Health Note
on the
New Jersey Department of Environmental Protection
proposed regulation:
Advanced Clean Trucks Program and Fleet Reporting Requirements
Proposed Amendment: N.J.A.C. 7:27A-3.10, Proposed New Rules: N.J.A.C. 7:27-31 and 33

Karen W. Lowrie, Ph.D.
with
Emma Kilkelly
Andrew Herrera
Kevin Petrozzo

Bloustein School of Planning and Public Policy, Rutgers University

Acknowledgements:

This independent report was made possible with financial support from the Energy Foundation and on behalf of the New Jersey Climate Change Alliance. We would like to thank Jeanne Herb and Marjorie Kaplan, facilitators of the New Jersey Climate Change Alliance, for their review of the report. We thank Emma Kilkelly, Andrew Herrera and Kevin Petrozzo for research assistance. We also thank representatives from Rutgers Environmental and Occupational Health Institute, the California Air Resources Board, Environment NJ, North Jersey Transportation Planning Association and the Northeast States for Coordinated Air Use Management for their time in speaking with the research team about the issue and providing expert knowledge. The report reflects the analysis and judgment of the authors alone and does not necessarily reflect the views or official policies or positions of advisors, their organizations, funders, or Rutgers University.

Submitted as comments by the New Jersey Climate Change Alliance

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
AIR QUALITY, ENERGY, AND SUSTAINABILITY, DIVISION OF AIR QUALITY
Advanced Clean Trucks Program and Fleet Reporting Requirements
Proposed Amendment: N.J.A.C. 7:27A-3.10
Proposed New Rules: N.J.A.C. 7:27-31 and 33

June 17, 2021

RUTGERS
THE STATE UNIVERSITY OF NEW JERSEY

NJ Climate Change Alliance

INTRODUCTION AND BACKGROUND

Economic, environmental and societal forces contribute substantially to our health – as much as, studies show, or more than genetics, individual behavior and access to healthcare.[1] Examples of these Social Determinants of Health (SDOH) include quality of housing and schools, access to healthy foods, living-wage jobs, transportation mobility, environmental exposures to pollution and other hazards, availability of social support networks and community safety.[2]

The proposed rule by New Jersey Department of Environmental Protection, the Advanced Clean Trucks Program and Fleet Reporting Requirements (**Proposed Amendment: N.J.A.C. 7:27A-3.10 Proposed New Rules: N.J.A.C. 7:27-31 and 33)** would adopt, by reference, California's Advanced Clean Trucks (ACT) Program, requiring manufacturers of vehicles over 8.500 pounds (weight Classes 2B-3 through 8 with 500 or more vehicle sales in NJ) to increase the percentage of zero-emissions vehicles (ZEV) or near zero-emission (NZEV) (only those using battery technology) sold in New Jersey. The purpose is to ultimately reduce emissions of greenhouse gases, oxides of nitrogen (NOx) and fine particles (PM2.5) through accelerating sales of ZEVs. After the ACT is implemented, DEP anticipates that the program will result in reductions of air pollutants as discussed below.

The proposed rule impacts important social determinants of health including most notably air pollution. Other potential drivers of health that may also be affected include jobs, fuel costs, maintenance costs and land use (charging infrastructure facilities). Noise is also a likely health determinant that will be impacted. The DEP proposed rule outlines and estimates many of these health impacts, predicting positive health, environmental and economic impacts.

Purpose of Report

Rutgers scholars have been at the forefront of promoting **Health in All Policies (HiAP)** as a collaborative approach to reducing disparities and improving the health of all communities and people by incorporating health considerations into decision-making across sectors and policy areas.[3] Given the limited time available in the review period of the draft DEP Rule, the authors were not able to conduct a full comprehensive Health Impact Assessment (HIA) that includes all health and health equity implications of its implementation. To do so would require many months of data gathering and detailed analysis. Instead, as part of our continuing HiAP efforts in New Jersey, this document is a truncated study focusing on a few key elements of the rule proposal, and contributing some limited new analytical framework to the discussion of health benefits. The report is framed in an HIA-like style, but is more aligned to the briefer rapid HIA or "Health Note" format, which can be developed in a short time frame, drawing from an

