersing them throughout the Ft. Meade boundaries (Ft. Meade job totals were retrieved from the Maryland Department of Business and Economic Development). It is likely that in reality there are multiple areas of high employment within the Ft. Meade area.

Transit Dependent
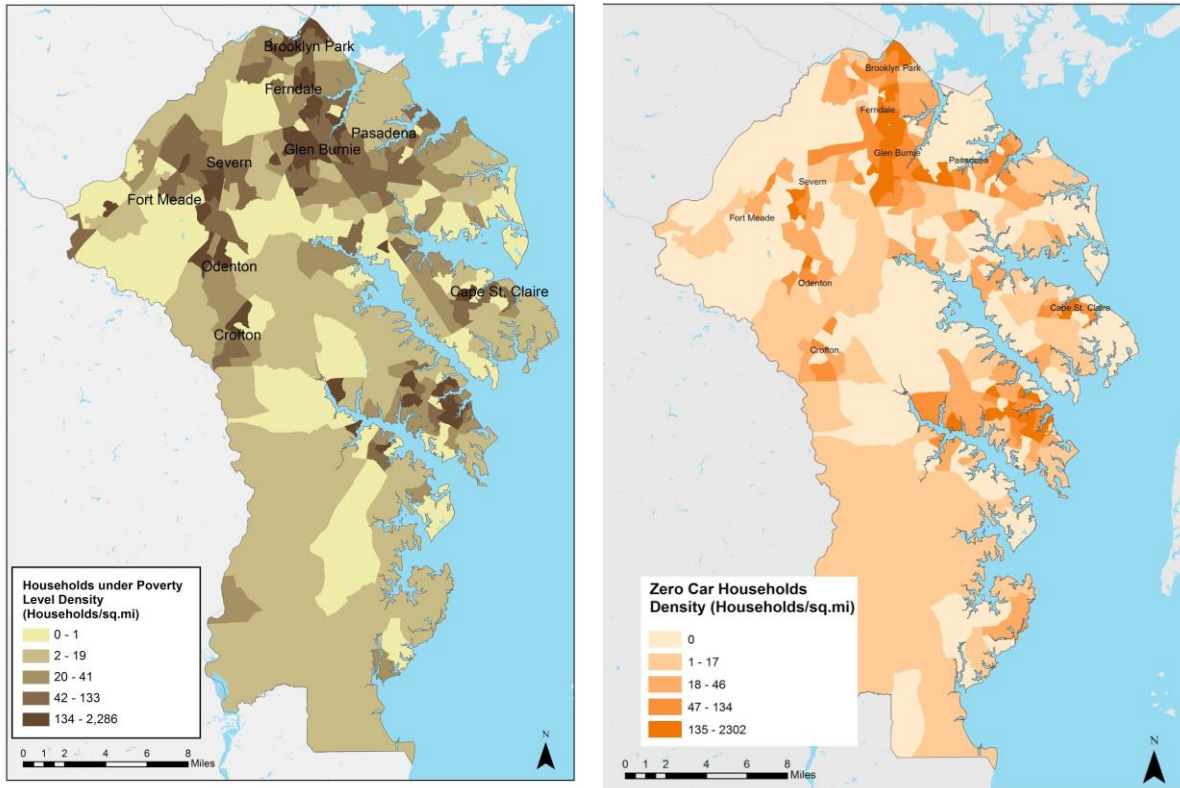
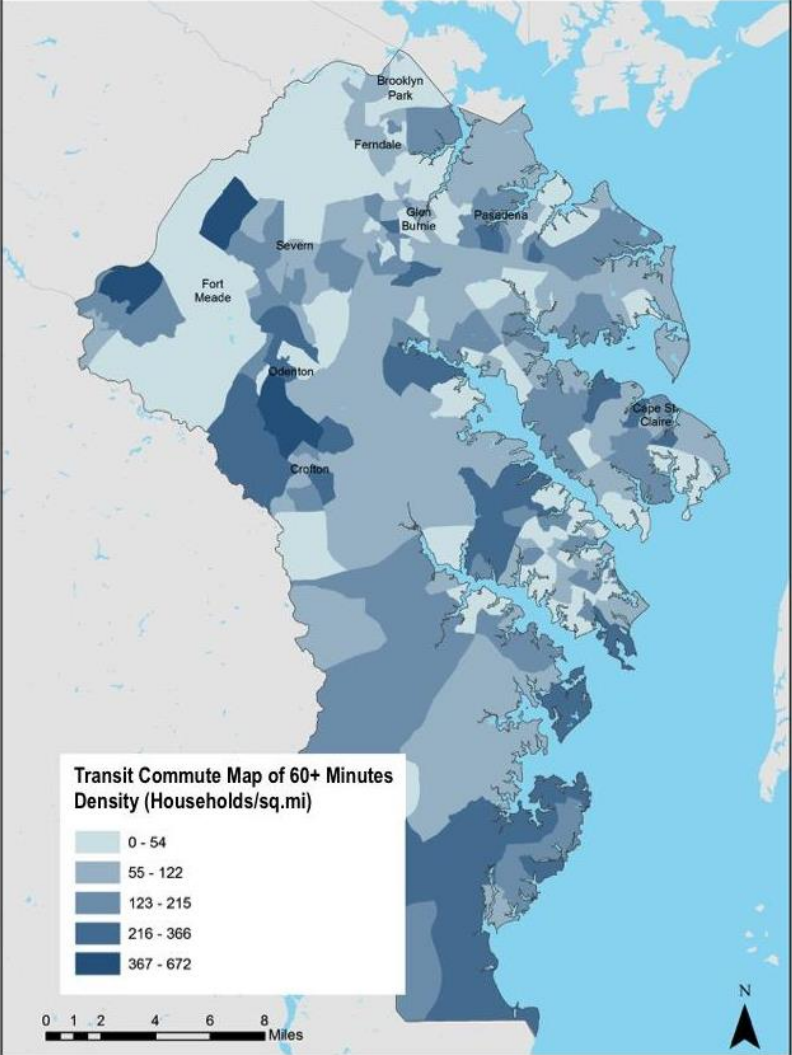**Figure 5: Density Map for Households Below Poverty Level (left)**
Density Map for Households With No Car (right)

