

**ENVIRONMENTAL JUSTICE AND INTERMODAL FREIGHT EMISSIONS:  
A CASE STUDY ALONG THE I-95 CORRIDOR**

by  
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A thesis submitted to the Faculty of the University of Delaware in partial  
fulfillment of the requirements for the degree of Master of Civil Engineering

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## **ABSTRACT**

Environmental Justice analysis is now part of the transportation planning process of most metropolitan planning organizations (MPOs). The analysis focuses on equitable distribution of money spent on transportation development and improvement projects. Another current topic of discussion in MPOs and other organizations is the congestion and environmental tradeoffs of shifting freight between modes, moving containers by rail or water instead of trucks. However, one of the unconsidered tradeoffs which this study explores is the impact of those emissions on nearby populations. Using the highway and rail corridors of New Castle County, Delaware and Cecil County, Maryland, the research evaluated the amount of emissions from each mode and looked at the affected populations as freight is shifted from truck to rail.

## **Chapter 1**

### **INTRODUCTION**

Environmental Justice analysis is now part of the transportation planning process of most metropolitan planning organizations (MPOs). The analysis focuses on equitable distribution of money spent on transportation development and improvement projects. A more reasonable title for these analyses could be Transportation Equity. This research looks at Environmental Justice in a new way. This study looks at the environmental tradeoffs of shifting freight between modes, moving containers by rail or water instead of trucks and explores the impact of those emissions on nearby populations. As a container of freight is moved from truck to rail, the emissions to the population near the roads is reduced, while the population near the rails sees an increase in emissions exposure. Using the highway and rail corridors of New Castle County, Delaware and Cecil County, Maryland, this research evaluated the amount of emissions from each mode and looked at the affected populations as freight is shifted from truck to rail.

Many studies have looked at the epidemiological effects of traffic-related air pollution. Reducing emissions by shifting modes and reducing congestion are also topics of wide discussion. However, how freight shifting between modes affects nearby populations has not been studied. This study looks at Environmental Justice and Intermodal Freight, specifically, the impact of emissions of freight shifting on nearby populations.



This paper reviews several studies focusing on the impact of traffic-related air pollution on health, as well Environmental Justice policies and case studies of several MPOs. Then, the paper explains the methodology the study used as well as the study areas and the definitions used. Following that are the results of the study. Finally the paper gives the conclusions and opportunities for future work.

## Chapter 2

### LITERATURE REVIEW

#### **Environmental Justice and Metropolitan Planning Organizations**

A Metropolitan Planning Organization, commonly referred to as an MPO, is the agency responsible for the transportation planning process within its specified geographic region. An MPO must be designated for each urban area with a population of more than 50,000 people.(Federal Highway Administration 2010) The duty of the MPO generally includes carrying out three federally required certification documents at regular intervals: the Transportation Plan (Plan), the Transportation Improvement Program (TIP), and the Unified Planning Work Program (UPWP). Also, the MPO conducts studies on transportation planning and accordingly designates the allocation of funds to projects. MPOs are also responsible for taking Environmental Justice (EJ) into account while conducting the transportation plans and projects.

For this research, I have reviewed the EJ plans and policies of several MPO's from this region as well as two other MPO's, Boston and Southern California. While general requirements for EJ are set for in federal documents, how MPOs implement EJ varies. In general, EJ is really more of a transportation equity evaluation and not environmental impacts.

### **Wilmington Area Planning Council (WILMAPCO)**

As an outgrowth of Title VI of the Civil Rights Act of 1964(United States Department of Justice 1964), EJ is generally defined as policies to ensure the non-discriminatory distribution of federal funds. For the Wilmington Area Planning Council (WILMAPCO), EJ follows the three core principles set forth by the Federal Highway Administration (FHWA) and Federal Transit Administration (FTA):

- *Avoid, minimize, or mitigate disproportionately high and adverse human health or environmental effects, including social and economic effects, on minority populations and low-income populations.*
- *Ensure the full and fair participation by all potentially affected communities in the transportation decision-making process.*
- *Prevent the denial of, reduction in, or significant delay in the receipt of benefits by minority populations and low-income populations. (Wilmington Area Planning Council 2009)*

In 2003, WILMAPCO developed their first EJ Report(Wilmington Area Planning Council 2003), in response to a Federal mandate to incorporate Environmental Justice considerations into their planning process. The 2003 report evaluated transportation equity in Cecil County, Maryland and New Castle County, Delaware. WILMAPCO looked at transportation accessibility and availability for minorities and low income residents. In 2007, WILMAPCO carried out another Environment Justice analysis(Wilmington Area Planning Council 2007 ). This report broadened the definition of EJ communities to include those that were “transportation constrained”, the elderly, disabled and zero-car households. The report suggested a set of practical and cost-effective measures for public transportation improvement to improve mobility and combat isolation. Two years after that, in 2009, WILMAPCO

conducted a transit and non-motorized transportation system analysis focusing on transportation equity for minorities, low-incomes, the limited English proficiency and the low literacy groups. The 2009 report(Wilmington Area Planning Council 2009) assessed the accessibility of bus stops, supermarket and employment connectivity of the mentioned groups in the Wilmington, DE region. WILMAPCO has incorporated Environment Justice into their project prioritization process. Specific studies conducted include walkability and public transportation accessibility and availability analyses of Southbridge, a working-class Wilmington neighborhood conducted in 2007 and 2008.

Although the negative impact of highways on the minority and low-income populations was mentioned in their 2035 plan, no study has looked at the impact of freight shifting between modes.

### **Delaware Valley Regional Planning Commission**

Delaware Valley Regional Planning Commission (DVRPC) is the agency serving the Great Philadelphia, PA region encompassing nine counties in two states - Bucks, Chester, Delaware, Montgomery and Philadelphia counties in Pennsylvania, and Burlington, Camden, Gloucester and Mercer counties in New Jersey. In all, 352 municipalities are included and the region has a population over 5.5 million.

In response to federal Title VI and environmental justice mandates, planning in the DVRPC has been done with the involvement of and for the benefit of all the region's residents. The DVRPC also aimed to create an overall transparent, inclusive planning process.

Like other MPOs, the DVRPC has spent much effort on ensuring meaningful public participation in programs and projects. To assist with this

participation, the DVRPC has developed the Planners' Methodology.(Delaware Valley Regional Planning Commission 2010) It establishes a framework for developing public participation plans for projects and offers a "tool kit" of public participation strategies. The methodology explains what public participation is and defines interested parties of a project.

In addition to Planner's Methodology, the DVRPC also developed a system for Environmental Justice assessment.(Delaware Valley Regional Planning Commission 2010) The Degree of Disadvantage (DoD) Methodology provides information on the Great Philadelphia Environmental Justice population. The EJ population of the region includes minority and the low-income groups, those with limited English proficiency, persons with physical disabilities, those over 75 years old and car-less households. The DoD Methodology also identifies the direct impacts of the region's transportation programs and projects on the defined population. Specifically, the methodology overlaps the key destinations, such as employment and health care, with its current transportation network and then determines the transportation service gaps for the disadvantaged groups. The DoD Methodology has been utilized for Environmental Justice analyses in a variety of transportation programs and projects which are recorded in the annual Environmental Justice report.

Nevertheless, focus has been put mainly on transit and highway locations(Delaware Valley Regional Planning Commission 2009) and the accessibility and mobility of the EJ populations. The MPO hasn't looked at the impact of freight shifting between modes.

