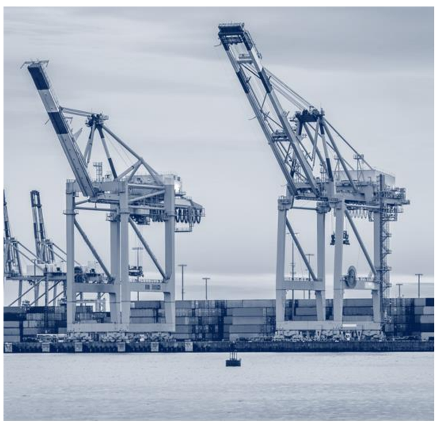
Newark Community Impacts of Mobile Source Emissions

A Community-Based Participatory Research Analysis





MJB & A

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Lead Authors:

Paul Allen, Dana Lowell, Luke Hellgren, Jane Culkin, Dave Seamonds, and Grace Van Horn (*M. J. Bradley & Associates*)

Reviewers:

Ana Isabel Baptista, PhD (*New Jersey Environmental Justice Alliance*)
Nicky Sheats, PhD (*New Jersey Environmental Justice Alliance*)

In consultation with:

Luke Tonachel (*Natural Resources Defense Council*)
Members of the Coalition for Healthy Ports (*including Greenfaith, Ironbound Community Corporation, New Jersey Clean Water Action, and New Jersey Environmental Justice Alliance*)

Funding for this report was provided by the Natural Resources Defense Council (NRDC). Lead manager for NRDC was Luke Tonachel.

About New Jersey Environmental Justice Alliance

The NJEJA (the Alliance, or NJEJA) is an alliance of New Jersey-based organizations and individuals committed to working together to create healthy, sustainable and just communities by eliminating environmental injustices in low income and communities Of Color. Together we support and work with communities through local, state, and national policy development, targeted campaigns and organizing, education, advocacy, training and technical assistance focused on critical environmental justice issues.

About M.J. Bradley & Associates

M.J. Bradley & Associates, LLC (MJB&A), founded in 1994, is a strategic consulting firm focused on energy and environmental issues. The firm includes a multi-disciplinary team of experts with backgrounds in economics, law, engineering, and policy. The company works with private companies, public agencies, and non-profit organizations to understand and evaluate environmental regulations and policy, facilitate multi-stakeholder initiatives, shape business strategies, and deploy clean energy technologies. In March 2020, MJB&A became a part of ERM, the world's leading sustainability consultancy. ERM has more than 5,500 technical experts and thought leaders in over 40 countries and territories.

For questions or comments, please contact:

Paul Allen
Senior Vice President
M.J. Bradley & Associates, LLC
+1 202 847 0088
pallen@mjbradley.com

Introduction and Executive Summary

The transportation and mobile source sector in New Jersey significantly contributes to air quality issues within the state: in 2017, mobile sources contributed 71 percent of nitrogen oxides (NOx) and 27 percent of fine particulate matter ($PM_{2.5}$) statewide.[1] Transportation is also the largest contributor (42 percent) to the state's greenhouse gas (GHG) emissions.[2] Reducing emissions from this sector will be critical if the state is to meet its emissions reduction goals and improve air quality, especially within disproportionately burdened, environmental justice (EJ) communities which experience higher levels of air pollutants known to impact human health such as $PM_{2.5}$ and NOx.

There is an extensive body of empirical evidence detailing the health impacts of diesel and other goods movement related transportation emissions in environmental justice communities (communities Of Color and low-income communities). In New Jersey, there is a pattern of proximity to goods movement and transportation infrastructure largely in communities Of Color and low wealth areas of the state. For example, a recent study produced by the Union of Concerned Scientists found that communities Of Color throughout the Northeast and Mid-Atlantic are more likely to be exposed to high levels of $PM_{2.5}$, which contributes to higher levels of asthma, lung cancer, and heart disease within these communities.[3]

Efforts to drive down emissions in this sector are often focused on electrification of vehicles, especially passenger vehicles. However, passenger vehicles, or even transportation broadly, are not the only significant contributor of harmful air pollution across environmental justice communities. While electrification can have a meaningful impact across the transportation sector, electrification efforts should also carefully consider the equity and health implications that electrification scenarios will have on these particularly overburdened parts of the state: these same areas are also home to fossil fuel energy infrastructure that may be part of the electrification of the transportation sector.

Environmental justice communities are increasingly calling for the examination and prioritization of reducing co-pollutants in climate mitigation strategies.[4] The legacy of cumulative impacts from multiple sources of pollution in communities Of Color and low wealth communities requires that every opportunity to reduce health-harming emissions be explored. While climate mitigation efforts, including those targeting the transportation sector, are focused on GHG emissions, there are important opportunities to target the reduction of co-pollutants such as PM, NOx, sulfur dioxide and harmful air pollutants. This approach will appropriately center equity and immediate health impacts in considering policies to address climate change.

In New Jersey, while vehicle emissions contribute broadly to both GHG and harmful local air pollution, emissions from diesel trucks and buses emit higher levels of air pollution which can lead to even greater health concerns in populations who are more directly exposed to diesel emissions. Communities located adjacent to ports and related goods movement infrastructure (e.g., warehouses, logistics centers, railyards, etc.) experience higher levels of truck traffic, both from surrounding thruways and on local streets, which exacerbate health concerns. Since these emissions are local in their effects, policies to reduce transportation emissions from medium- and heavy-duty vehicles can significantly improve the health and well-being of communities in urban areas or around transportation corridors, which are often Of Color, low-income or otherwise vulnerable or disadvantaged communities.

[1] https://www.nj.gov/dep/baqp/inventory.html

[2] https://www.nj.gov/dep/aqes/oce-ghgei.html

[3] Union of Concerned Scientists. (2019). Inequitable Exposure to Air Pollution from Vehicles in the Northeast and Mid-Atlantic Fact Sheet. https://www.ucsusa.org/sites/default/files/attach/2019/06/Inequitable-Exposure-to-Vehicle-Pollution-Northeast-Mid-Atlantic-Region.pdf

[4] Sheats, N. (2016). Achieving emissions reductions for environmental justice communities through climate change mitigation policy. Wm. & Mary Envtl. L. & Pol'y Rev., 41, 377.

This community-based participatory research project, completed in partnership with the New Jersey Environmental Justice Alliance (NJEJA) and the Natural Resource Defense Council (NRDC), evaluates the transportation-related pollution burden that environmental justice communities experience in and around port-adjacent communities in Newark, New Jersey. It highlights which transportation sources are the largest contributors to pollution exposure across the region generally and in specific hot spot areas. It then analyzes potential pathways, specifically focused on electrification, to reduce transportation-related emissions.

This analysis evaluates the distribution and intensity of vehicle emissions within the study area, and pathways for their reduction, by: 1) creating a comprehensive inventory of nearby vehicle emissions data across the marine and ground transportation sectors; 2) calculating relative emissions and emissions exposure within the entire study area as well as at specific locations determined by NJEJA and allies; and, 3) evaluating electrification pathways to reduce vehicle emissions.

Key Findings from Analysis

1) **The highest transportation emissions burden can be found in locations close to high density truck and bus routes and locations close to port facilities and rail yards.** However, the analysis shows that total emissions exposure, and relative contribution from different transportation sources, varies significantly across the study area.

2) **Emissions of $PM_{2.5}$, black carbon, and NOx from non-roadway sources, particularly locomotives and port operations, have the highest air quality impact in the total study area, followed by medium- and heavy-duty vehicles.** These sources far outweigh the emissions exposure from passenger vehicles and together contribute around 95 percent of the total emissions exposure modeled within the study area (from mobile source emissions).

3) **Population centers and residential areas in close proximity to roadway emissions would benefit from efforts to reduce emissions from medium- and heavy- duty vehicles which can significantly reduce air emissions of particulates and NOx within certain key locations in the study area**. The analysis shows that while electrification could be one path to these reductions, electrification of these vehicles must be accompanied by a focus on emissions reductions from electric generating units co-located within the same community in order to ensure a reduction in overall air pollution burden.

Study Design and Local Community Leadership and Engagement

This study was conducted in close consultation with the New Jersey Environmental Justice Alliance (NJEJA). NJEJA is a statewide alliance of organizations and individuals focused on a wide range of environmental justice issues.

Following a community-based participatory research model, this study built on strengths and resources within the community to integrate and achieve a balance between research and action for the mutual benefit of all partners. As an equal partner in the project, NJEJA provided critical guidance and input through their place-based experience and local data as well as helping to shape the study to ensure its usefulness for local applications. This guidance took many forms, including:

- Establishing study geographic scope;
- Determining included sources and emissions (within the analytical restrictions of this study);
- Identifying local hot spots (e.g. idling locations) and possible sensitive areas (e.g., schools) for deep analysis;
- Helping to prioritize pollutants and mobile sources of interest;
- Facilitating feedback of local residents and advocates through the Coalition for Healthy Ports (CHPS); and
- Shaping scenarios and highlighting local priorities for electrification analysis.