Figures 5 and 6 describe communities identified as being potentially transit dependent within Anne Arundel County. While there are many factors associated with transit dependence, such as age, disability, income, and location, we measured transit dependence using the following factors: zero car households and households in poverty. This analysis gives a sense of where low-income residents live and which communities have and do not have access to personal vehicles. In addition to the transit dependent analysis, we also identified individuals experiencing transit commute times over 60 minutes, to see if there is a correlation between transit dependence and long commute times.

Figure 5 shows the concentrations of households below the poverty line (left) and concentrations of households without a car (right). These density maps show similar patterns of highly concentrated areas, indicating a correlation between the two factors. This result is expected, as households below the poverty line may not be able to afford a car. These maps show patterns of transit dependence in pockets in Annapolis, Glen Burnie, Severn, Cape St. Claire, and Pasadena.

Figure 6 shows concentrations of communities that experience average transit commute times of 60 minutes or more. This map presents similar patterns as the maps in Figure 5, meaning that there is likely an overlap between transit dependent communities

Figure 6: Density Map for individuals commuting 60 minutes or more

and those who experience long commute times. Adding Figure 6 to the equation, even though it does not identify transit dependent communities, helps create an idea of which areas would benefit the most from additional public transit services.

Conclusions and Recommendations

The following findings highlight the areas of Anne Arundel County that exhibit spatial gaps between high concentrations of low-income workers' residential and employment areas and available public transit options. They also point out areas that may identify those who are "transit dependent." The recommendations detail locations not served by transit and the potential transit dependent community.

Finding 1

The transit coverage maps suggest that dense neighborhoods of low-income workers are mostly served by transit, but that these neighborhoods are not all comprehensively covered by transit, leaving certain portions of the neighborhoods beyond walking distance (half-mile) from transit stops.