---

[1] http://www.countyhealthrankings.org/what-is-health
[2] https://www.cdc.gov/socialdeterminants/
[3] https://www.cdc.gov/policy/hiap/index.html

expedited review of research to describe both positive and negative effects of a policy decision.[4]

This report, submitted under the Public Comment period for the proposed DEP rule, offers a "health lens" through which to view some of the potential impacts of implementing elements of the rule. This analysis includes an emphasis on health equity, or the concept of equitable access to conditions and resources that allows one to live the healthiest life possible. It pays strong attention to impacts on populations and communities that may already suffer disproportionate health, social, environmental, and economic inequities, which may be exacerbated by a proposed decision. Thus, this evaluation is in effect a public health prevention model intended to help to prevent potentially unanticipated negative outcomes and costs, and to provide guidance on policy decisions that will improve health and reduce disparities.

The primary contributions of this rapid HIA, as distinct from other summaries of health benefits of reduced diesel emissions and ZEV conversion are that it:

1. Provides updated literature from the past five years;
2. Adds a new "impacted population" geospatial analysis and a COBRA scenario output;
3. Includes noise as a health impact; and
4. Lays out a more comprehensive conceptual pathway that could frame a full Health Impact Analysis that could be done at a later time to examine other social determinants of health in greater detail.

The report includes the following three main sections:

1. **CONCEPTUAL PATHWAY OF SOCIAL DETERMINANTS OF HEALTH RELATED TO THE RULE** – Presents a model of the primary social determinants of health potentially impacted or changed by implementation of the rule in New Jersey, including connections between changes to these determinants and resulting changes in intermediate factors and eventually in health outcomes.
2. **LITERATURE REVIEW AND IMPACTED POPULATION MODELS: PROJECTED HEALTH IMPACTS OF SELECTED DETERMINANTS** – Describes a rapid review of scientific and public health literature conducted on selected aspects of the rule, focusing on adding the most recent literature or studies to those already well-cited in other reports. This section also includes two analyses conducted to estimate the impacted populations in New Jersey.
3. **OBSERVATIONS** - Concludes with supported recommendations to facilitate positive impacts on health and mitigate negative impacts.

[4] https://www.pewtrusts.org/en/research-and-analysis/fact-sheets/2017/11/pilot-program-to-help-states-and-localities-consider-health-in-policymaking