These elements are of vital importance to the communities located within the study area and were included because community leaders were able to bring these considerations to light. This bias to action approach to the research ensured that the aims of the study aligned with the goals of the groups advancing strategies for environmental justice with respect to transportation climate mitigation strategies. The results of this study help refine and prioritize the necessary interventions to reduce emissions with the greatest impact in environmental justice communities in close proximity to transportation infrastructure like seaports, airports, and highways.

Figure 1 Key Demographics of Study Area

	Study Area	New Jersey
Population	209,000	8,880,000
Population, % of Color	58%	32%
Median household income[1]	~$44,000	~$88,000
Burdened communities[2]	47 of 52 (90%)	662 of 1,987 (33%)

Adapted from U.S. Census Bureau 2014-2018 American Community Survey Estimates

[1] Population-weighted average estimate
[2] Defined as any census tract, as delineated in the most recent federal decennial census, that is ranked in the bottom 33 percent of census tracts in the State for median annual household income

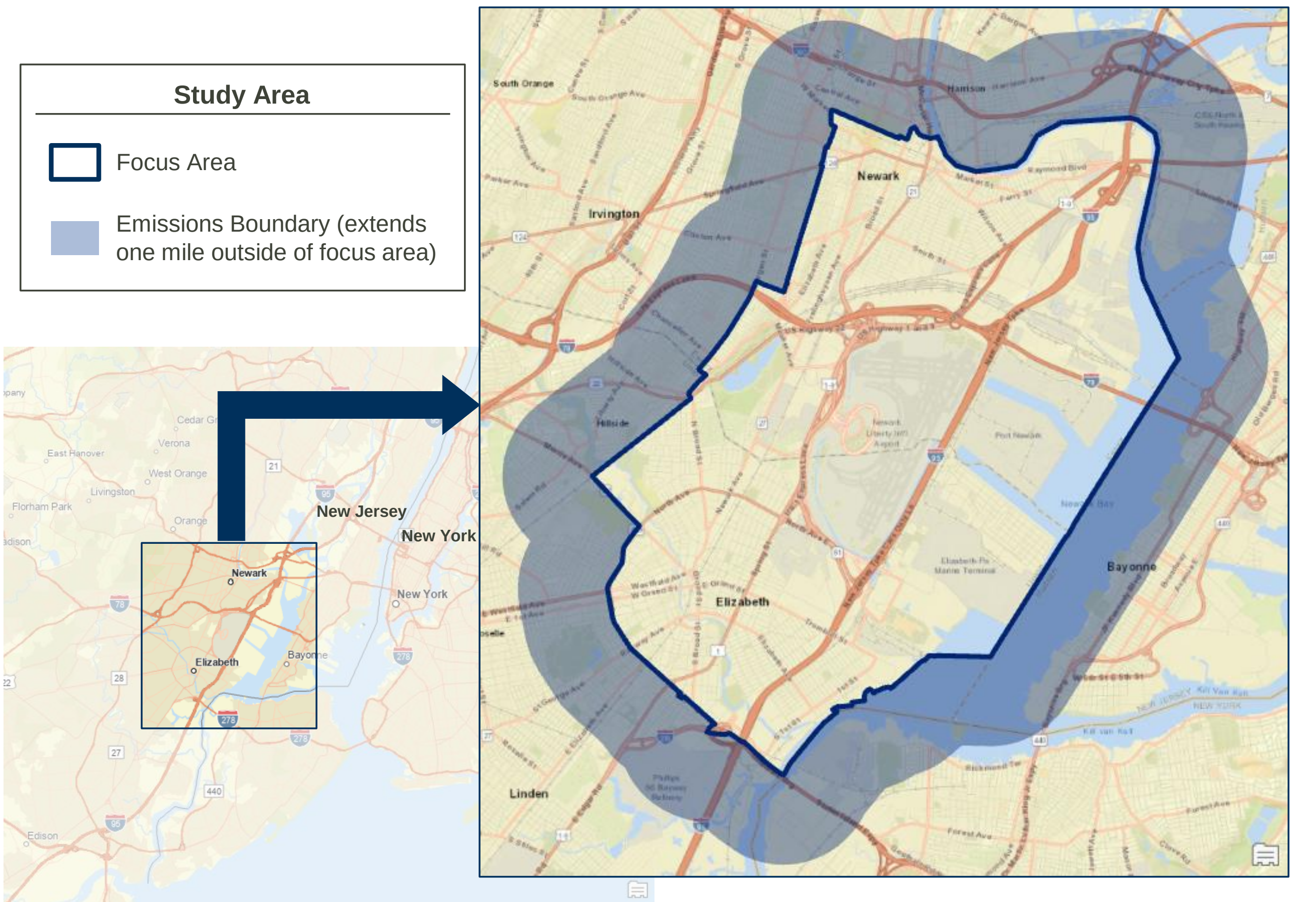
Methodology

MJB&A conducted a two-phase analysis in and around the ports of Newark and Elizabeth to evaluate transportation-related emissions and calculate how these emissions accumulate across the region to result in total emissions exposure. Phase One constituted developing a detailed inventory of roadway and non-roadway mobile source emissions, while Phase Two evaluated relative emissions and emissions exposure across the region and in particular in key areas.[5]

Working with NJEJA, MJB&A defined a study area that included much of southeast Newark and north Elizabeth, including Newark Airport and the ports of Newark and Elizabeth. By including both roadway and non-roadway sources, it covered key emissions known to negatively impact human health and the environment—specifically, NOx, fine particulate matter ($PM_{2.5}$), black carbon, and carbon dioxide (CO_2). To account for emission dispersion and ensure that emissions that may impact communities were included, a one-mile buffer (displayed in blue in Figure 2) was added to the analysis.

In this study, we use the term "emissions" to mean modeled emissions from transportation *sources in* the study area (or a subset of the study area). "Exposure" is a function of both emissions and dispersion and refers to the *cumulative (transportation) emissions impact* experienced at a location or area; that is, emissions from nearby transportation sources are included as well as those that have been carried by wind to a location from other sources.

Figure 2 Geographic Scope and Study Area



[5] See Appendix A for a detailed methodology.

Phase One: Emissions Inventory

Phase One created an inventory of local transportation emissions using both top-down and bottom-up approaches. This analysis was based on publicly available resources, purchased vehicle registration data, and adjustments using spatial analysis to account for local characteristics. Emission sources were disaggregated to the furthest extent possible to provide the most accurate and transparent representation of transportation-related emissions in the area. This inventory is comprised of a collection of 75 unique emission sources (48 roadway sources and 27 non-roadway sources) that have different emission factors, dispersion characteristics, and ultimately, contributions to emissions exposure.[6]

Roadway Emissions

MJB&A used a combination of spatial traffic datasets and Newark-specific summary traffic/vehicle data to create a traffic inventory that provided a detailed breakdown of vehicle miles traveled (VMT) by vehicle type, roadway type, county, and zip code, where applicable.

To translate VMT to emissions, MJB&A applied emissions factors to the most dominant vehicles stock at the state-, county-, and zip code-level for each roadway type. Figure 3 identifies each roadway sources captured within the emissions inventory and displays vehicle traffic on all roadways included in the analysis.

Figure 3 Roadway Mobile Emission Sources

Included Vehicles

Light-duty vehicles

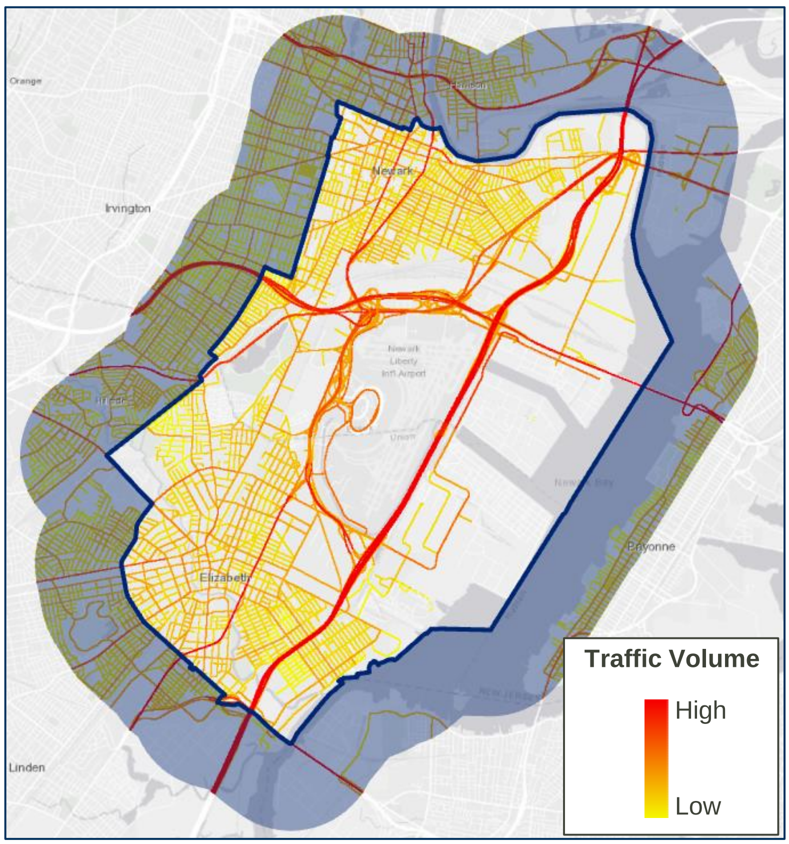
- Motorcycle
- Passenger car
- Light-duty truck

Medium-/Heavy-duty vehicles

- Single-unit truck
- Combination Truck

Buses

- School bus
- Intercity bus
- NJ Transit Bus (NJ Transit-designated routes only)



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[6] Note that this emissions inventory and subsequential dispersion analysis are not comprehensive of all emission sources located within the study area. This analysis focused on select, transportation-related mobile sources and did not account for other potential sources of emissions, such as (but not limited to) electric generating units, industrial manufacturing facilities, oil refineries, buildings, construction, and airplanes (landing, taking off, and taxiing).