Recommendation: Investigate the feasibility of additional service in Odenton, south of Brooklyn Park, south of Glen Burnie, Cape St. Claire, Pasadena, and Crofton. The addition of even a single transit stop in a highly concentrated area could potentially lead to a significant increase in the percentage of the low-income workforce being covered by transit.

Finding 2

The spatial mismatch maps suggest that there are concentrated areas of employment not accessible by transit outside of the half-mile buffers (shown in Appendixes C and D).

Recommendation: Investigate the potential need for transit service to employment areas at the intersection of I-97/Crain Highway corridor, south and west of Crofton, south of Odenton, and southeast of Pasadena.

Finding 3): The transit dependent maps show that there is likely a correlation between high concentrations of areas with zero car households and households in poverty. These areas are what may be the "transit dependent" community. In addition, we also see a correlation between the transit dependent communities and areas where people are subject to 60 minute or more commute times.

Recommendation: Investigate transit needs in potential "transit dependent" areas such as parts of Pasadena, the I-97 corridor, Annapolis, and Cape St. Claire.

Limitations and Further Research

One of the study's main limitations of the study is that it does not provide origin-destination patterns. It was able to identify the concentrations of workers residences and workplaces, and the spatial mismatches between them, but it does not include the transportation patterns from residences to jobs. However, further analysis of the origin-destination patterns of the County's low-income workers can help more accurately assess the potential need for new stops or lines, so that service is planned to cover routes with the most workers.

The transit dependent analysis can benefit from an integrated score creation. For example, the chosen characteristics to define transit dependent population—zero car households, low-incomes and high commuting times—could be merged in a single score to categorize and measure transit dependency.

Regarding the methodology for the spatial mismatch maps (kernel density/heat maps), while all concentrated employment and residential areas are represented, the density of these jobs and residences is not 100% accurate, although they are still very good representations of the actual employment and residence locations. This is due to how data sources attribute jobs and residence data at block level groups, rather than in their actual locations. More precise data would allow a more accurate representation of job and residence locations.

The county's future research on transportation accessibility and mobility should also address the following research questions:

- Income maps suggest transit coverage may reach wealthier residential areas more than low-income residential areas. Is transit coverage higher for wealthy communities than low-income communities? (see Appendix F for income distribution)

- Transit coverage and spatial mismatch identify low-income workers' need for transit in certain neighborhoods. Will these communities actually be better served through additional transit? Do people want additional transit and will they use additional services? What is the best way to provide transit accessibility to these communities?

- Ft. Meade is a large employer in Anne Arundel County. How are jobs distributed in Ft. Meade and is additional transit service needed in these areas?