## **Baltimore Regional Transportation Board**

Baltimore Regional Transportation Board (BRTB) is the metropolitan planning organization for transportation planning in the Baltimore, MD region. The BRTB represents Baltimore City and Anne Arundel, Baltimore, Carroll, Harford and Howard counties. The MPO region is the nation's 19th largest, with over 2.5 million people. The BRTB region is divided into 94 smaller areas called Regional Planning Districts.

In 2004, the BRTB undertook a project to explain Environmental Justice to the public. Eight listening sessions and a community dialogue were held in communities throughout the region. These talks collected the public's concerns about regional transportation. In 2006, the BRTB began phase two of the project where participants chose the top three areas of concern in the Baltimore region - access to quality transit service, air quality and congestion, and public involvement in the planning process - and potential communities where these concerns exist. Four locations were selected and case studies were developed to fully explore these concerns. In March 2007, the case studies were presented to attendees of a community workshop.

In 2008, a final workshop was held and a Community Guide was released.(Baltimore Metropolitan Council 2008) The objective of the guide was to give communities the tools to bring EJ issues to the attention of local government. The report highlighted the importance of the communities' involvement and that of a systematic process for identifying and evaluating environmental justice issues.

The current EJ focus for the BRTB is looking at patterns of transportation investments as they relate to EJ, assessing the positive and negative impacts of

transportation projects and involving minority and low-income populations to the decision-making process.(Baltimore Regional Transportation Board 2010)

### **Northern New Jersey Region**

The North Jersey Transportation Planning Authority (NJTPA) is the MPO for thirteen counties of Northern New Jersey. The region has a population of about 6.5 million people and provides 3.5 million jobs making this the fifth most populous MPO region in the US. NJTPA considers Environmental Justice in transportation planning as the fair distribution of benefits as well burdens among all people. In complying with federal regulations and guidelines, NJTPA works to identify and assess the needs of the low-income and the minority populations in their regional transportation plans and transportation improvement plans. NJTPA also places an emphasis on public involvement in their planning processes by working to eliminate participation barriers for the low-income and minority groups.

To ensure that all sectors of the population within its region are being served in proportion with their transportation needs, the NJTPA conducts Environmental Justice Regional Analyses. The purpose of these analyses are to make sure that there has been a proportionate distribution of transportation investments in identified environmental justice (EJ) communities as compared to the remainder of the region. The 2004 analysis evaluated trends in population growth and distribution based on the 1990 and 2000 census data. This analysis was supplemented with data from the Regional Transportation – Household Interview Survey (RT-HIS), a regional survey of detailed daily travel patterns conducted during 1997 and 1998.(North Jersey Transportation Planning Authority 2004).

The 2004 study included elderly and disabled persons, in addition to minority and low-income populations, as the environmental justice (EJ) population at the request of the NJTPA's Project Prioritization Committee (PPC). The study summarized the demographic and travel characteristics of EJ populations, evaluated the implications of past policies and addressed issues for further study.

The study identified pedestrian safety as a key issue, since walking is a significant mode of transportation for EJ populations. The effectiveness of bus facilities along with the potential for additional transit investment targeted to EJ communities needed to be further evaluated. The study also concluded that since the change in EJ populations was rapidly growing and shifting in geographic distribution, a better method for making future estimates was needed.

In 2005, the NJTPA conducted the second phase of the analysis. During this analysis, only minorities and low-income sectors were considered as the EJ population. The aim of this 2005 study was to compare the distribution of benefits of transportation projects between the EJ communities and non-EJ communities. The NJTPA area is divided into 158 districts. Any districts with EJ populations were identified as EJ districts. Transportation projects were divided into three categories - congestion management system projects, roadway maintenance projects and bridge repair projects. The proportion of the EJ districts with the transportation projects was evaluated to make sure the benefits brought from the projects were distributed proportionally. In cases where the distribution of benefits was not proportional, new policies were recommended.

In the NJTPA's 2035 plan, the relationships among affordable housing, job locations and transportation system access was explored and Environmental



Justice was included as one of the key issues.(North Jersey Transportation Planning Authority 2009) The 2009 study studied negative impacts of highway investment on EJ population. Noise pollution and transportation related emissions in EJ neighbors were described. However, no result of the impact of traffic related air pollution on EJ populations has been released.

### **Southern California Association of Governments**

Southern California Association of Governments (SCAG) is the nation's largest metropolitan planning organization. It represents a region of 189 cities and more than 19 million residents. The region includes Los Angeles, Orange, San Bernardino, Riverside, Ventura and Imperial counties. The SCAG is in charge of the region's research and plans for transportation, growth management, hazardous waste management, and air quality. The SCAG is required to produce a Regional Transportation Plan (with a minimum 20-year planning horizon) every three years and a Regional Transportation Improvement Program (RTIP) every two years.

Similar to other MPOs, SCAG's goal is to assure that its transportation programs and plans do not create disproportionate negative impacts for low-income and minority people in the region. The distributions of costs and benefits which may be brought by the programs and projects should be equally share for all groups or a more beneficial outcome for lower-income groups. In Appendix G to their 2004 Regional Transportation Plan(Southern California Association of Governments 2000), SCAG explained the technique used for their Environmental Justice Analysis. The analysis was divided into two parts, environmental, health, and safety equity and socioeconomic equity. The environmental, health, and safety equity portion focused on noise, traffic congestion, air quality, and traffic safety. For socioeconomic equity,

the MPO used two indicators, mobility and accessibility. All of the evaluation criteria were quantified by models used by SCAG. The overall outcomes of each area were separated by ethnic and income groups and comparisons were done among the groups. For example, for the air quality environmental justice analysis, emissions estimates from the SCAG model were developed for a series of scenarios. The changes in emissions resulting from each scenario and the affected populations were compared.

Despite that the air quality analysis distributed the overall to the EJ population according to its proportion in a certain geographic level, no transportation network was used. And my study looks at the environmental impact of certain highways and rails.

### **Boston Region MPO**

The Boston Region Metropolitan Planning Organization serves the Boston, MA metropolitan area, including 101 cities and towns in eastern Massachusetts. The region is generally within a distance of 20 miles from the city of Boston with a population of more than three million of which two-thirds work in the region.

The Boston Region MPO developed a systematic method of considering Environmental Justice in transportation programs and projects, which is called the Regional Equity Program. The program has three core elements - community outreach, incorporation of Environmental Justice in the planning process, and analysis of the effects of planned transportation projects. The Regional Equity Program also includes system-level analysis on EJ areas and non-EJ areas. Specifically, accessibility, mobility and volumes of carbon monoxide (CO) are set as three categories. The results of the analysis on EJ areas and non-EJ areas are compared to evaluate the effect of the projects. The method has been incorporated in the

development of current and planned future Regional Transportation Plan and Transportation Improvement Programs.

In the 2030 highway design(Boston Region Metropolitan Planning Organization 2009), the method developed in the Regional Equity Program was used to conduct the Environmental Justice Assessment. The environmental justice areas are based on the demographics of the people living in a transportation analysis zone (TAZ). According to the report, accessibility, mobility and environment (in the form of the volumes of CO) were evaluated for both EJ TAZ and non-EJ TAZ, for various scenarios, baseline, 2030 build, and 2030 non-build. The evaluations of EJ TAZ and non-EJ TAZ were compared. The result shows that the MPO's recommended transportation projects (the 2030 build scenario) will not generate more burden than the 2030 no-build network. The recommended projects will bring more benefits to EJ population than the non-EJ population.