Non-Roadway Emissions

In addition to roadway emissions, this analysis focused on select non-roadway mobile emission sources located within railyards, port facilities, and the Newark International Airport; specific "hotspot" locations where heavy-duty diesel vehicles idle were also included.[7] MJB&A utilized data from the Port Authority of New York and New Jersey (PANYNJ) 2016 Greenhouse Gas and Criteria Pollutant Emissions Inventory for base port and airport emissions. Additional adjustments were required to allocate emissions from commercial marine vessels to specific ports. Using best available locomotive activity data for the relevant railyards, MJB&A performed detailed emissions analyses to estimate locomotive emissions within each railyard.

For each of these sources, all emissions within each source area were assumed to originate in an evenly distributed manner across the source (e.g., across the entire area of the railyard or port berth). Figure 4 identifies each non-roadway source captured within the emissions inventory and shows the boundaries and locations associated with each source.

Figure 4 Non-Roadway Mobile Emission Sources

Included Areas & Locations

Port[1]

1. Port Elizabeth
2. Port Newark
3. Howland Hook

Railyard[2]

4. ExpressRail Elizabeth
5. ExpressRail Staten Island
6. South Kearny
7. NS E-Rail
8. Oak Island
9. Trumbull

Airport[3]

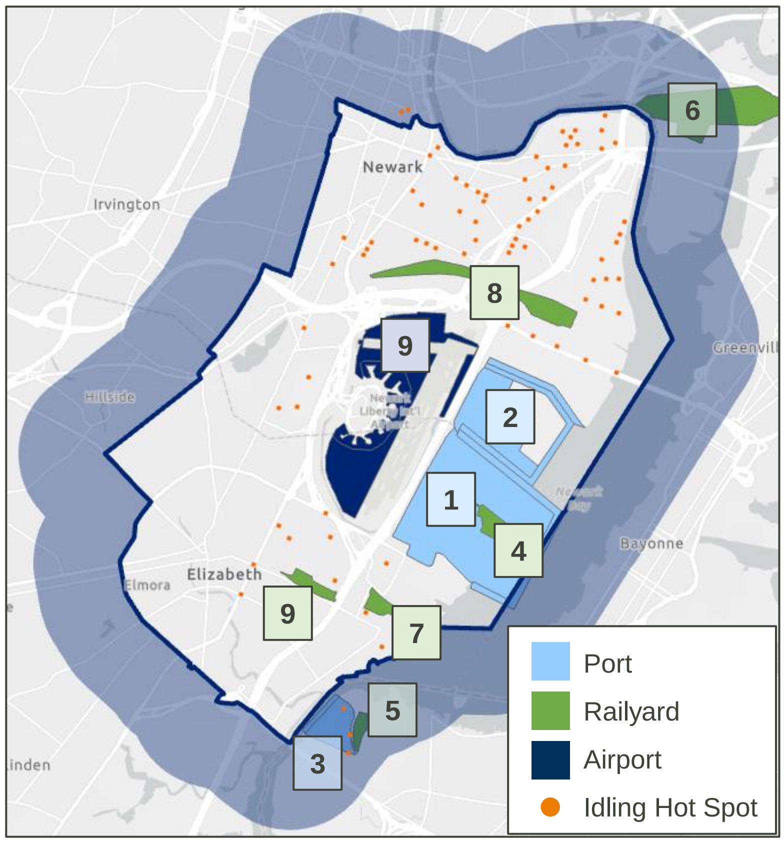
10. Newark International Airport

Heavy-duty diesel truck idling

- Identified hotspots

Emission Sources

[1] Cargo handling equipment, commercial marine vessels, & on-port heavy-duty diesel vehicles
[2] Switch & line-haul locomotives
[3] Ground support equipment & auxiliary power units



Phase Two: Emissions Evaluation

In Phase Two, MJB&A evaluated transportation emissions by utilizing the emissions inventory developed in Phase One to: 1) create heat maps of emissions exposure across the community and 2) evaluate the effect that policy interventions would have on emissions exposure under a range of electrification scenarios (e.g., low-to-high and in select policy-specific cases).

[7] Emissions from heavy-duty diesel vehicle idling are considered to be port-related activity (e.g., non-roadway) but occur on or along roadways and are referred to as roadway sources in the remaining report

To determine the level of emissions exposure experienced at any given location or area within the study area, MJB&A performed a dispersion analysis that modeled the movement of each pollutant. Although this analysis is a simplification of atmospheric dispersion modeling that can be used to develop air quality standards,[8] it does account for important factors that affect pollutant dispersion, such as fuel-source specific emission impact curves and wind direction. MJB&A utilized U.S. EPA AERSCREEN modeling tools to create engine-specific emission impact curves[9] to estimate the relative magnitude of emissions downwind from the source. These impact curves were combined with local wind data to create wind-adjusted impact functions that accounted for 360-degree dispersion out to one mile from the emissions source.

These impact functions were then applied to the emissions inventory created in Phase One to produce source-specific, spatial emission dispersion data. Ultimately, the outputs (or "exposure" values) of each dispersion analysis were aggregated to produce cumulative values; Figure 5 shows an illustrative example of how cumulative exposure values were calculated.

These spatial, cumulative exposure values enabled the ability to characterize relative pollution exposure at any location or within any defined area in the study area. To highlight the most impactful emission sources and identify emissions reduction interventions that could have the largest impact in the area, MJB&A performed detailed analyses at key "receptor sites" provided by NJEJA (displayed in Figure 6).[10] A case study of Hawkins Street Elementary School (receptor site #3) is further discussed on pages 12 and 13.

Figure 5 Illustration of Cumulative Exposure Calculation

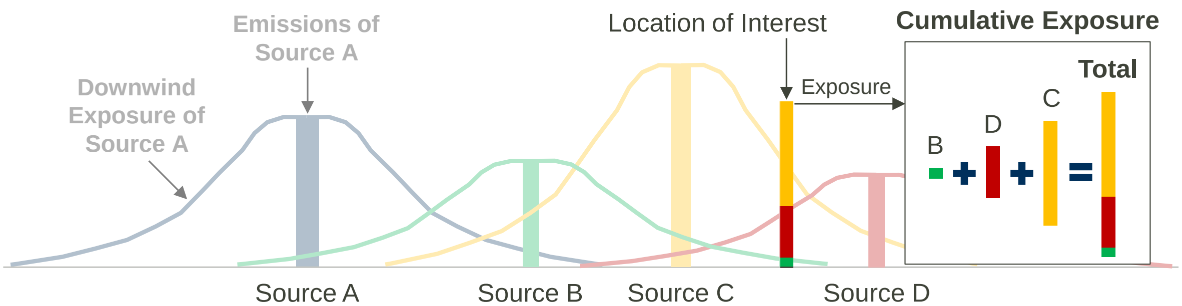
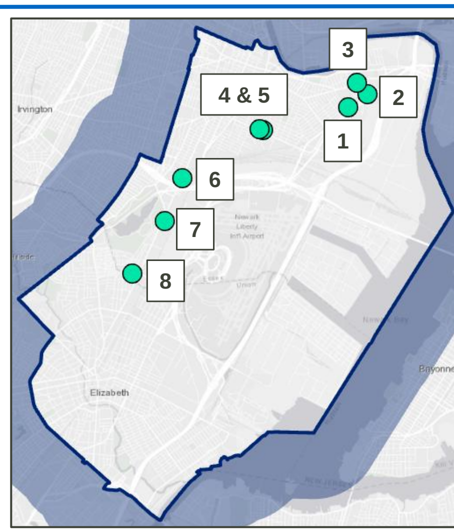


Figure 6 NJEJA Receptor Sites

Receptor Sites

1. Ironbound Aquatic Center
2. Newark Pre-School Council
3. Hawkins Street Elementary School
4. St. Justine II Pre-School
5. Fresenius Kidney Care Center
6. The Harbor
7. DaVita Parkside Dialysis Center
8. Kretchmer Senior Center



[8] Output of this analysis ("exposure" values) may be viewed as proportional to typical atmospheric dispersion model outputs (e.g., pollutant concentrations given as grams per cubic meter) but should not be directly compared

[9] Generic dispersion curves were modeled for all relevant engine types; see Appendix B for more information