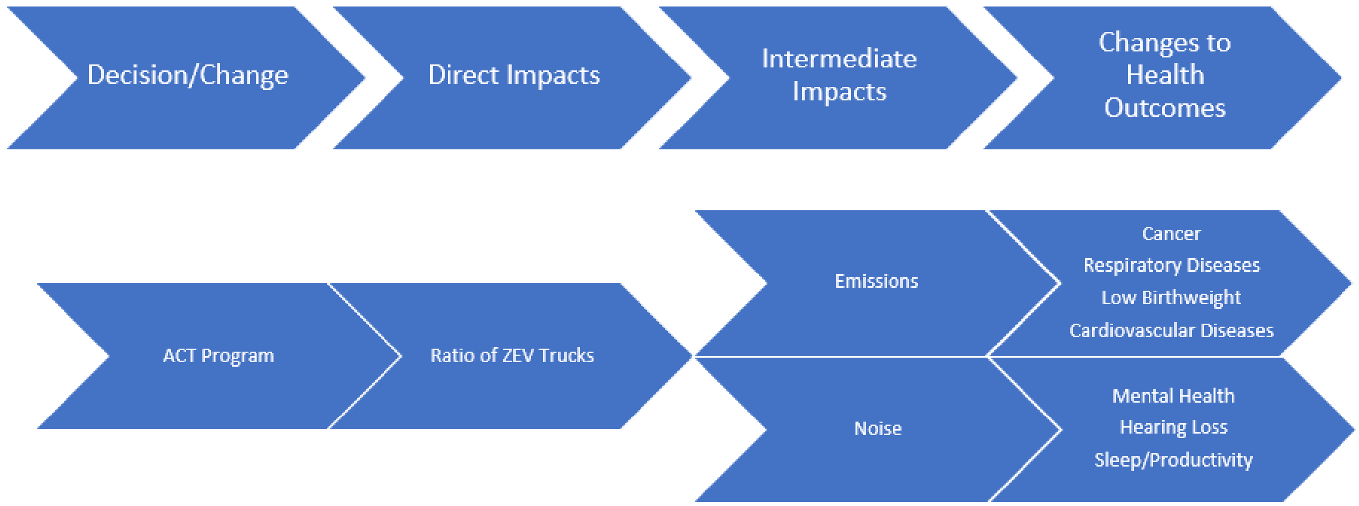
CONCEPTUAL MODEL OF SOCIAL DETERMINANTS OF HEALTH RELATED TO THE ACT RULE

The conceptual model is a depiction of the pathway from the implementation of an activity to its ultimate effects on human health. The model's first column uses the language from the rule as the "**Rule Components**." The next column lists "**Direct Impacts**" that can be expected as a result of implementation of the rule. These are the changes in society, the economy or the environment that are reasonably expected to happen. The next column "**Intermediate Impacts**" are the changes to social determinants of health that are hypothesized to occur – either positively or negatively (the direction of the changes are based on the finding of the literature review). Thus they are written as "changes" and not as "increases" or "decreases." The key objective of the literature review is to understand the linkages between the direct impacts and intermediate impacts. Finally, the "**Health Outcomes**" column displays the ways that those determinants listed in the prior column affect human health as ultimate physical or mental health outcomes.

Fig. 1 - **Conceptual Model – New Jersey DEP Rule – Advanced Clean Trucks Program**

Rule Component	Direct Impacts/Changes	Primary Intermediate Impacts	Health Outcomes
Increase in proportion of ZE and NZE trucks sold	Change in number of gas/diesel-powered trucks	Change in air pollution Change in noise pollution	Change in outcomes associated with air pollution, such as asthma, cancer, respiratory illness Change in outcomes associated with noise pollution (stress, mental health, educational attainment, etc.)
Increase in proportion of ZE and NZE trucks sold	Change in need for ZE and NZE development and manufacture.	Change in jobs/employment opportunities Change in occupational exposures to emissions	Change in jobs and income-related health outcomes, such as chronic disease and mental health.
Increase in proportion of ZE and NZE trucks sold	Change in demand for charging infrastructure	Change in amount and size of charging stations Siting of new charging stations	Stress/Mental Health Change in jobs and income-related health outcomes, such as chronic disease and mental health. Health equity implications
Increase in proportion of ZE and NZE trucks sold	Change in demand for gasoline/diesel Increase in demand for electricity	Change in jobs. Change in electricity generation Change in fuel costs	Change in jobs and income-related health outcomes, such as chronic disease and mental health. Change in outcomes associated with air pollution, such as asthma, cancer, respiratory illness

Fig 2. **Health Impact Pathway**



The top diagram in Figure 2 above depicts a health impact pathway or logic model that begins with a decision regarding a policy or plan, which then creates direct impacts on a social determinent of health (affecting something in the economy, education, jobs, environment), which then causes a set of intermediate impacts that could result from that change, and then finally could result in a change in population health outcomes. The bottom diagram depicts the application of this pathway to the proposed ACT rule. The decision to adopt the proposed rule and implement the program should have the expected result of changing the ratio of ZEV to gasonline-powered trucks on the roads. This will result in a set of intermediate impacts, here shown as change in emissions and change in noise. Changes in these conditions will then have expected health outcomes, shown here as a range of physical and mental health conditions.

Research Questions

The following research questions address the DEP Rule components selected for evaluation. The sub-questions under each relate to the specific direct impacts examined. These elements were selected from the more complete list of potential social determinants impacted because the research team assessed that they had the strongest connections to health and equity (air emissions), and that they had strong potential to affect health and had not yet been comprehensively by the DEP in the rule proposal (noise).

1. How will projected ***reduced emissions*** from trucks impact health outcomes?
    - Change in health conditions
    - Impacted populations
2. How will ***noise changes*** from the ACT program impact health outcomes?
    - Change in health conditions
    - Impacted populations

LITERATURE REVIEW AND IMPACTED POPULATION MODELS: PROJECTED HEALTH IMPACTS OF SELECTED DETERMINANTS

Literature Review Process: Methodology

Based on the model and research questions, a set of search terms was developed. We searched for studies that examined the connection between the direct impacts of the proposed rule and the health determinants. Searches were conducted using platforms available through the Rutgers Library system including EBSCO and PubMed. The team attempted to find systematic reviews or meta-analyses, whenever possible. For our review, we included studies conducted from 2015 - present, unless we determined it to be key research through reference review or because it was cited in another source as a key piece of support, and we also focused only on studies published in English, and those that closely related to the research questions

As a supplementary search, we also consulted key pieces of grey literature (nonsystematic research, U.S. agency and nongovernmental organization reports and publications), and also some Health Impact Assessment (HIA) reports from the national database (available at www.healthimpactproject.org) that pertained to related topics. These HIAs were particularly useful for the sections of this report that discuss the pathways between the intermediate impacts and the health outcomes.