However, despite the fact that these studies are called Environmental Justice, they have not looked at the impacts of the traffic-related air pollution.

### **Traffic-Related Air Pollution and Health**

Bhatia, Lopipero, and Smith (1998) evaluated the relationship between occupational exposure to diesel exhaust and lung cancer. They used the data from 29 quantitative studies reported in peer-reviewed journals. They conducted a meta-analysis of these studies by combining results from these published data of lung cancer mortality among workers with potential exposure to diesel exhaust fumes. Their study reported a causal association between increased risks for lung cancer and diesel exhaust exposure. They also pointed out that differences in study methods or exposure settings may explain differences in observed risks from the prior studies.

Health effects on children due to vehicle exhaust have also been evaluated. In 1995, a study (Brunekre, Janssen et al. 1997) was conducted in the Netherlands concerning the association between air pollution caused by traffic and lung function in children living near busy roads. Lung function and/or questionnaire data (age, gender, height, weight, the distance from home to roads, etc.) were obtained from about eighty percent of children from participating schools in the study areas. The authors classified traffic density on the roads and measured the concentrations of PM<sub>10</sub> and NO<sub>2</sub> in the participating schools. In their study, associations between traffic density and lung function in children living near roads were found. The association was stronger in children living less than 300 meters to the roads and was stronger in girls than in boys.

Another study that looked into the association between children with cancer and their exposure to air pollution from traffic was conducted by Raaschou-Nielsen, Hertel, Thomsen, Olsen (2001). In this study, the authors chose the average concentrations of benzene and nitrogen dioxide as the indicators of traffic-related air pollution. The authors calculated the exposure to benzene and nitrogen both during pregnancy and during childhood. The exposure were assessed based on a variety of vehicle, traffic and meteorological data. The study compared the exposures at the residences of children with the most common types of cancer with those of those of a population-based, random sample of children from the same country without cancer. The researchers found that the risk of lymphomas increased by 25% when the concentration of benzene and nitrogen dioxide were doubled during the pregnancy. However, no support was found for the hypothesis that traffic-related air pollution at

the residence of children caused leukemia, central nervous system tumors, and all selected cancers.

Brauer, Hoek et al. (2003) developed a GIS-based model to estimate long-term average airborne particulate concentrations in three locations of Europe. The authors selected about forty sites that represent rural and urban traffic locations in the Netherlands, Germany and Sweden. They collected traffic-related variables including traffic density, traffic proximity, household density, etc.. The air samples at each site were collected and analyzed for four 2-week periods distributed between February 1999 and July 2000.

A Swiss study on air pollution and lung diseases in adults supported the premise that living near busy roads had adverse respiratory health effects (Bayer-Oglesby, Schindler et al. 2006). The study was conducted in 1991 and 2002. The study evaluated the association between respiratory symptoms and the exposure to traffic pollution among both smokers and non-smokers. In the study, PM10 was set as the indicator of air pollution. The concentrations were estimated by a dispersion model and assigned to each participant's geo-coded address. The study highlighted the relationship between breathing disorders and the proximity of homes to traffic.

Another study which looked at the association between traffic-related air pollution and respiratory symptoms in adults was conducted in the U.S.(Garshick, Laden et al. 2003). The research team selected a sample of the general population of southeastern Massachusetts. The study was a close parallel to the Swiss study. Data collected included the distance from the home to roads, the prevalence and potential risk factors of respiratory illnesses.

Some studies also compared the mortality effect of air pollution with those of other diseases, such as obesity, diabetes, etc. (Finkelstein, Jerrett et al. 2004), compared the mortality rate attributable to traffic pollution with that associated with chronic respiratory and pulmonary diseases and diabetes. The authors studied patients from a clinic in Canada between 1985 and 1999. The study found that subjects living close to a major road had an increased mortality rates and the mortality effect of traffic pollution was similar to that of chronic respiratory and pulmonary diseases and diabetes. Another study (Pope, Burnett et al. 2002) was based on the data collected by the American Cancer Society, a mortality study of approximately 1.2 million adults. The concentration of particulate pollution contributors, such as PM<sub>2.5</sub> and PM<sub>10</sub>, were collected. They concluded that the risk associated with exposure to particulate air pollution was much smaller than the risk of cigarette smoking but was comparable to the estimated effect of being moderately overweight.

Despite that some of the studies taking residents near major roads as subjects, all the researches above focused on the links between air pollution and epidemiology, while my study discusses congestion and environmental tradeoffs. With the scenario that freight shifts between modes, my study explores the impact on the nearby population.

### Chapter 3

## METHODOLOGY

This research examines the burdens on the environmental justice population from freight transport, specifically, the exposure to vehicle emissions. There is much current discussion in the literature about shifting freight from trucks to rail or ships to reduce emissions. This work will look at how those mode shifts might impact populations living along the various modal transportation corridors.

### **Identify Environmental Justice Population**

Title VI of the Civil Rights Act of 1964 states that

*No person in the United States shall, on the ground of race, color, or national origin be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving Federal financial assistance. (United States Department of Justice 1964)*

To comply with Title VI, the U.S. Department of Transportation (DOT) states that the recipients of Federal aid have been required to certify and the U.S. DOT must ensure nondiscrimination.(United States Department of Transportation 2010)

The U.S. DOT defines the Environmental Justice population as follows–

Persons belonging to any of the following groups:

**Black**. a person having origins in any of the black racial groups of Africa.

**Hispanic**. a person of Mexican, Puerto Rican, Cuban, Central or South American, or other Spanish culture or origin, regardless of race.

**Asian.** a person having origins in any of the original peoples of the Far East, Southeast Asia, or the Indian subcontinent.

**American Indian and Alaskan Native.** a person having origins in any of the original people of North America and who maintains cultural identification through tribal affiliation or community recognition.

**Native Hawaiian or Other Pacific Islander.** a person having origins in any of the original peoples of Hawaii, Guam, Samoa, or other Pacific Islands.

**Low-Income.** a person whose household income (or in the case of a community or group, whose median household income) is at or below the U.S. Department of Health and Human Services poverty guidelines.

When considering the identification of the Environmental Justice population, most MPOs use the six groups identified by U.S. DOT. Some MPOs (Baltimore Metropolitan Council, 2010; Delaware Valley Regional Planning Commission, 2010; Wilmington Area Planning Council, 2010) also include persons with physical disabilities, the elderly, those with limited English proficiency, and low literacy groups. In this study, the U.S. DOT classifications were used.

To assess the impact on the environmental Justice population regarding to emissions caused by freight transport, I developed a Geography Information System (GIS) based methodology mainly including three aspects.

1. Identify the freight transport network.
2. Identify the Environmental Justice population under exposure to the freight transport-related emissions.
3. And conduct Environmental Justice Analysis on the identified population.



Demographics of the people living in the study area, Cecil County and New Castle County will be studied, based on census block level for minorities (both ethnicity and race). Information on median income is only available from the Census Bureau at the block group level (a block group is an aggregation of census blocks). For this study, the median income for the block group was used as the median for all the census blocks contained in the group. While this may introduce some error, the author feels it will still adequately demonstrate her points.