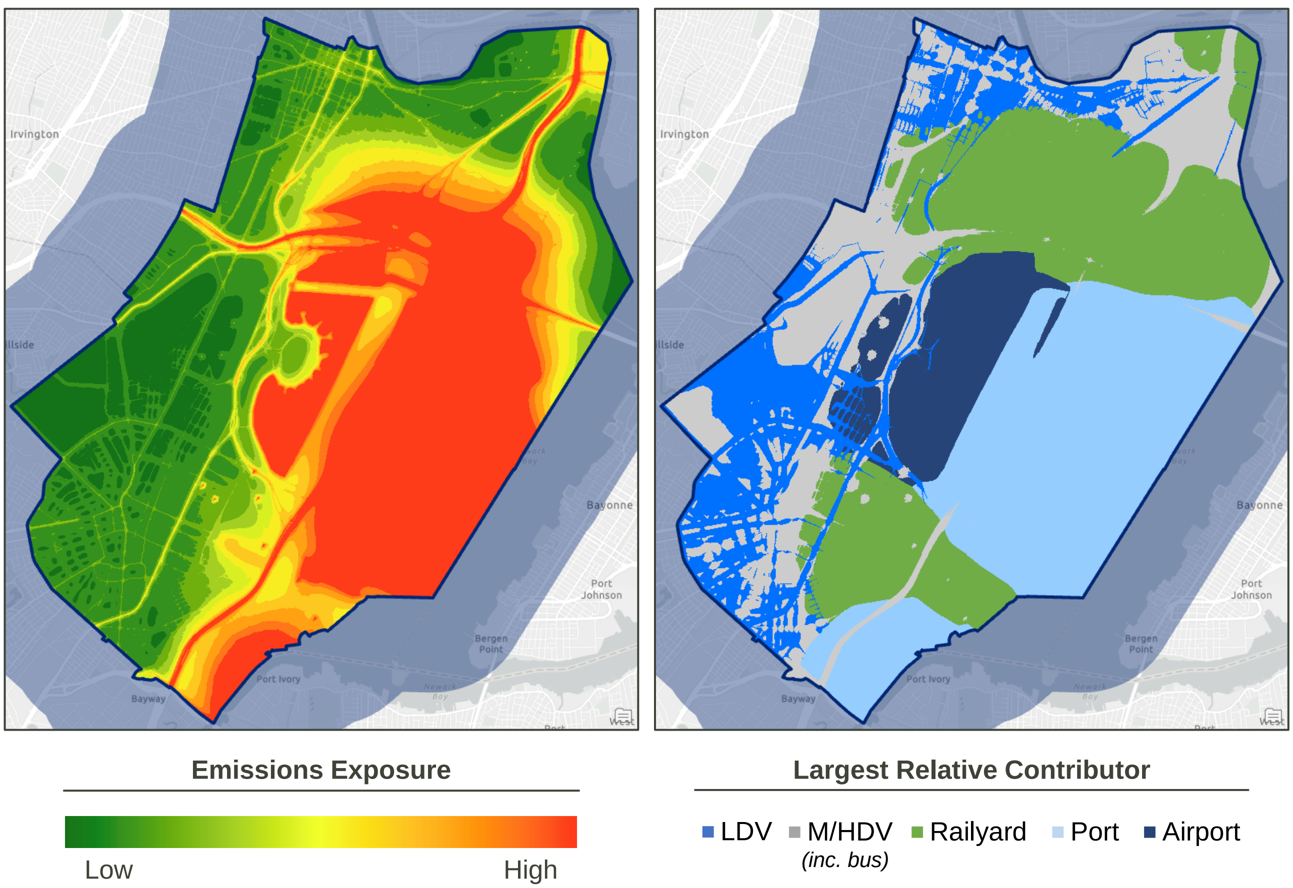
[10] See Appendix C for results from each receptor site.

Key Findings

Total emissions exposure, and relative contribution from different transportation sources, varies significantly across the study area.

This analysis finds that those emissions sources that contribute most to a location's exposure may be up to a mile away from the study area and that community exposure to pollution is affected by both nearby emissions and total exposure from sources that are not in the immediate vicinity.[11] Since pollutant exposure is a function of both emissions and dispersion, locations with the highest exposure are likely to be close to, and downwind from, port facilities, railyards, and high-density truck and bus routes. Figure 7 presents two different ways to visualize $PM_{2.5}$ emissions exposure experienced throughout the study area.[12] The leftward map represents the relative emissions exposure as a "heat map" to convey how $PM_{2.5}$ exposure varies across the area. The rightward map indicates the emissions source that is most responsible for $PM_{2.5}$ exposure experienced at any given location.[13]

Figure 7 $PM_{2.5}$ Emissions Exposure Across Study Area



[11] As a reminder, in this study, we use the term "emissions" to mean actual emissions from sources in the study area (or a subset of the study area). "Exposure" is a function of both emissions and dispersion and refers to the cumulative emissions impact experienced at a location or area; that is, emissions from nearby sources are included as well as those that have traveled to a location from other sources.

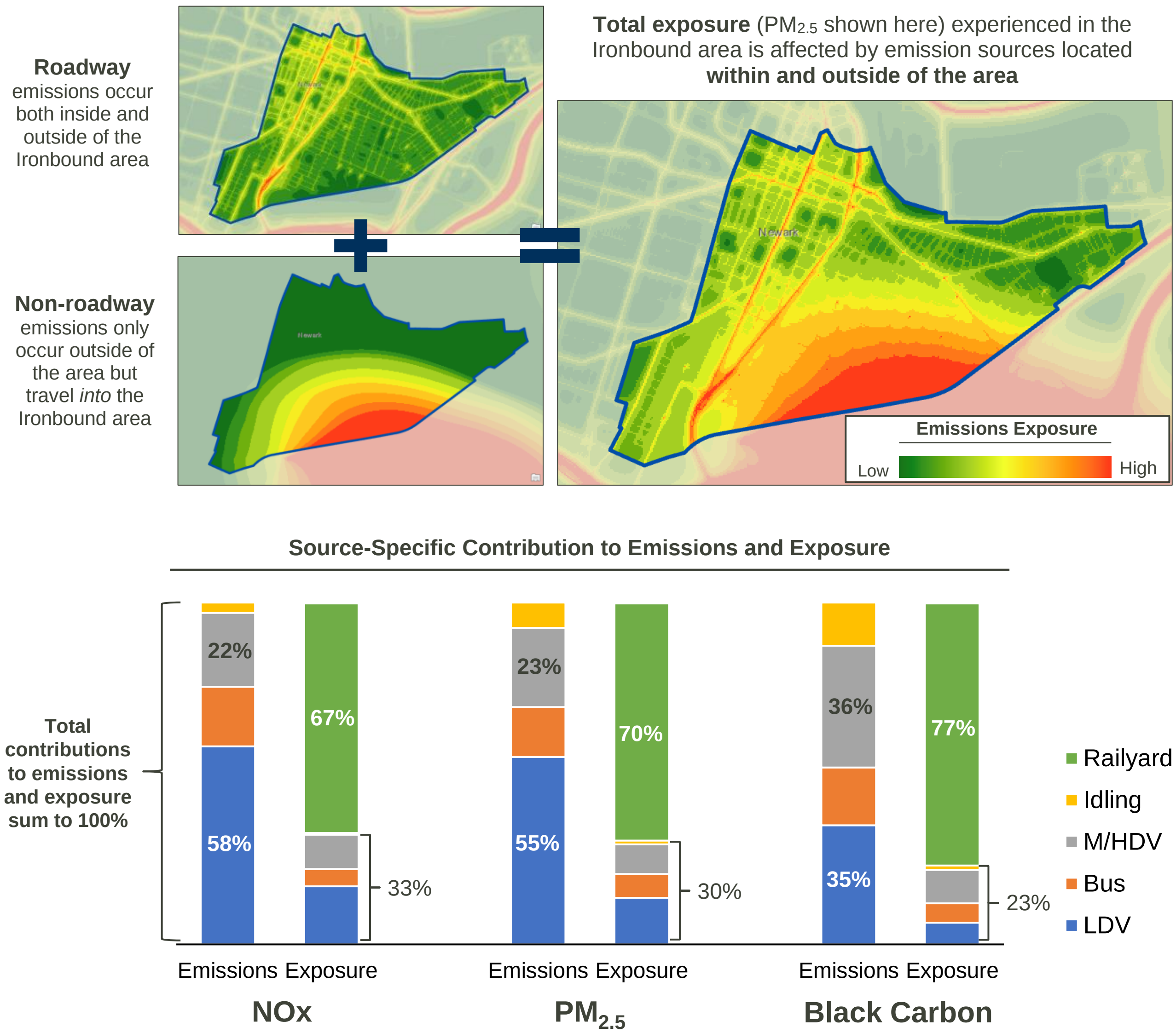
[12] See Appendix B for detailed emission exposure maps by emission source and pollutant (NOx, $PM_{2.5}$, and black carbon) for a more refined spatial visualization of contributing emission sources

[13] Emission sources aggregated as light-duty vehicles, medium-/heavy-duty vehicles (including buses), aggregated railyards, aggregated ports, and Newark International Airport.