- Potential transit dependent communities were identified in this study, but it is difficult to tell if they are actually dependent or if they are choice riders. Choice riders are those who have the means or opportunity to access other modes of transportation, but choose to use public transit. In areas with more wealth and/or adequate transit, such as Annapolis, these "choice riders" may exist. A further research area would be to determine if identified transit dependent communities actually fit that definition, or if they have other means of transportation. In Annapolis, there may be large populations of both transit dependent and choice rider communities.
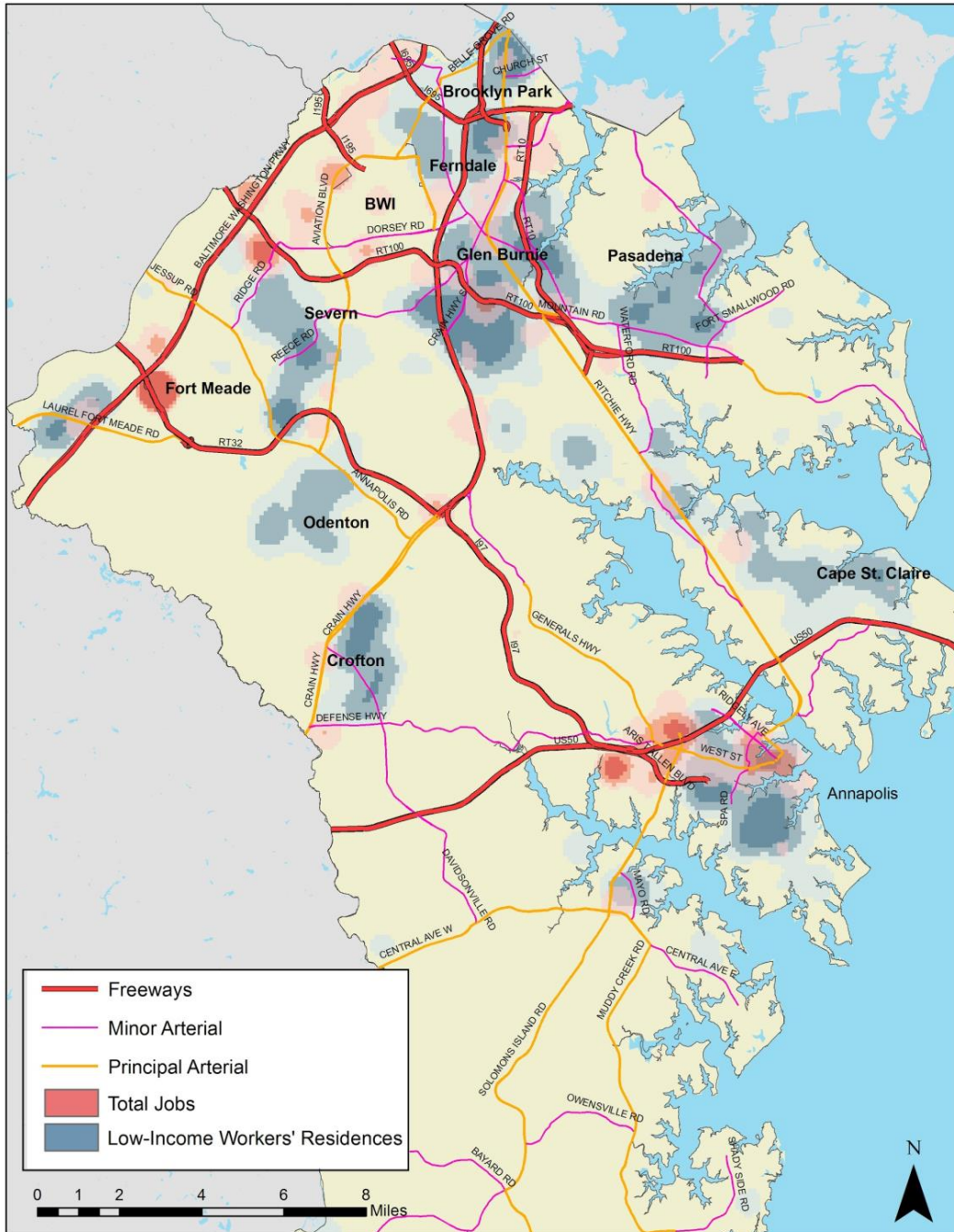
Appendix

Appendix A:

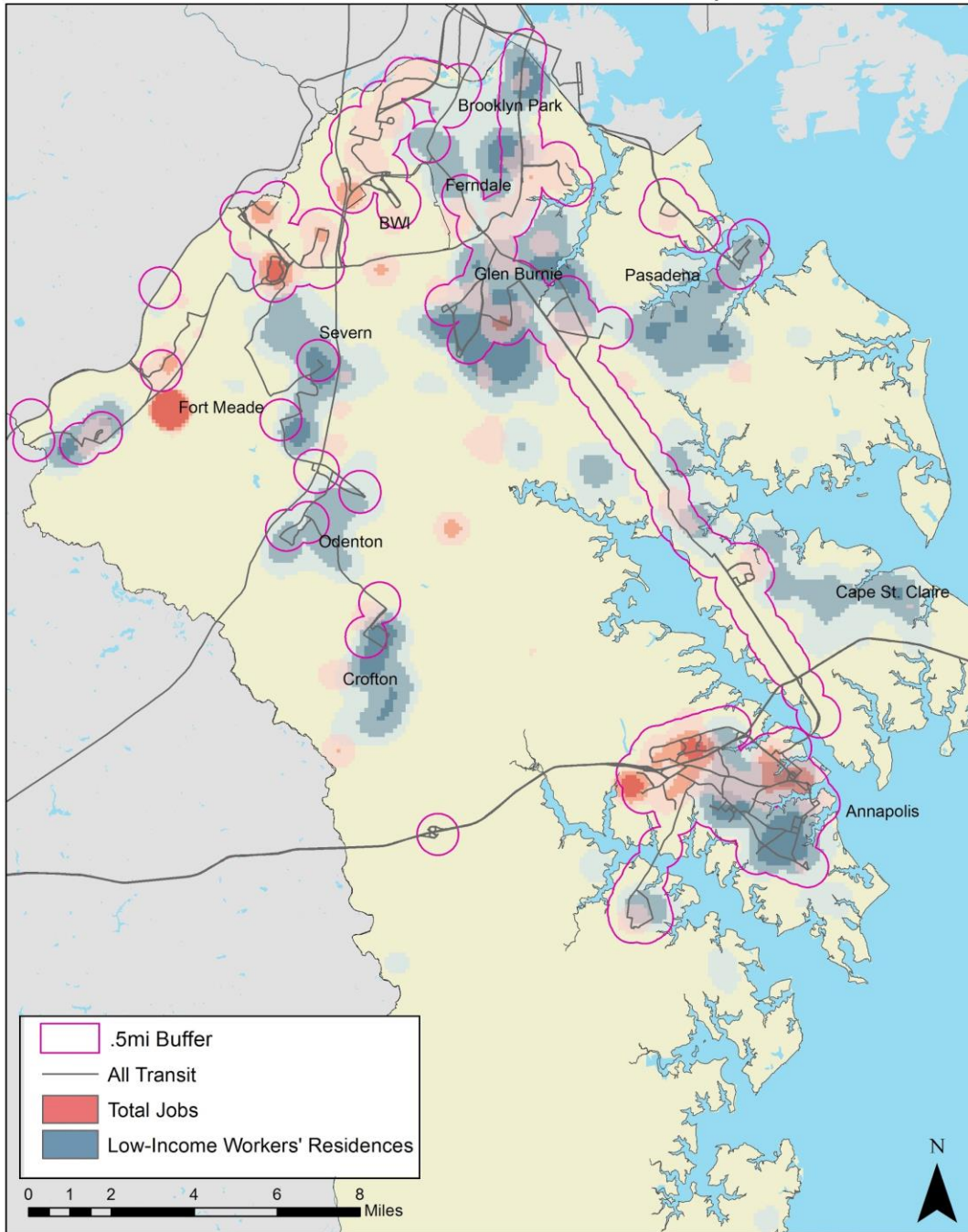## Heat Map of Total Jobs and Low-Income