### **Identify the Environmental Justice Area**

The study area used in this research is the region of responsibility for the Wilmington Area Planning Council, Cecil County, Maryland and New Castle County, Delaware. In this study, the GIS analysis software, ArcGIS (ESRI 2010) was used. ArcGIS enables spatial analysis, data management, and mapping.

Some emission-related health studies identify areas of interest at the tax parcel level, where the specific resident addresses were known. However, for Environmental Justice Analysis conducted by an MPO, larger statistical areas, such as Transportation Analysis Zone (TAZ) (Baltimore Metropolitan Council 2010) or census blocks (Wilmington Area Planning Council 2010) are chosen.

In this study, the Environmental Justice population was divided into three groups - minority by origin, minority by race, and low-income according to the data from U.S. Census Bureau. The minorities by origin group refers to the person's origin, that is, Hispanic or non-Hispanic. The minorities by race group refers to the person's race, including black, American Indian, and Asian.

### **Identify Freight Transport Network**

This study focused on the impact of freight movement by truck and rail. Using GIS, the rail lines in New Castle and Cecil counties were identified and those owned by Amtrak, and used exclusively for passenger service, were excluded. The major truck freight corridors in the area of interest were determined to be those sections of Interstates 95, 295 and 495 within the two county region.

### **Identify Exposed Environmental Justice Area**

To identify the area of emissions exposure adjacent to the freight corridors, a 300 meter buffer is set around each truck and rail section in the two county region. This 300 m buffer is the same area used by WILMAPCO in current EJ studies and is also found in many of the medical studies. This buffer area identified exposed populations. The exposed population was the residents of all census blocks which have any portion of the block within the 300m buffer. Tax parcel data would have been more precise to identify the exposed population but this data was not available. Using census blocks will still be useful for comparison.

### **Conduct Environmental Justice Analysis**

The objective of an Environmental Justice Analysis conducted by an MPO is to examine that transportation projects and their associated funds are properly between Environmental Justice and non-EJ populations. However, one could argue that what is called EJ is more closely related to Transportation Equity. The impact of the projects on populations from the perspective of exposure to emissions has not been part of EJ studies. This research will look at the exposed populations to emissions from truck and rail. This study will also look at the impact of modal shift. As freight is shifted from trucks to rail cars, the emissions exposure of those near roads would be

reduced, while those near rails would increase. This research will quantify the emissions by each mode and the associated exposed population, looking to see if the benefits to one group outweigh the increased exposure by another. Also, this study will look at how the demographics of the populations living within the areas adjacent to the road and rail systems compare to regional averages. This will show if the populations living near freight corridors have higher than average EJ populations.

## Chapter 4

### RESULTS

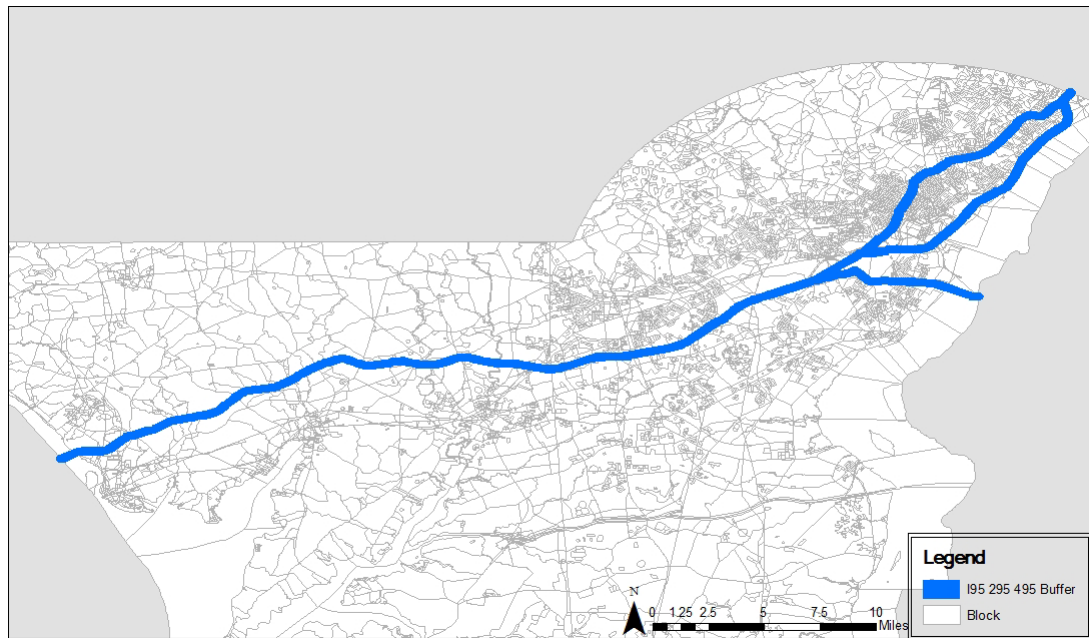
#### **Environmental Justice Population in the Study Area**

The study area, Cecil County and New Castle County, has a total population of 586,216, among which 119,520 are minority races, 27,597 persons (out of total population) are of Hispanic origin, 46,776 out of total population have household incomes below the poverty line. The average Environmental Justice Population Ratios for Minorities (Race), Minorities (ethnicity), and Low-incomes are 20.39%, 4.71% and 7.98%. Table 1 lists the statistics.

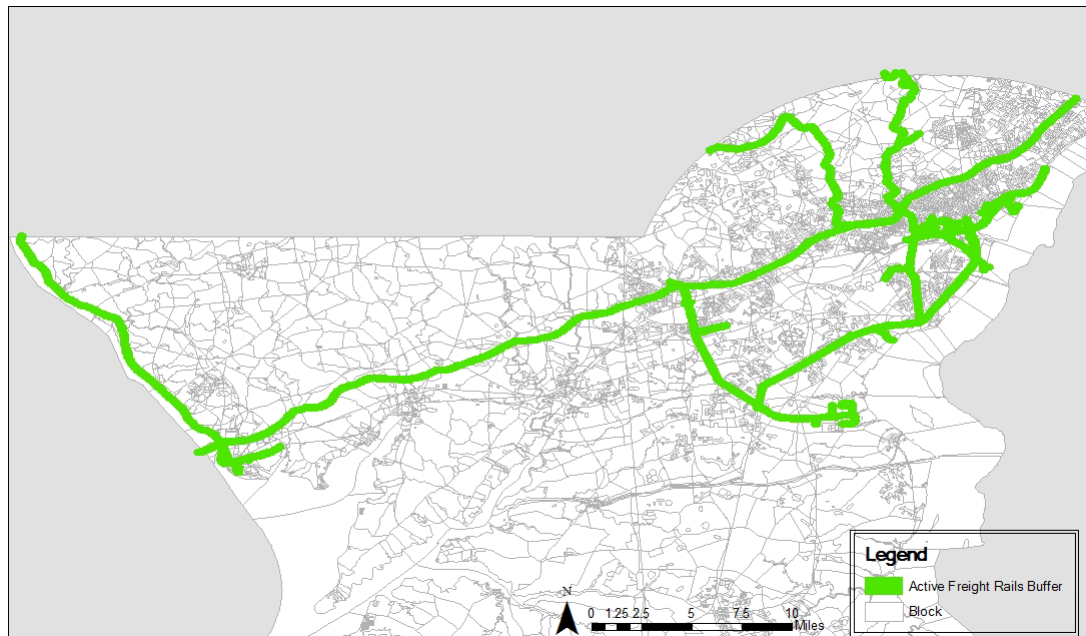
**Table 1      Demographic Statistics of Cecil County and New Castle County**

<b>Total Population</b>	<b>Total Minorities by Race</b>	<b>Average EJ Population Ratio</b>
	119520	20.39%
586216	<b>Total Minorities by Origin</b>	4.71%
	27597	7.98%
	<b>Population under Poverty Line</b>	
	46776	

Figure 1 and Figure 2 are the 300 meter buffering areas of interstates and rails.