As Figure 7 shows, location has a significant impact on the magnitude of exposure and the specific emission sources responsible for that exposure. Railyards, especially, are the primary source of exposure in many neighborhoods and communities around the study area, but high traffic bus and truck routes that travel through and around downtown Newark and Elizabeth are largely responsible for exposure in those areas.

The importance of accounting for pollutant dispersion and movement can also be seen in the Ironbound neighborhood and surrounding area of Newark. This study defined this area with a western border of Dr. Martin Luther King, Jr. Boulevard, extending through downtown and into the North and South Ironbound neighborhoods, bordered by U.S. Route 1 and Raymond Boulevard. Figure 8 shows a heat map of $PM_{2.5}$ emissions exposure within this defined area, which derives from both roadway and non-roadway sources. The chart in Figure 8 explores more detail on how each source contributes, on a relative basis, to emissions and exposure within the Ironbound area. The analysis shows that while total emissions emitted *within the area* primarily derive from light-duty vehicles (or medium- and heavy-duty vehicles for black carbon, specifically), emissions that originate from *outside the area* (in this case, Oak Island railyard to the southeast) are largely responsible for the total emissions exposure experienced within the area.

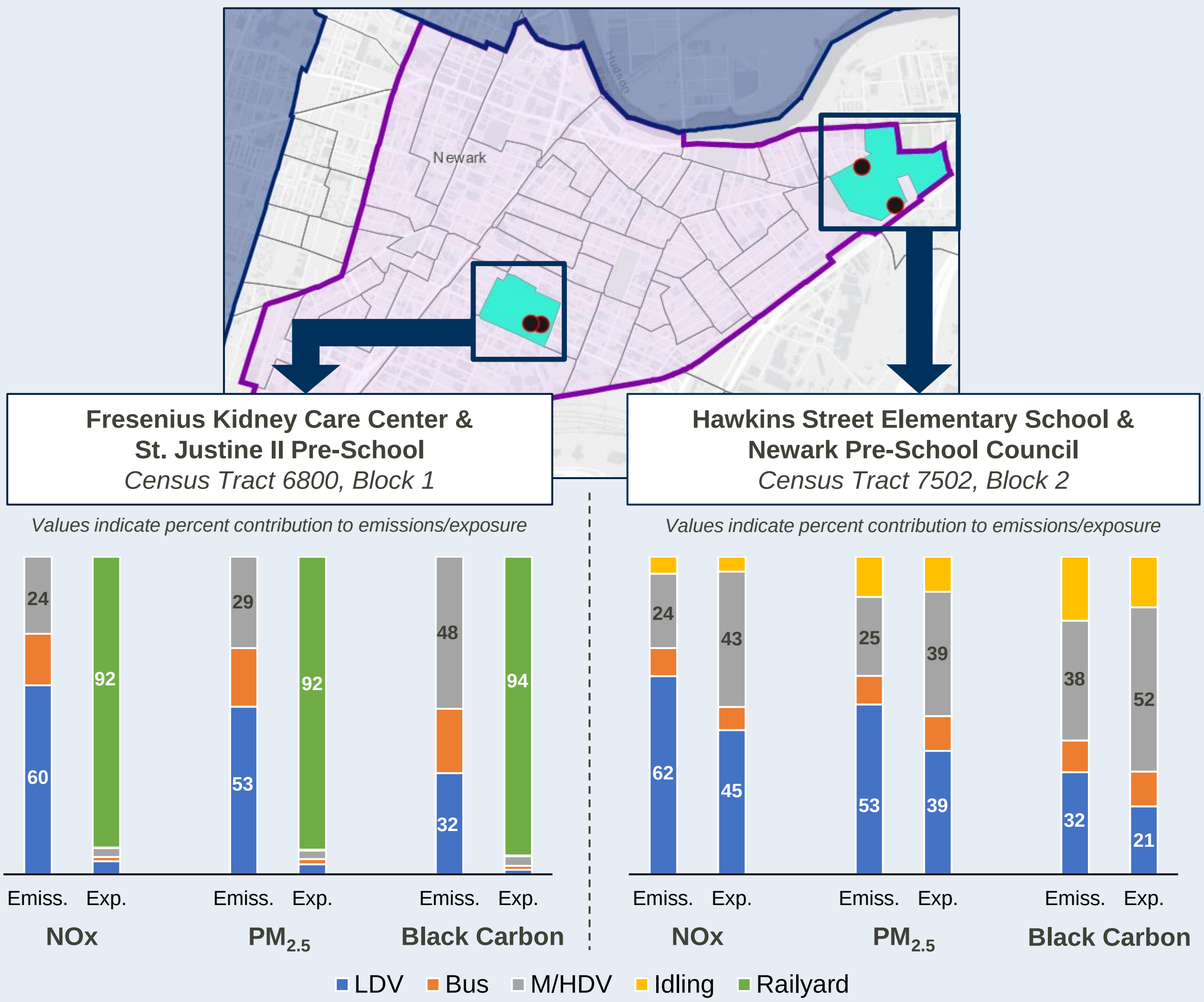
Figure 8 Emissions and Exposure in the Ironbound



Looking at specific locations within the total exposure heat map of Figure 8, one can see how certain points within the neighborhood, for example those around downtown Newark to the north and west, are more affected by exposure from roadway sources. Figure 9 illustrates a case study that was performed around key receptor sites to further highlight how nearby emissions can compare to exposure on a hyper local level. This case study also shows the significance of a location's proximity to emission sources; while non-roadway emissions have a significant impact on the emissions exposure experienced across the Ironbound area, vehicle emissions—particularly those from medium- and heavy-duty vehicles—can also have a major impact on local exposure in certain population centers.

Figure 9 Ironbound Receptor Site Case Studies: Emissions vs. Local Exposure

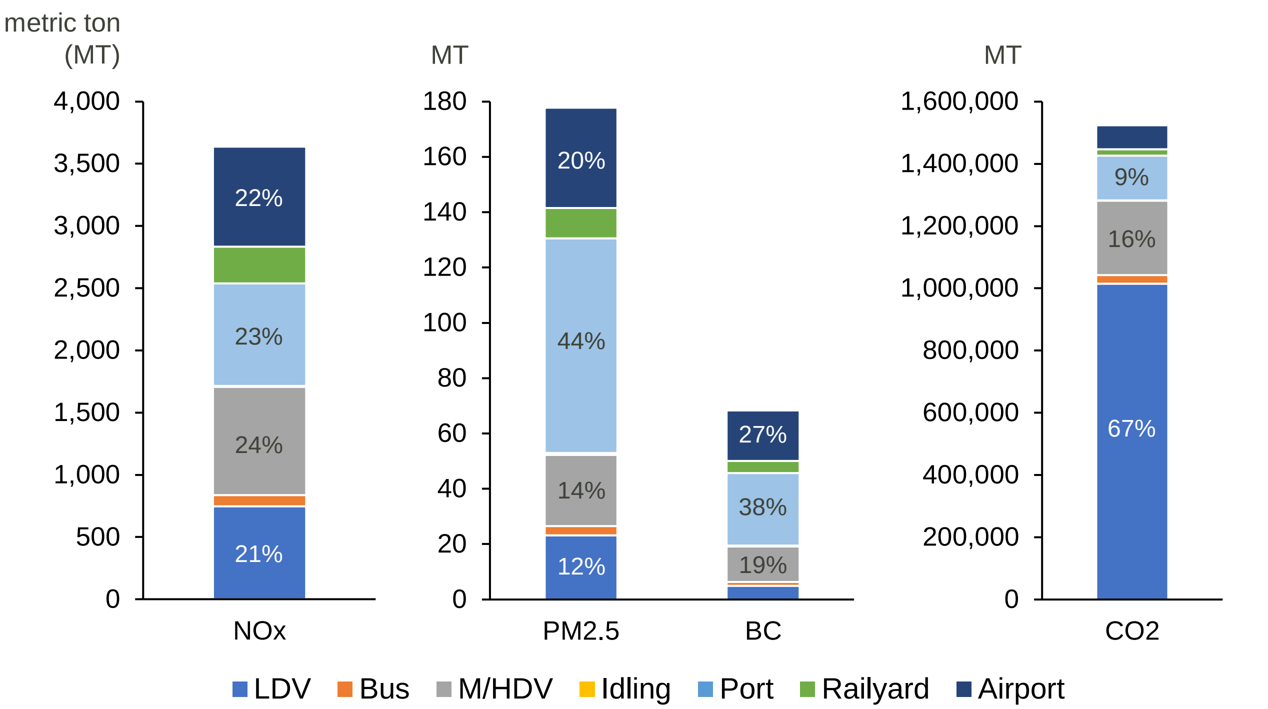
The highlighted areas below are both census tract blocks within the Ironbound and surrounding area. However, the key sources of emissions and exposure for each area vary significantly. Emissions that occur nearby Fresenius Kidney Care Center & St. Justine II Pre-School (within the tract block) derive largely from local traffic, but the pollution exposure experienced within the area is primarily caused by locomotives in Oak Island railyard, located approximately one-third of a mile away. Emissions near Hawkins Elementary and Newark Pre-School Council primarily come from local vehicle traffic, but idling emissions and truck traffic on surrounding highways (US-1 and the NJ Turnpike) contribute more significantly to exposure.