Literature Review Summary Findings

The full summary of the literature review is found in the Appendix. Here we list the key findings related to the research questions and key components we studied:

1. How will projected ***reduced emissions from trucks*** impact health outcomes?

General impacts

Extensive literature establishes that an association exists between air pollution from vehicle traffic (such as nitrogen dioxide and small particulates) and public health (Filleul et al, 2005; Pope et al, 2009). These impacts are greatest from diesel emissions, and the Nitrous Oxides (NOx) and ultrafine particulate matter (PM2.5) that are contained in it (Miller and Newby, 2020), along with "numerous organic compounds, including over 40 known cancer-causing organic substances."[5] There is evidence of a causal relationship between exposure to these emissions and a number of adverse health outcomes, including respiratory disease and lung function impairment, asthma incidence, cardiovascular disease, and overall mortality (Saelens et al, 2003; Miller and Newby, 2020). Therefore, reductions in diesel emissions from heavier trucks have more significant impacts on public health improvement than from other vehicle emissions, which also have already been reduced in toxicity through regulation in recent decades (Perez, 2015). Recent research has found that communities with even a small increase in long-term exposure to PM2.5 have a significant increase in their COVID-19 death rate (Wu et

[5] https://ww2.arb.ca.gov/resources/overview-diesel-exhaust-and-health

al, 2020). Additional recent research by Salvi and Salim (2020) found that exposure to gasoline and diesel emissions leads to neurotoxicity and altered neurobehavioral function.

In 2016, the USEPA report "Greenhouse Gas Emissions and Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles—Phase 2, Regulatory Impact Analysis" detailed the latest literature and strength of evidence about the impact of truck emissions on various health conditions. The report noted that diesel exhaust "varies significantly in chemical composition and particle sizes between different engine types (heavy-duty, light-duty), engine operating conditions (idle, acceleration, deceleration), and fuel formulations (high/low sulfur fuel). Also, there are emissions differences between on-road and nonroad engines because the nonroad engines are generally of older technology. After being emitted in the engine exhaust, diesel exhaust undergoes dilution as well as chemical and physical changes in the atmosphere. The lifetime for some of the compounds present in diesel exhaust ranges from hours to days."[6]

A California Air Resources Board's 2019 assessment ascribed monetary values associated with each avoided premature death and health incident, and NJDEP used this model to monetize expected health outcomes associated with the emissions reductions projected as a result of this rule, estimating that the ACT program "will result in monetized benefits from avoided premature deaths and avoided health incidents from 2024 through 2040 equal to roughly $882 million expressed in 2018 dollars" (NJDEP, 2021). DEP notes this estimate is likely to be low considering additional health concerns that may lead to conditions that are not measured in this model.

Impacts on Subpopulations

In terms of environmental justice concerns, it is well-known that roadways, and other areas where trucks are in use for loading or delivery can create "hot spots" of locally elevated air pollution levels, which may impact inequitably impact some citizens more than others (Karner, et al, 2010; Rowangould, 2015). At low-speed and heavy-idling conditions, which can be of particularly significant concern around industrial areas like warehouses and ports, in-use truck emissions are as much as 7 times higher than current federal standards in part because engine temperatures are not high enough to keep the emissions controls operating efficiently (Cooke, 2020) Cooke's (2020) analysis shows that nationwide, the communities with the largest exposure to truck pollution are disproportionately communities of color. The benefits of electrification vary by neighborhood. Areas with high numbers of idling trucks should see much greater reductions in air pollution from electrifying heavy-duty vehicles. In one such "idling hot spot", modeling shows that electrifying 25 percent of medium and heavy-duty vehicles would result in 13% less exposure to PM2.5, due to reductions in idling and heavy-duty vehicle movement emissions (Allen et al, 2020).