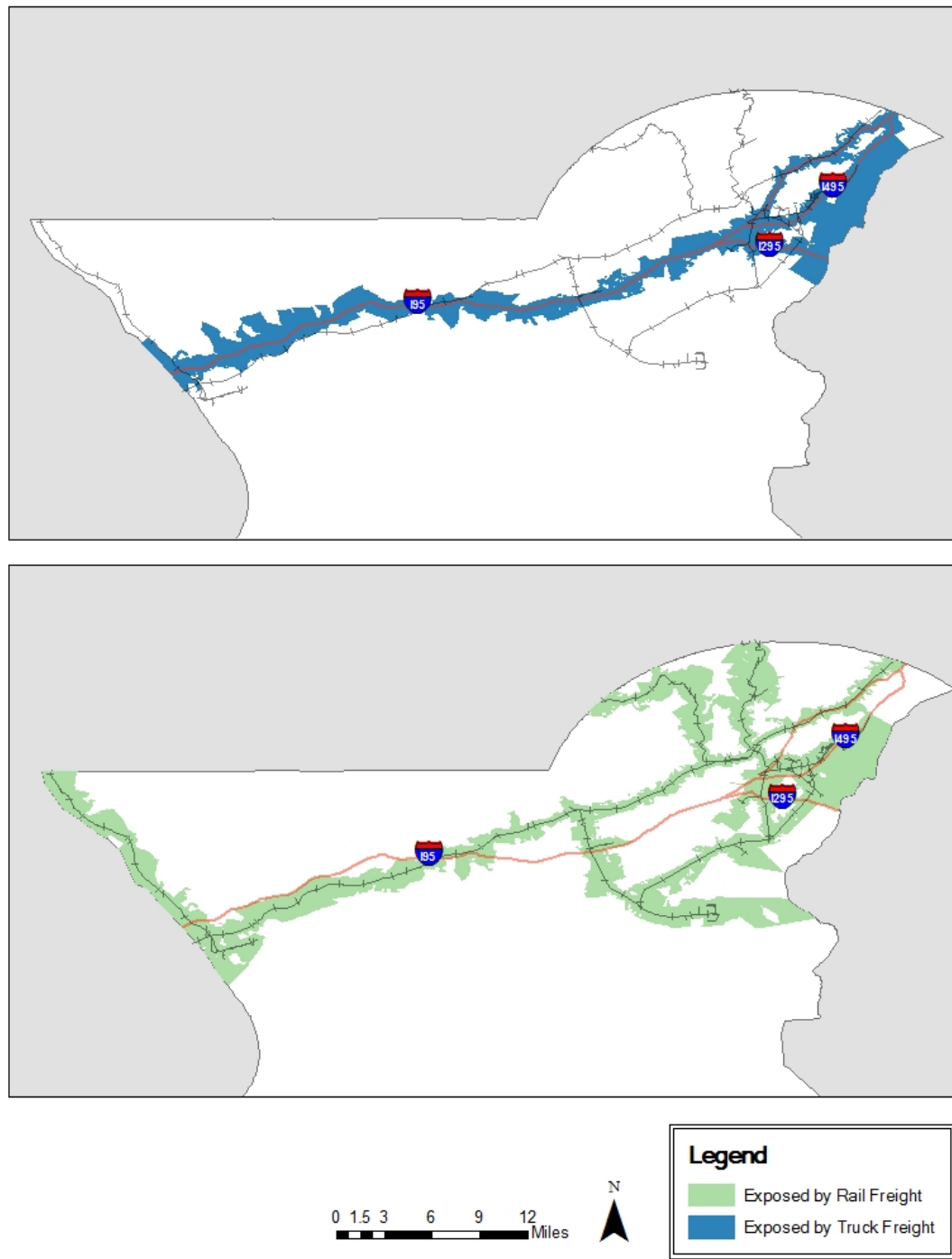


**Figure 1** 300 meter buffering area of interstates



**Figure 2** 300 meter buffering area of rails

Figure 3 shows the census blocks exposed to emissions from freight along interstates and active freight rails.



**Figure 3** Exposed Areas from truck and rail emissions

Table 2 gives the total exposed blocks and population, as well the Environmental Justice population ratios, the Minority by Race, the Minority by Origin, and the Low-Income.

**Table 2      Exposed Areas from Truck and Rail**

	<b>Exposed Blocks</b>	<b>Total Exposed Pop.</b>	<b>Minority by Race Ratio</b>	<b>Minority by Origin Ratio</b>	<b>Low Income Ratio</b>
<b>Truck</b>	840	49958	30.48%	8.25%	10.26%
<b>Rail</b>	2002	128748	19.89%	5.63%	11.49%

### **Emission Rates along Interstates and Freight Rails**

Emission rates for rail and truck were obtained from the Laboratory for Environmental Computing and Decision Making at Rochester Institute of Technology, Rochester, NY. As part of the Geospatial Intermodal Transport Initiative, standard emission rates for trucks and freight rail have been developed. Specific details and assumptions used can be obtained from the GIFT project team. The emissions rate for truck and rail in gm per TEU mile are given in Table 3 below.



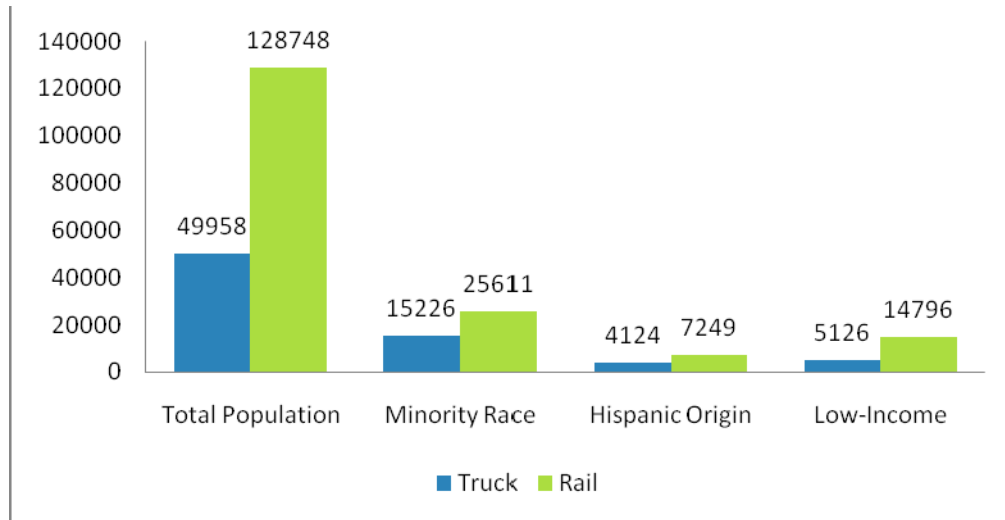
**Table 3      Pollutant Rate (g/TEU mile)**