Workers' Residences with Roads
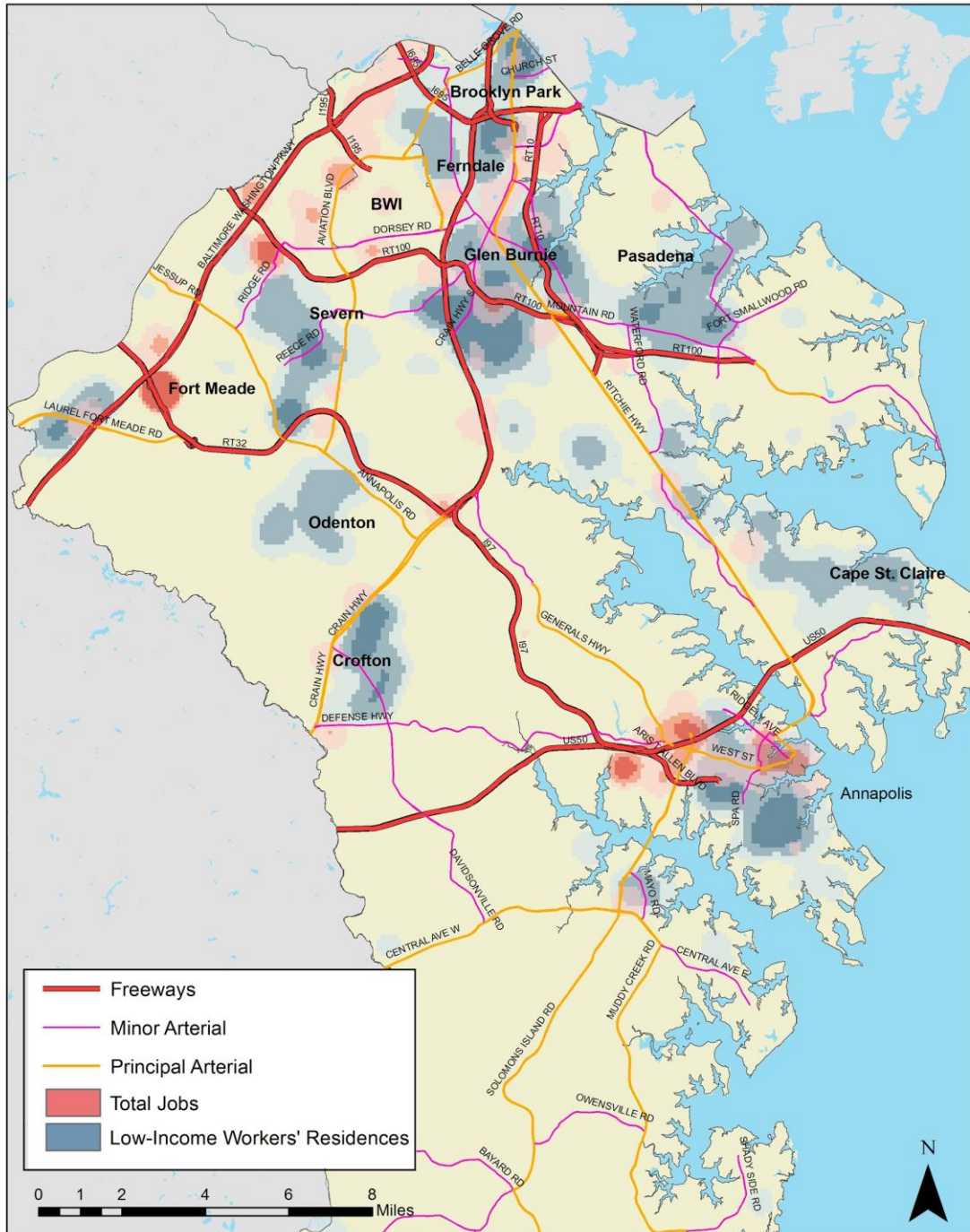
Appendix B:

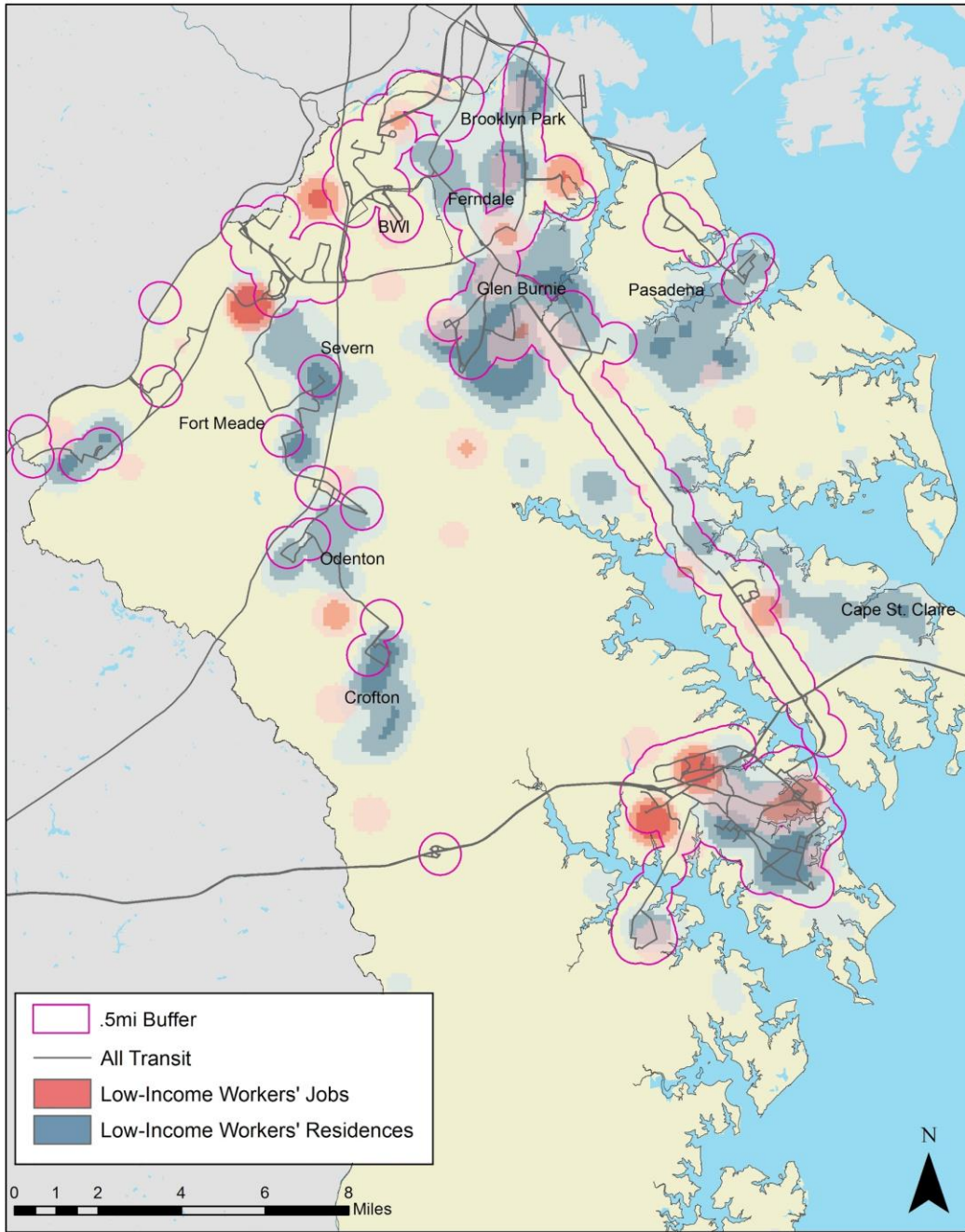## Heat Map of Total Jobs and Low-Income Workers' Residences with Roads