[6] https://nepis.epa.gov/Exe/ZyPDF.cgi/P100P7NS.PDF?Dockey=P100P7NS.PDF

A study in California found a higher prevalence of high-emitting vehicles in low-socioeconomic-status communities (Park et al, 2016). Introducing ZE trucks in cities addresses health inequities, as they will disproportionately benefit some urban communities that also disproportionately suffer the negative air quality impacts associated with living in traffic-dense areas, and in lower socioeconomic neighborhoods, often suffer from higher rates of respiratory and other illnesses due to many factors including housing condition and access to healthcare (Nopmongcol et al, 2017; Wengwei et al, 2017; Woodcock, 2009; Miles and Jacobs, 2008; Ferrero et al, 2016). Studies have shown association between near-road exposure and asthma exacerbation in children (Price et al, 2013).

Low-income housing is disproportionately sited adjacent to busy roads (Bae et al, 2007), more likely to be near point-source industry and often has greater indoor air risks such as mold (Vardoulakis et al, 2015). The cumulative burden for such vulnerable communities is higher than the entire region and modest improvements in air quality would have a significant impact (USEPA, 2003). Pre-existing exposure to traffic-related air pollution makes these populations even more vulnerable to respiratory effects of additional pollution (Matt et al, 2016). Pregnant women and children are likely to be affected by exposure to NOx and PM2.5. Recent studies provide evidence for modest, positive associations between exposure to traffic emissions (PM, NOX, CO) and adverse pregnancy outcomes (Steib et al, 2016; Gaskins, 2018; Olsson et al, 2015), common pediatric infections during early childhood (Kennedy et al, 2018; Lanari et al, 2016) and potential links to hyperactivity/inattention scores (Fuertes et al, 2016) and cognitive impairment (Sunyer et al, 2015). Gilliland et al (2017) looked specifically at various strategies contained within the San Pedro Bay Ports Clean Air Plan (especially the Clean Truck Program), and found that emissions reductions from these programs improved air quality and were associated with improvements in respiratory health for children.

Electricity Generation Mix Impacts

Many studies support the assertion that the emissions and human exposure impacts of EV adoption, especially in comparison to conventional gasoline- or diesel-powered engines, depend on numerous factors including geography, electricity generation mix, type of EV and charging patterns (Requia et al, 2018). Primarily, the overall benefits to emission reduction depend strongly on the electricity power plant portfolio and somewhat on charging strategies (Jochem et al, 2016). EVs replace tailpipe emissions but increase electricity demand. Therefore, maximum health benefits are not realized until the power generation fuel mix generates fewer emissions (preferably low-to-zero) than gas and diesel engines (Peters et al, 2020; Sabel et al, 2016; Requia et al, 2017; Gabbatis, 2018; McLaren et al, 2017; Shi et al, 2016; Frey 2018; Perez et al, 2015).

When electric vehicles are recharged from electricity produced from conventional technology power plants such as oil or coal-fired plants, they may produce equal or sometimes more greenhouse gas emissions than conventional gasoline vehicles (Poullikkas, 2015). In fact, Allen et al (2020) concluded that if electrified vehicles are powered exclusively by electricity-generating units that run on fossil fuels that are located within EJ communities (such as with Newark), greater reductions in PM2.5 emissions could be achieved by replacing existing heavy-duty vehicles with new models with conventional combustion engines, than by replacing them with electrified vehicles. This study underscores the point that to achieve health benefits for all communities, moving toward non-emitting electricity generation is a goal that goes hand-in-hand with electrification of vehicles.

Even though most EV and hybrid fuel options do reduce GHG and urban air pollutant emissions compared with conventional gasoline vehicles, this benefit is reduced and can even be eliminated if coal without carbon capture is the sole electricity source for charging (Delucchi, 2013). When entirely or almost entirely powered by completely renewable fuels such as wind, solar and hydroelectricity, fuel-cycle GHG emissions from EVs can be almost 100% eliminated, but if power is coal-based, battery electric vehicles may reduce emissions by 20% or even slightly increase them (Requia et al, 2017).