	<b>CO2</b>	<b>SOx</b>	<b>NOx</b>	<b>PM10</b>
<b>Truck</b>	.833	0.008	10.709	0.246
<b>Rail</b>	.317	0.003	4.447	0.154

### **Comparison**

#### **Exposure to Emissions by the Proximate Populations**

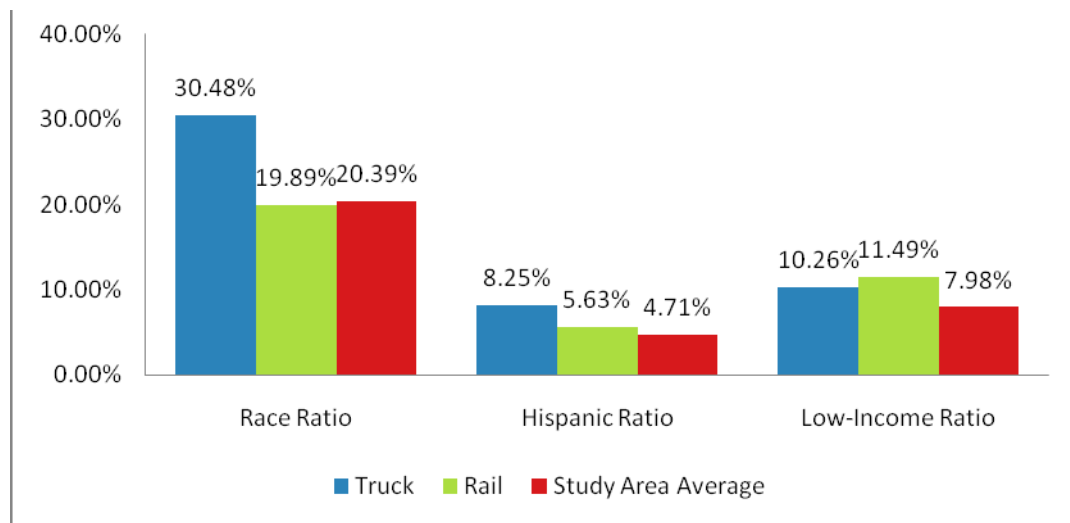
Looking at Table 3, it would be easy to conclude that moving freight from truck to rail would be environmentally advantageous. The emissions per TEU mile for a rail engine are lower. However, table 2 showed that there is a significantly higher population or persons living near the rail lines, so one must consider some aggregate of emissions and total population to look at real exposure. A low emissions option that exposes more people may not be better than a higher option that exposes fewer people, particularly when considering PM10 emissions. As shown in the literature review, particulate emissions have been found to be a contributing factor to chronic pulmonary conditions, like asthma. Figure 4 illustrates the exposed population both from truck freight and rail freight.



**Figure 4 Exposed Population to Truck and Rail Freight**

### **Environmental Justice Population Ratio**

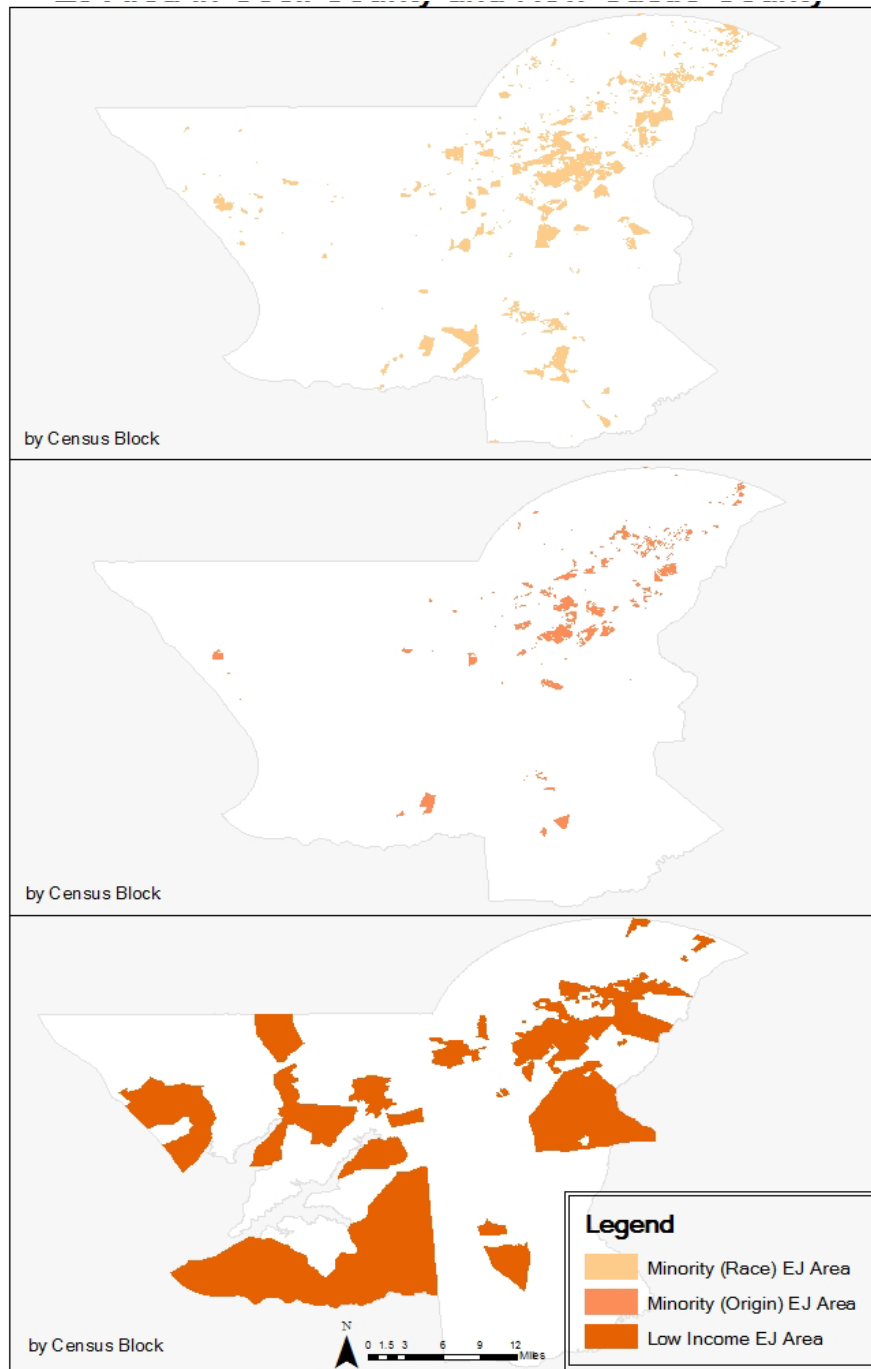
When dealing of issues like EJ, one must consider the constituencies affected. The percentage of minorities by race, minorities by origin and incomes below poverty line are higher in the two freight corridors then the average for the two county region. Figure 5 illustrates the difference among EJ population ratios of area exposed from truck, that of area exposed from rail, and the region average.