Appendix C:

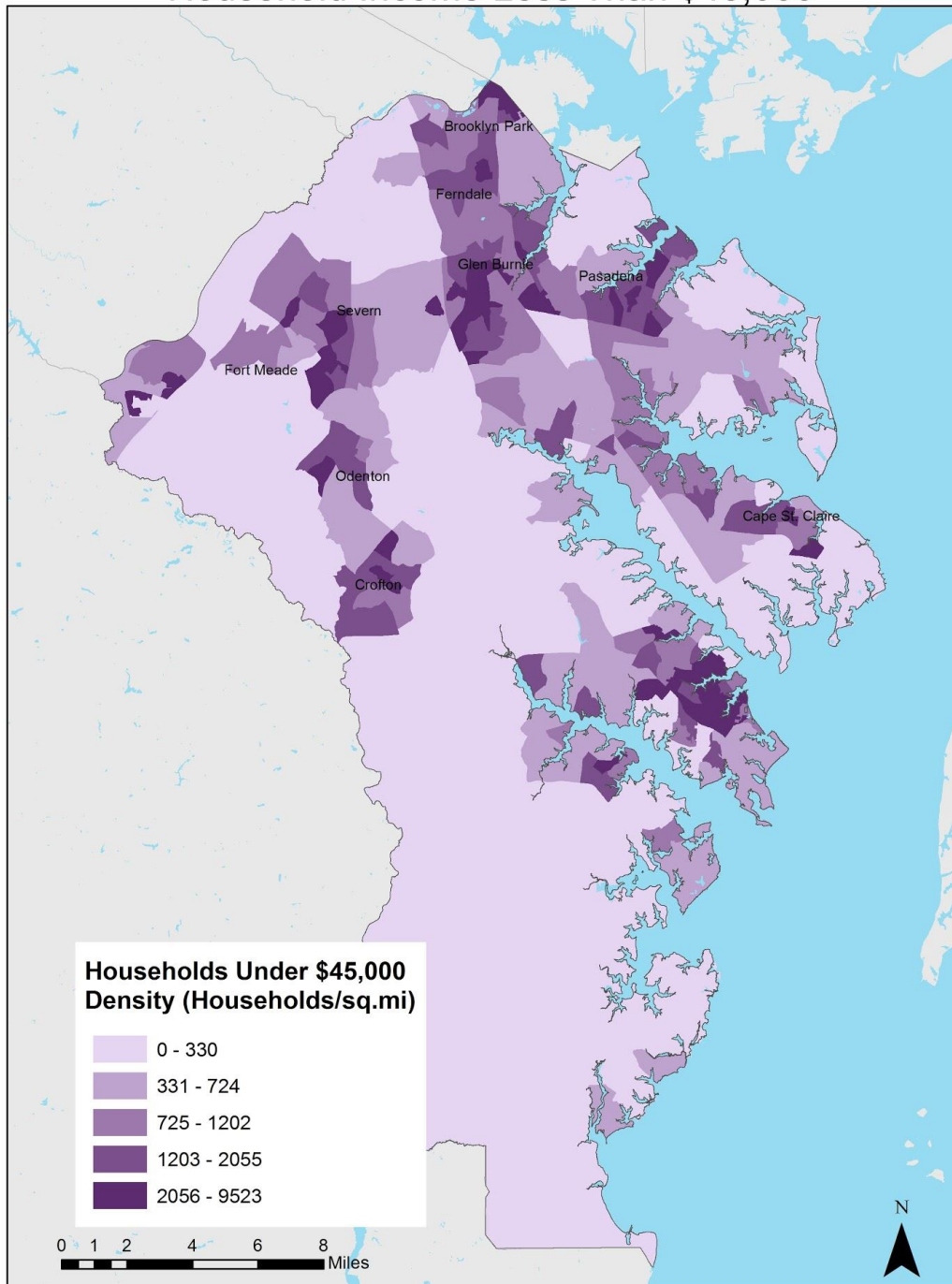## Heat Map of Total Jobs and Low-Income Workers' Residences: .5mi Buffers Around Transit Stops

Appendix D:

Heat Map of Low-Income Workers' Jobs and Residences: .5mi Buffers Around Transit Stops

Appendix E:

Household Income Less Than $45,000

Households Under $45,000 Density (Households/sq.mi)

- 0 - 330
- 331 - 724
- 725 - 1202
- 1203 - 2055
- 2056 - 9523

Brooklyn Park

Ferndale

Glen Burnie

Pasadena

Severn

Fort Meade

Odenton

Crofton

Cape St. Claire

0 1 2 4 6 8 Miles

N

Appendix F:

Total Household Income

Total Household Incomes Density (Households/sq.mi)

- 4201 - 50340
- 50350 - 112400
- 112500 - 171200
- 171300 - 277300
- 277400 - 955300

0 1 2   4   6   8
Miles

N