Emissions from non-roadway sources, particularly locomotives and ports operations, have the highest air quality impact in the total study area, followed by medium-and heavy-duty vehicles.

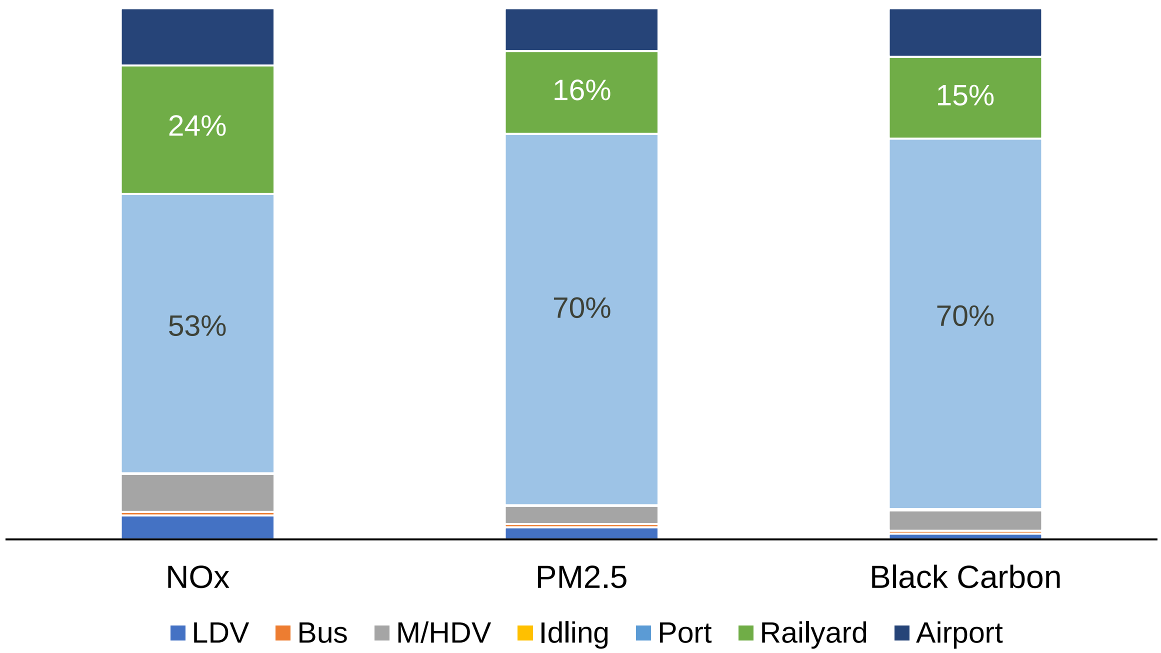
This analysis finds that non-roadway sources are responsible for the majority of $PM_{2.5}$ and black carbon emissions in the study area, while roadway vehicles produce similar NOx to non-roadway sources and much more CO_2. Figure 10 shows how light- and medium-/heavy-duty vehicles in the study area emit about the same amount of NOx as included sources in the airport and ports. However, non-roadway sources—particularly ports—are the dominant contributor to $PM_{2.5}$ and black carbon emissions in the area.

Figure 10 Total Emissions in Study Area, by Source



Although Figure 10 provides insight into emissions produced in the area, the dispersion analysis used to calculate total exposure reveals the even larger impact that ports and railyards have on local communities. As shown in Figure 11, these two sources alone are responsible for 77% of NOx exposure and around 85% of $PM_{2.5}$ and black carbon exposure. Buses and medium- and heavy-duty vehicles are the next largest sources of exposure, contributing jointly to around 8% of NOx and 4% of $PM_{2.5}$ and black carbon exposure.

Figure 11 Relative Contribution to Emissions Exposure within Study Area



While there are some policies in place to reduce the emissions from locomotives and marine vehicles, these vehicle classes have historically presented a much more difficult path for emissions reductions, including through electrification, due to limited policy attention and lack of funding. Policy intervention can help drive further development in this space. As discussed in the following finding, however, it is also important to look at emissions exposure on a very local basis when considering policy interventions.

Population centers and residential areas in close proximity to roadway emissions would benefit from efforts to reduce emissions from medium- and heavy-duty vehicles which can significantly reduce air emissions of particulates and NOx within certain key locations in the study area.

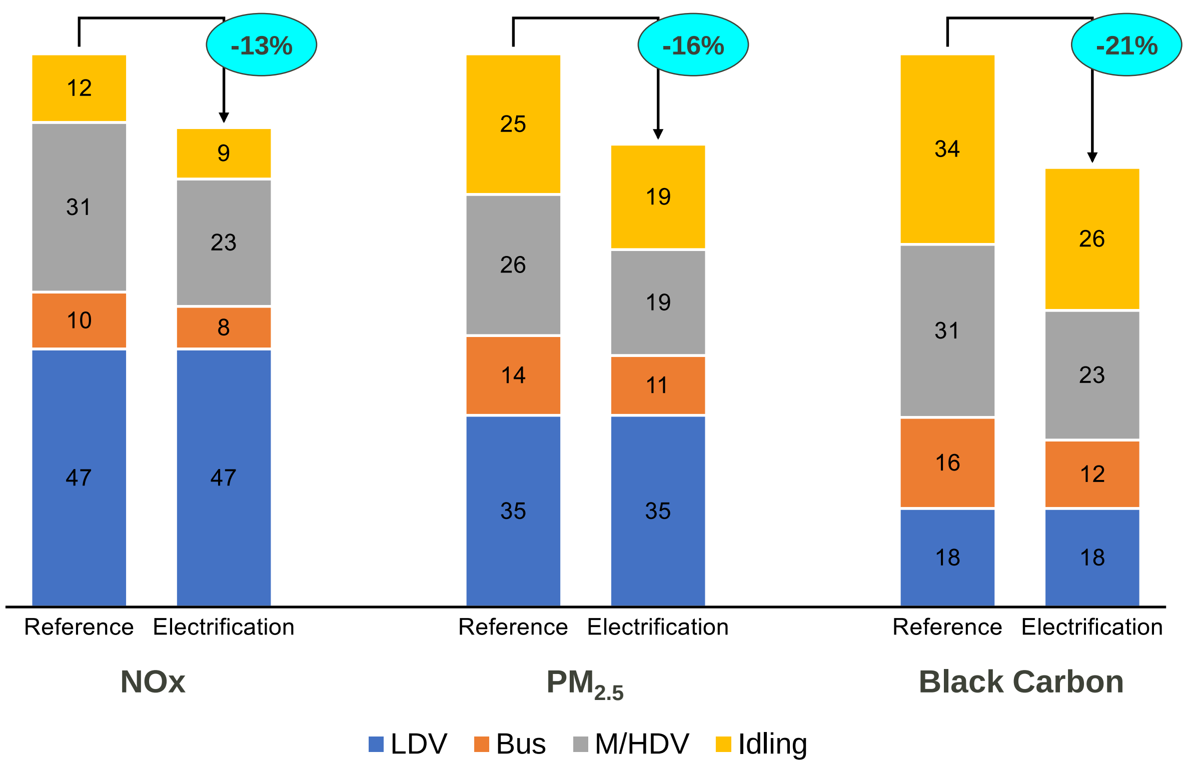
This analysis also includes an assessment of emission sources' relative contribution to exposure at a hyper local level—at a school, a hospital, or any other point within the study area. This highlights that many locations within the study area experience much lower relative exposure from non-roadway sources and may receive higher relative and total impact exposure from roadway sources depending on the location's proximity to a roadway.[14]

Because many population centers are severely impacted by roadway emissions, reducing emissions from high-emitting light-, medium- and heavy-duty vehicles can meaningfully reduce exposure in locations and areas near roadways. These benefits can be particularly local in nature if the emissions exposure at a specific location is dominated by emissions from a nearby truck or bus route or idling hot spot. The emissions exposure experienced at Hawkins Street Elementary School, for instance, is entirely from roadway sources, especially medium- and heavy-duty vehicle traffic and additional idling emissions from heavy-duty diesel trucks. Figure 12 shows how a 25 percent electrification of buses and medium- and heavy-duty vehicles can

[14] In short, this is because, among other things, the impact of non-roadway emissions is concentrated within one-mile of each source whereas roadway vehicle emissions are more evenly "spread" over the study area emissions. Although non-roadway sources disperse farther than roadway vehicles and distribute their emissions more substantially across a wider region, their relative impact on a specific location's exposure may be relatively small depending on that location's proximity to each type of emissions source.

reduce emissions at Hawkins St. Elementary School by 13 to 21 percent, depending on the pollutant.[15] Note that a significant share of these reductions come from a decrease in heavy-duty diesel vehicle idling emissions, which come from a nearby identified idling "hot spot." These emissions reductions could represent meaningful improvement in health outcomes for the children and staff attending this school in addition to those living and working in the surrounding areas. However, when assessed across the entire study area, this level of electrification of roadway vehicles would only reduce emissions exposure by 1 to 2 percent, simply because the magnitude of total port and railyard emissions affecting exposure in the study area is so high.[16]

Figure 12 Case Study: Effect of Electrification on Exposure at Hawkins St. Elementary School



[15] See Appendix C for results from each receptor site.