**Figure 5      Environmental Justice Population Ratios**

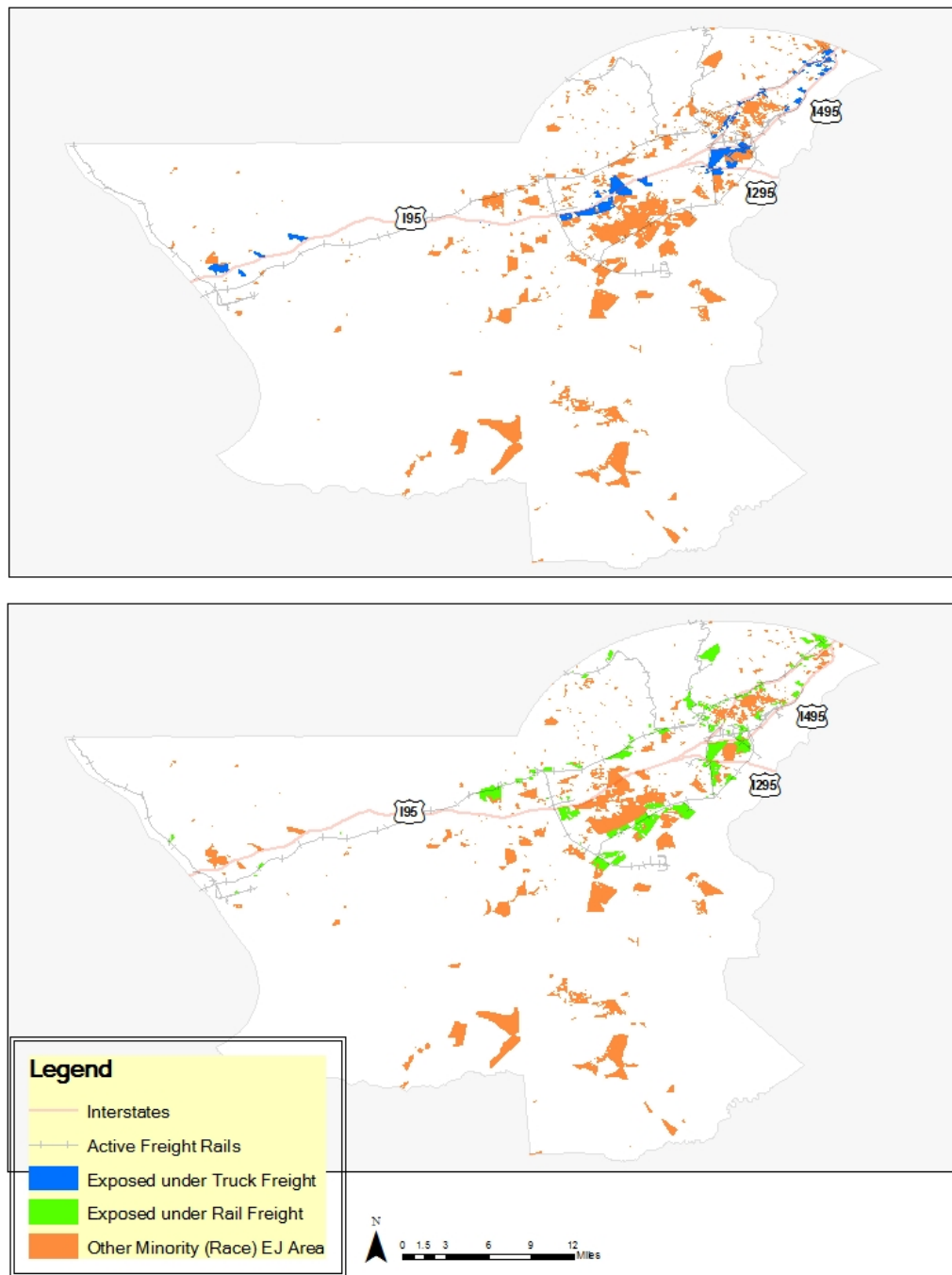
### **Exposed Environmental Justice Area**

It can also be useful to look at the geographic distribution of the three EJ population factors across the 10000 census blocks of Cecil County and New Castle County. The areas highlighted on the figures below represent census blocks where the EJ population is higher than the regional average. Of 10000 census blocks, 1803 blocks are highlighted as the minority race Environmental Justice area, 671 as the minority ethnicity EJ area and 4127 blocks are identified as low-income EJ area. The following is the map of Environmental Justice areas in Cecil County and New Castle County.

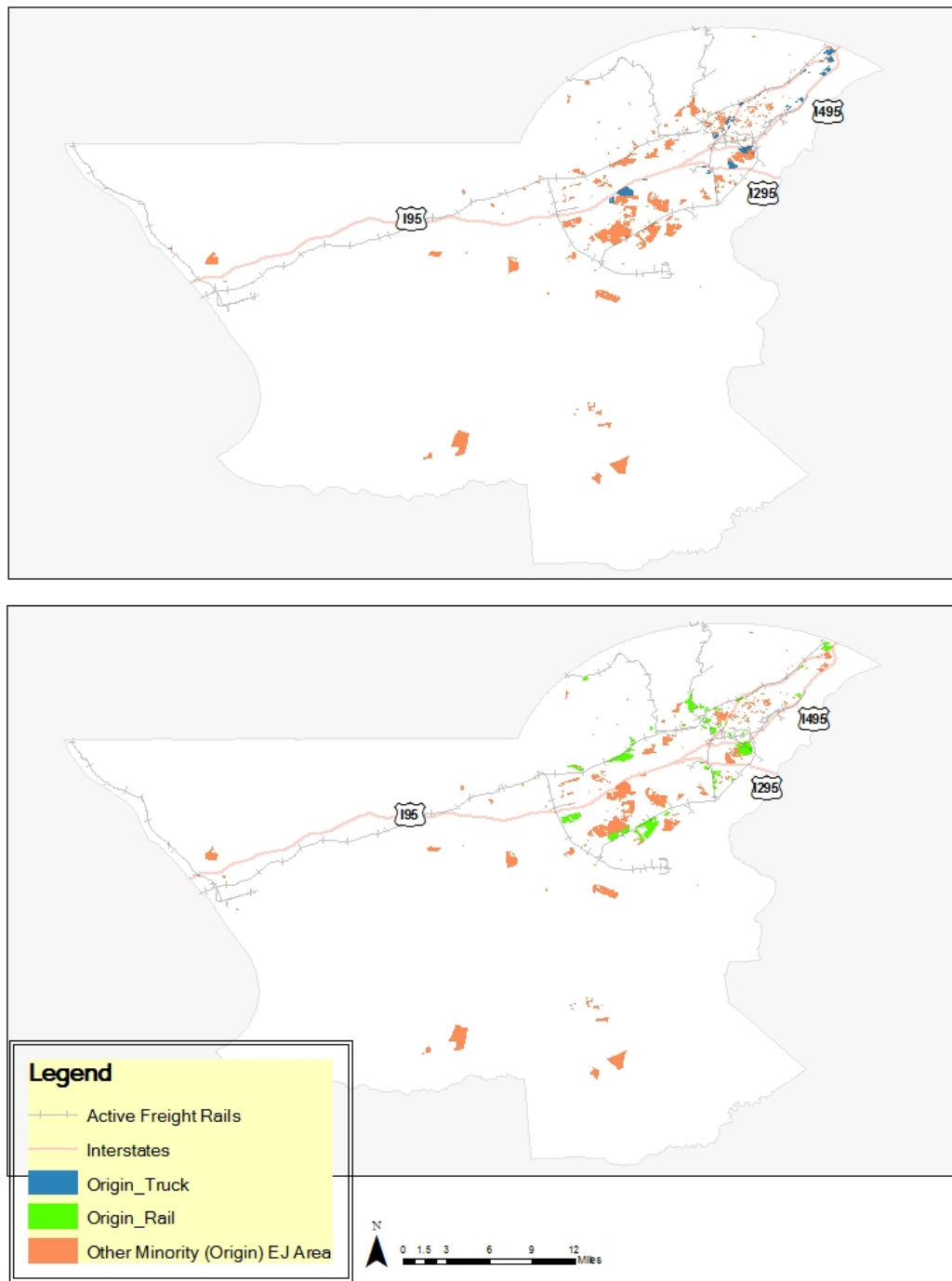


**Figure 6** Environmental Justice areas in Cecil County and New Castle County

The following maps help illustrate the freight emissions exposed census blocks in the context of the two county area. (Figures 7, 8, 9 and 10).