[16] A 60 percent electrification of all roadway vehicles (light-duty, buses, and medium-/heavy-duty) would reduce total area NOx emissions exposure by about 7 percent and $PM_{2.5}$ and black carbon by 3-4 percent when averaged across the study area, though it could have significant impacts on specific locations within the study area.

It is also critical that any analysis of electrification of transportation sources as an emissions reduction strategy take into account the potential impact of increased emissions from local power plants, which also contribute to the local pollution burden. In other words, if electrification is to be pursued for the light-, medium-, and heavy-duty transportation sector, to assure emissions reductions compared to the status quo, it must be paired with emissions reductions in local electric generating units (EGUs) as well, and across the broader power pools that dispatch generating units. To illustrate this point, MJB&A performed a preliminary emissions analysis of nearby EGUs, displayed in Figure 13.

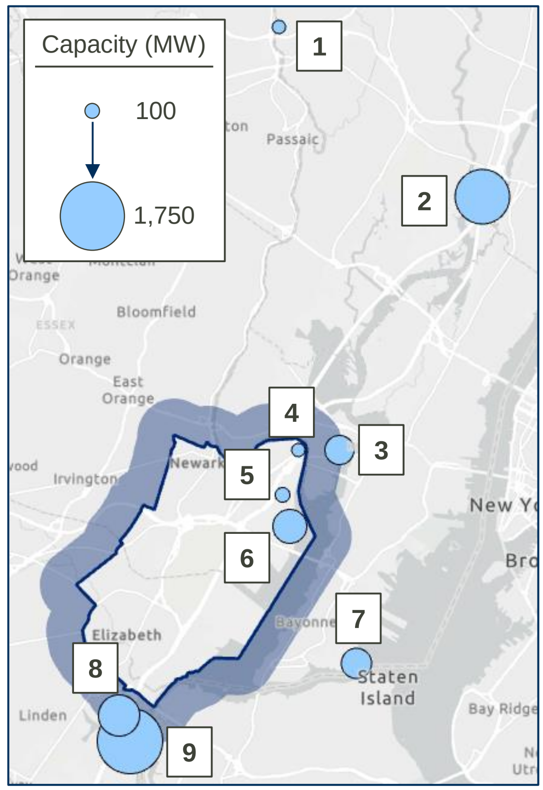
Figure 13 Electric Generating Units (EGUs) Included in Analysis

Included Power Plants*

1. Elmwood Power Park
2. Bergen Generating Station
3. PSEG Kearny Generating Station
4. PSEG Essex Generating Station
5. Newark Bay Cogeneration Plant
6. Newark Energy Center
7. Bayonne Energy Center
8. Linden Cogeneration Plant
9. PSEG Linden Generating Station

*All natural gas facilities

10. Elmwood Power Park
11. Bergen Generating Station
12. PSEG Kearny Generating Station



These EGUs exist within the PJM grid, a wholesale electricity market that operates in states throughout the mid-Atlantic. This analysis does not conduct a dispatch model to identify if these emitting EGUs, in particular, are likely to increase their output—and thus emissions—if electricity demand increases due to electrification of transportation. However, it does attempt to compare the relative emissions rates of transportation sources with the average emission rates of local EGUs to determine one possible scenario regarding the emissions effect of electrified transportation.

Figure 14 shows the emission rates of light-duty vehicles, buses, and medium- and heavy-duty vehicles under three conditions: 1) the average vehicle from the current fleet, 2) a new conventional internal combustion engine vehicle, and 3) an electric vehicle powered exclusively by the EGUs shown in Figure 13.

Figure 14 CO_2, NOx, and $PM_{2.5}$ Emissions Rates: Vehicles vs. EGUs

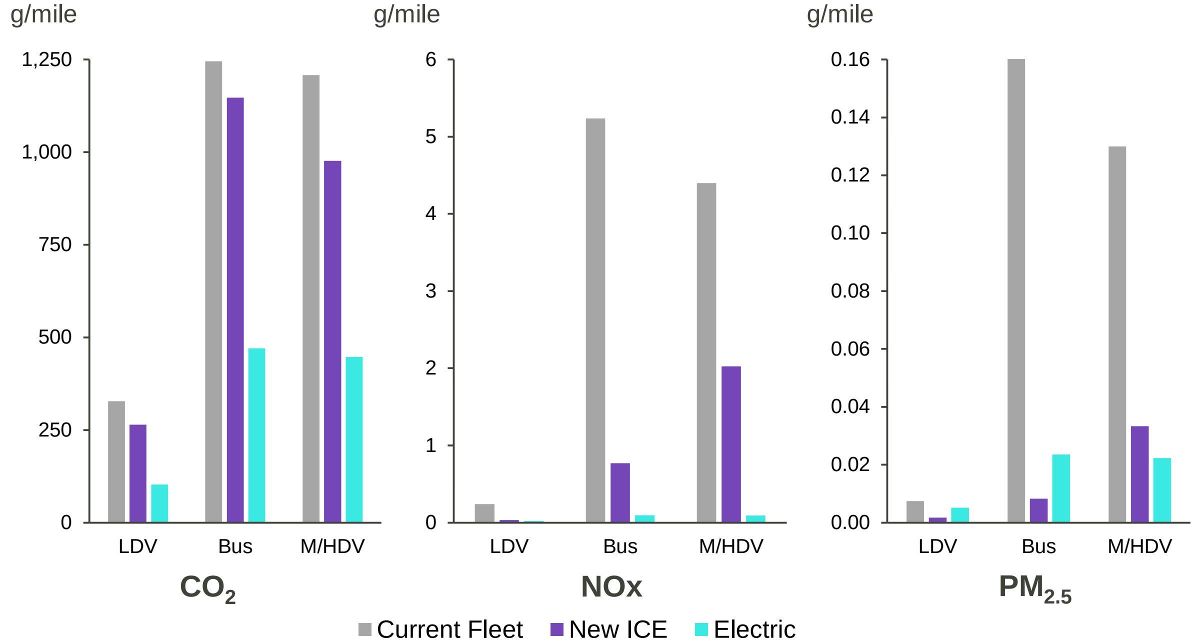


Figure 14 shows that the NOx and CO_2 emissions rates of these units are significantly lower than the rates of the vehicle fleet considered in this analysis. Accordingly, if one were to assume that 100 percent of the electricity needed to power a newly electrified truck, car, or bus were to come from these local EGUs, total NOx and CO_2 emissions would still decrease compared to prior emissions from a conventional gas- or diesel-powered vehicle. Of course, local emissions could be even lower if some portion of that electricity to power a new electric vehicle is produced by non-emitting generation or generation outside the region. However, a more detailed dispatch analysis is necessary to determine which, if any, EGUs in the area increase output and therefore determine local emissions impact. As with the transportation emissions exposure findings in this study, power plant emissions can have hyper local impacts that can be obscured when looking across broad areas.

Furthermore, the analysis finds that local EGUs have a lower $PM_{2.5}$ rate than the current vehicle fleets across all classes and than a new conventional truck, but higher emissions rates than that of the average new conventional light duty vehicle or bus. Accordingly, if a conventional bus is replaced with an electric bus, and all electricity to power that bus comes from local emitting EGUs, total local emissions (i.e., those from transportation sources affecting the study area and these local power plants) are likely to decrease. However, it is possible that somewhat greater $PM_{2.5}$ emissions reductions could be achieved through the purchase of a new conventional bus. Similarly, if a passenger vehicle is electrified and powered by exclusively local emitting EGUs, $PM_{2.5}$ emissions in the same locality could rise compared to a case in which that passenger vehicle was simply replaced by a new, cleaner conventional car.

One benefit of electrification, compared to replacing vehicles with new conventional vehicles, is that emissions can continue to decrease over time. The "electric" emissions in Figure 14 can be viewed as a ceiling on local emissions for electric vehicles, with room for improvement if and when the electric sector continues to reduce emissions through improving performance of emitting sources and replacing emitting resources with renewables, advanced energy storage, or other zero emitting resources.

In addition, further analysis could be conducted to assess the dispersion of NOx and $PM_{2.5}$ from electricity sources, as these impacts are often very local. As discussed above, because many population centers are severely impacted by very local roadway NOx and $PM_{2.5}$ emissions, electrifying high-emitting light-, medium- and heavy- duty vehicles can significantly reduce exposure in locations and areas near roadways.

However, those communities adjacent to EGUs may experience concurrent increases in emissions from the electric sector. Though outside of the scope of this study, more analysis should be conducted to identify the local impacts of these potential shifts in emissions.

In total, this study finds that the emissions impact of transportation electrification depends on which pollutant is being considered, what electricity generation sources are assumed to serve new demand, and how locally emissions are accounted for (i.e., averaged across a region or taking into account local emissions hot spots).