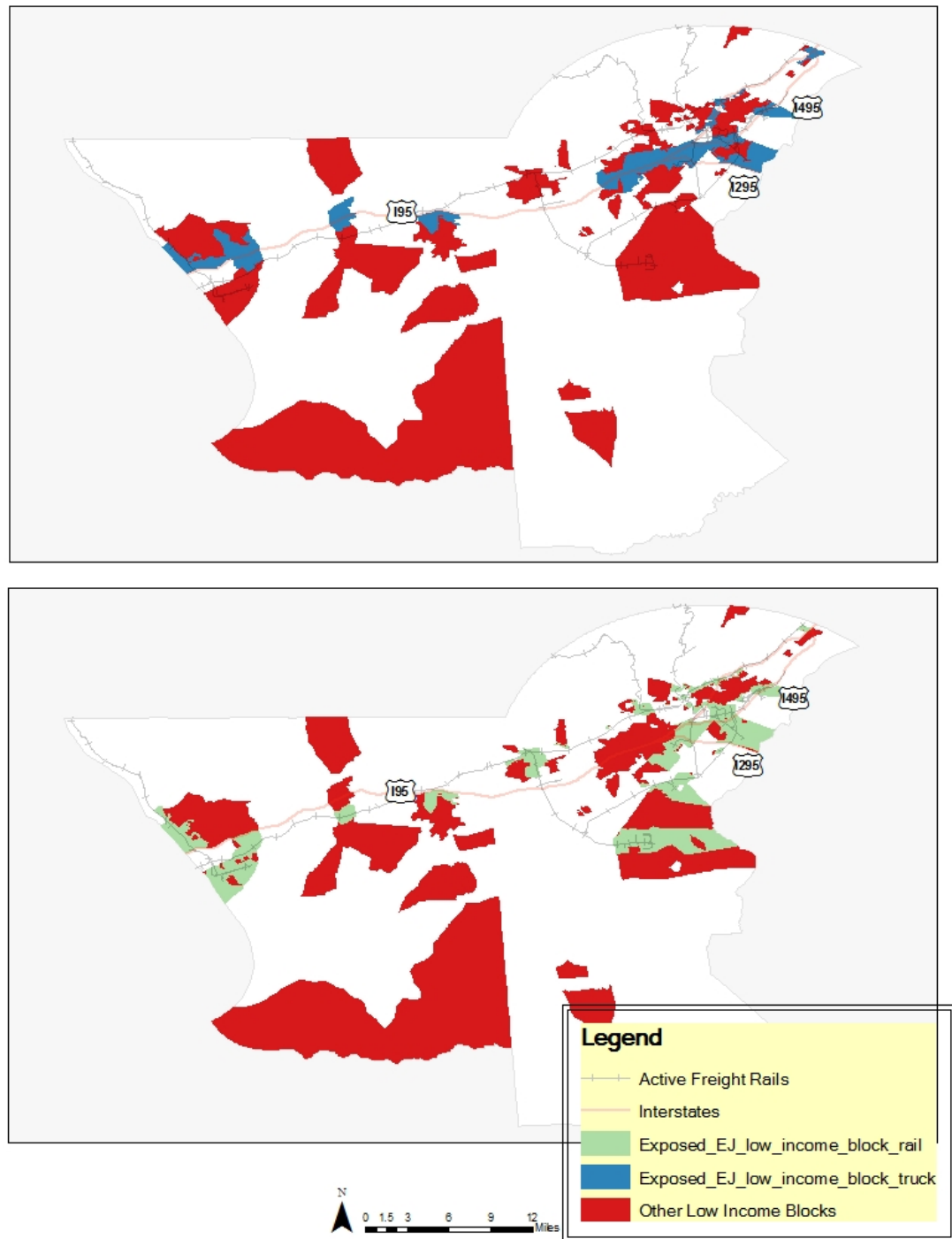


**Figure 7** Exposed minority area by race

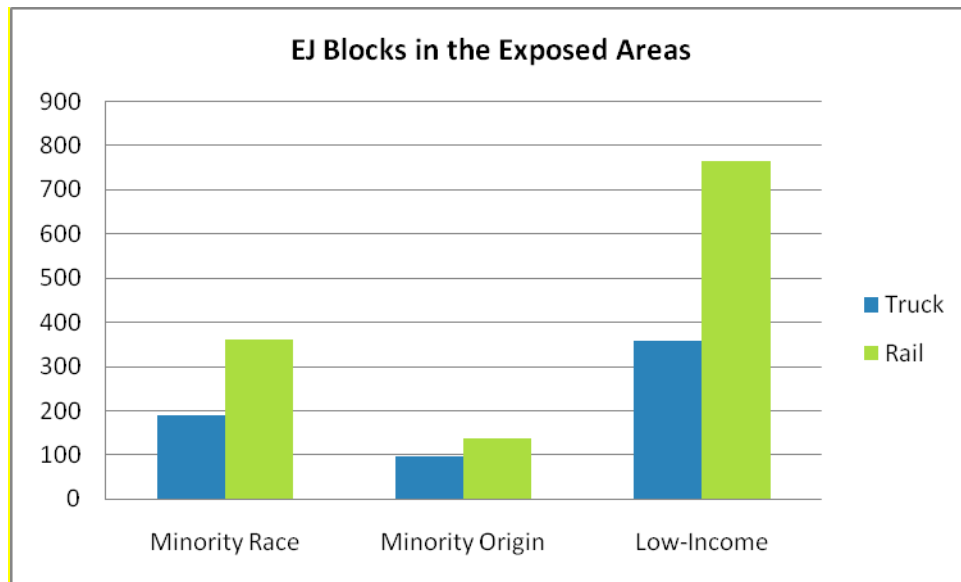


**Figure 8** Exposed minority area by origin





**Figure 9** Exposed Environmental Justice area by low-income



**Figure 10** Exposed Environmental Justice blocks

## **Chapter 5**

### **CONCLUSION**

While labeled as Environmental Justice analyses, these analyses are more accurately described as Transportation Investment Equity studies. Current federal policy and MPO implementation does not consider the impact of emissions on nearby populations and the fact that EJ populations may reside along these corridors in higher percentages than may be found in the region. While investments to moving freight from truck to rail may reduce emissions on a per TEU mile basis, one must also take into consideration the population being exposed to those emissions. This study has only considered direct engine emissions, but other factors such as noise and overall quality of life could play a part in true EJ analysis.

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