Discussion

This analysis displays the direct relationship between local air quality and pollution from transportation sources. While this is not a new finding—the literature on the impact of transportation emissions on human health and the environment is substantial—the street by street variation in the level of emissions impact that communities may experience sheds light on the direct impact that higher polluting vehicle routes have on local street and neighborhood air quality. This finding—and its implications—are critical for policymakers who are looking to create more equitable communities that do not disproportionately burden parts of the population with levels of air pollution that negatively impact health.

Historically, policies focused on reducing emissions from the transportation sector have been designed with the goal of reducing transportation pollution by either requiring—through vehicle emissions standards—or encouraging—through vehicle trade-in or scrappage programs—cleaner light-duty and medium-and heavy-duty vehicles. Within the medium- and heavy-duty space, vehicle trade-in programs and scrappage programs have led to some improvements in air quality. However, these policies have not gone far enough in reducing emissions, in particular in communities that are disproportionately burdened by poor air quality.

Many states across the country have shifted their transportation sector emissions policy, focusing instead on strategies to reduce climate-warming GHG emissions, often evaluating local air quality improvements as a co-benefit to CO_2 emissions reductions. The majority of policies implemented to reduce emissions within the transportation sector within the United States have focused primarily on the electrification of light-duty vehicles. These policies typically have a goal of broadly reducing GHG emissions from the transportation sector and focus less on local harmful air pollution.

New Jersey has followed this climate-centric path, and has implemented several policies as part of its climate and energy agenda to reduce GHG emissions from the transportation sector. This has included: signing the light-duty and medium- and heavy-duty zero-emissions vehicle electrification Memorandums of Understanding;[17]developing several incentive programs designed to encourage the procurement of light-duty electric vehicles; and, through the passage of SB 2252, codifying procurement targets, setting charging infrastructure targets, and creating transit bus electrification targets. These and other initiatives have placed New Jersey among the states actively pursuing transportation electrification, in particular for light-duty vehicles.

These policies, while constituting a meaningful step in reducing GHG emissions across the state, do not adequately focus on medium-and heavy-duty vehicle pollution or improving local air quality within environmental justice communities. For communities like those in the study area and especially those adjacent to the ports of Newark and Elizabeth, other types of vehicles in addition to light-duty vehicles have a significant impact on the emissions of local air pollution, like $PM_{2.5}$, black carbon, and NOx, that negatively impact human health the most.

Based on the findings of this analysis, when evaluating roadway transportation emissions sources, medium- and heavy-duty vehicles have an outsized impact on the harmful local pollutants that impact human health as well as contributing significantly to transportation sector GHG emissions. This analysis further found that reducing emissions from the medium- and heavy-duty vehicle sector would have meaningful and immediate impacts on air-quality within disproportionately burdened communities. These objectives, and programs specifically aimed at these communities' needs, should be centered alongside that of GHG reduction when developing transportation policies. This rebalancing is critical to ensure that GHG reduction policies, including those focused on electrification, are improving air quality within disproportionately burdened communities today in order to reduce the lifetime health burdens that community members face. For communities like those within the study area, the greatest opportunity for local air quality improvement

[17] In 2018, New Jersey joined eight other states in signing the state zero-emissions vehicle (ZEV) Memorandum of Understanding (MOU). New Jersey specifically set a target of 330,000 light-duty plug-in electric vehicles (PEV) in the state by December 2025. In 2020, New Jersey joined 15 other states and Washington DC in signing the state Medium- and heavy-duty Zero emission vehicle MOU.

comes when these emissions are directly targeted by policy, rather than arising as a co-benefit from policies focused on GHG reduction.

The State of California, in particular, has taken a leadership role in approving a number of policies in recent years designed to reduce emissions from medium- and heavy-duty vehicles, including the recent approval of two landmark rulings — the Advanced Clean Truck Rule and the Heavy-Duty Low NOx Omnibus Rule. Both of these rulings are designed to address medium- and heavy-duty vehicles emissions in distinct and complementary ways— with one program focused on developing a market for new zero-emitting medium- and heavy-duty vehicles and the other designed to reduce emissions from existing trucking fleets.

By addressing both local harmful air pollution in the short-term and developing a supply chain for zero-emitting trucks, the state is both considering the immediate and long-term needs of communities located in heavily trafficked areas. The California Air Resources Board (CARB) estimates that both of these policies will dramatically reduce emissions and improve air quality. Notably, CARB anticipates that the NOx Omnibus Rule is expected to reduce harmful NOx emissions in California by more than 24 tons per day once it is fully phased in by 2031.[18]

These policies, and those like them, represent a possible model for New Jersey to follow if it is serious about reducing community pollution exposure from the transportation sector. Several additional examples of how states are pursuing medium- and heavy-duty electrification are described below. Critical to implementing any policy similar to those described below is ensuring that reductions in medium- and heavy-duty vehicle emissions occur within environmental justice communities.

- **California Advanced Clean Trucks Rule**— The Advanced Clean Truck Rule focuses on developing a market for zero-emission MHDVs by requiring manufacturers of Class 2b-8 vehicles to sell zero-emission trucks at an increasing percentage of their annual California sales from 2024 to 2035 and by requiring large employers and fleet owners to report their existing fleet operations. California is also developing a partner regulation to the Advanced Clean Trucks rule that will require all medium and heavy-duty fleets to be 100% zero-emissions by 2045, per Executive Order N-79-20.
- **California Innovative Clean Transit—** All new transit buses in CA must be zero-emission, electric buses by 2029. By 2040, all public transit agencies must transition to 100% zero-emission bus fleets. Zero-emission bus technologies include all-electric or fuel cell electric buses.
- **California Heavy-Duty Low NOx Omnibus Rule—** The Heavy-Duty NOx Omnibus Rule increases exhaust emissions standards and test procedures, requiring engines to be approximately 75 percent below current standards beginning in 2024, and 90 percent below current standards in 2027.
- **California Port Electrification Goals—** A number of Ports in California have set aggressive truck electrification goals. The San Pedro Bay Port 2017 Clean Air Action Plan proposes to establish a new clean truck program with a goal to have a fully zero-emission drayage truck fleet by 2035 and to require all trucks entering the port to be zero-emission, meet the Low-NOx standard, or pay a fee by 2024. By 2035, trucks would need to be zero-emitting or would have to pay a fee. Additionally, the Ports of Los Angeles and Long Beach Clean Air Action Plan set a goal of 100 percent zero-emission drayage trucks by 2035. By 2035, all drayage trucks at California ports must be zero-emissions, per Executive Order N-79-20.

Importantly, this analysis also reveals the significant contribution to GHG and local harmful pollutant emissions from non-roadway sources in port-adjacent communities—specifically, from ports and railyards. However, strategies to reduce these emissions have not received the same amount of policy focus or investment as have roadway sources of emissions. While there are measures that can be taken in the short term to reduce some of these emissions (e.g., reducing vessel and locomotive idling or electrification of shore

[18] California Air Resources Board. (2020). Facts about the Low NOx Heavy-Duty Omnibus Regulation. https://ww2.arb.ca.gov/sites/default/files/classic//msprog/hdlownox/files/HD_NOx_Omnibus_Fact_Sheet.pdf

power sources), more dedicated action and research and development will be needed to have a meaningful impact on reducing emissions from these non-roadway sources. Some ports, such as Long Beach and Los Angeles, have reduced emissions under state regulation and long-term planning, but a more comprehensive approach is needed within ports in order to improve air quality in port-adjacent communities.

By taking a comprehensive approach to all modes of mobility and by keeping a focus on where air pollution exposure is most severe, policymakers in states like New Jersey can become leaders in equitably addressing emissions reductions within the transportation sector.

Conclusion

The damaging and significant health effects associated with exposure to local air pollutants such as NOx, black carbon, and $PM_{2.5}$ are well documented and significantly impact vulnerable populations in disproportionately burdened communities. This report contributes to this broader body of work by displaying the unequal emissions burden that roadway and non-road vehicles have on the port-adjacent communities of Newark. Notably, this report finds that a wide range of pollution sources dramatically impact the levels of exposure felt throughout a community— displaying the important role that bus and trucking routes, ports, and railyards have on the relative emissions exposure that community members experience.

Many population centers and residential areas, in particular, are highly impacted by roadway emissions—particularly those from medium- and heavy-duty vehicles. While it is critical to work towards addressing both roadway and non-road vehicle emissions, roadway gasoline and diesel vehicles have a cleaner alternative technology that is either already available (e.g., light-duty electric vehicles and transit buses) or is anticipated to be on the market within the next five years (e.g., box trucks). Investing in this technology today is not only feasible but is essential in order to make meaningful emissions reductions, improving air quality in disproportionately burdened communities and enabling the state to meet its short- and long-term emission reduction goals. Climate mitigation efforts in the transportation sector often focus primarily on the reduction of GHG in the sector, particularly through the electrification of passenger vehicles. This study illustrates the importance of prioritizing the reductions of harmful local air pollutants alongside CO_2 in this sector in order to realize the immediate health benefits such a reduction will have on areas most burdened by transportation sector emissions.