A review of literature from the past year summarized that: "EV's can reduce tailpipe emissions and associated air pollution, but the scale of adaptation needs to be wide and energy sources need to be clean for benefits to occur" (Glazener and Khreis, 2019). Distributional injustices can occur with EV promotion, as pollution, and therefore health, impacts shift spatially from the location of the tailpipe emission to the power plant locations (assuming fossil fuel technology), which may or may not be more remote, and may or may not affect more socially and environmental vulnerable populations (Nichols et al., 2015).

Impacted Populations Models

COBRA: Air Quality and Health Benefits[7]

Using the CARB methodology described in the proposed DEP rule (NJDEP, 2021), the NJDEP estimates emissions reductions of the ACT rule once implemented in New Jersey in 2040 to be 1,300 tons of NOx per year and 40 tons per year of PM2.5

Using this estimate, the Bloustein research team inserted these emissions modifications into the EPA's COBRA tool. CO-Benefits Risk Assessment (COBRA) is a screening tool that estimates the air quality and health benefits of different emissions scenarios. As far as the researchers are aware, this tool does not account for the fuel mix of the electric power.

[7] https://www.epa.gov/cobra

Fig. 3 - **COBRA Health Benefits Scenario for Projected Annual Emissions Reductions Expected in 2040 from ACT Proposed Rule:**

Location(s)	Sector	Emissions Modification(s)
New Jersey - All Counties	Highway Vehicles	$PM_{2.5}$ reduce by 40 tons
	Diesel Fuel	NO_x reduce by 1,300 tons

Results are shown in the table below.

Monetary value of each health endpoint is based on data on the healthcare costs of the endpoint and research into the Willingness-to-pay to avoid the endpoint (2017 dollars). A 3% discount rate applied.

Incidence refers to the number of new cases of a health endpoint over a specific period of time. It is calculated as statistical risk reduction aggregated over the population – "statistical life saved" equals the sum of many small risk reductions.

Fig. 4 - **COBRA Model Output: New Jersey with 2040 ACT emission reduction projections**

Health Endpoint	**Change in Incidence (cases, annual)**		**Monetary Value (dollars, annual)**	
	Low	High	Low	High
Mortality *	25.819	58.422	$282,535,199	$639,306,481
Nonfatal Heart Attacks *	3.043	28.255	$489,834	$4,548,083
Infant Mortality	0.106	0.106	$1,293,864	$1,293,864
Hospital Admits, All Respiratory	5.411	5.411	$348,270	$348,270
Hospital Admits, Cardiovascular **	6.801	6.801	$218,165	$218,165
Acute Bronchitis	37.086	37.086	$22,885	$22,885
Upper Respiratory Symptoms	672.553	672.553	$28,734	$28,734
Lower Respiratory Symptoms	471.950	471.950	$12,745	$12,745
Emergency Room Visits, Asthma	17.858	17.858	$10,061	$10,061
Asthma Exacerbation	694.974	694.974	$51,573	$51,573
Minor Restricted Activity Days	20,823.512	20,823.512	$1,825,491	$1,825,491
Work Loss Days	3,518.059	3,518.059	$704,270	$704,270
Total Health Effects			**$287,541,092**	**$648,370,623**

According to the COBRA model outputs, the ACT program emission reductions could save anywhere from $287.5 million to $648.4 million per year by 2040, and could include health impacts that result in 3,500 fewer work loss days and more than 672,553 avoided cases of upper respiratory symptoms. Even with the assumptions and caveats inherent in the model, the impacts can be substantial. With more time, the research team would perform additional scenario runs to examine the robustness and trend behavior of these estimates.

Impacted Populations near National Network Highways

The literature on road buffers is very detailed and diverse. Literature has found that air pollution only reaches background levels at locations that are beyond 400 meters (1/4 mile) from a high volume road (Karner et al., 2010). Particulate matter is most concentrated within 200 meters of high volume roadways (Fischer et al., 2000). Some of the locations with highest emissions exposure tend to be near or downwind from high-density truck and bus routes, and those populations near roadway emissions would benefit from emission reductions from medium and heavy duty vehicles (Allen et al, 2020).

Knowing that many medium and heavy-duty trucks travel along the state's major arteries, the research team performed a geospatial analysis that consisted of drawing a buffer of 0.5 mile around all of the major National Network roads in New Jersey, and we calculated the number of people living in census tracts that are all or partially within that buffer area.

Figure 5

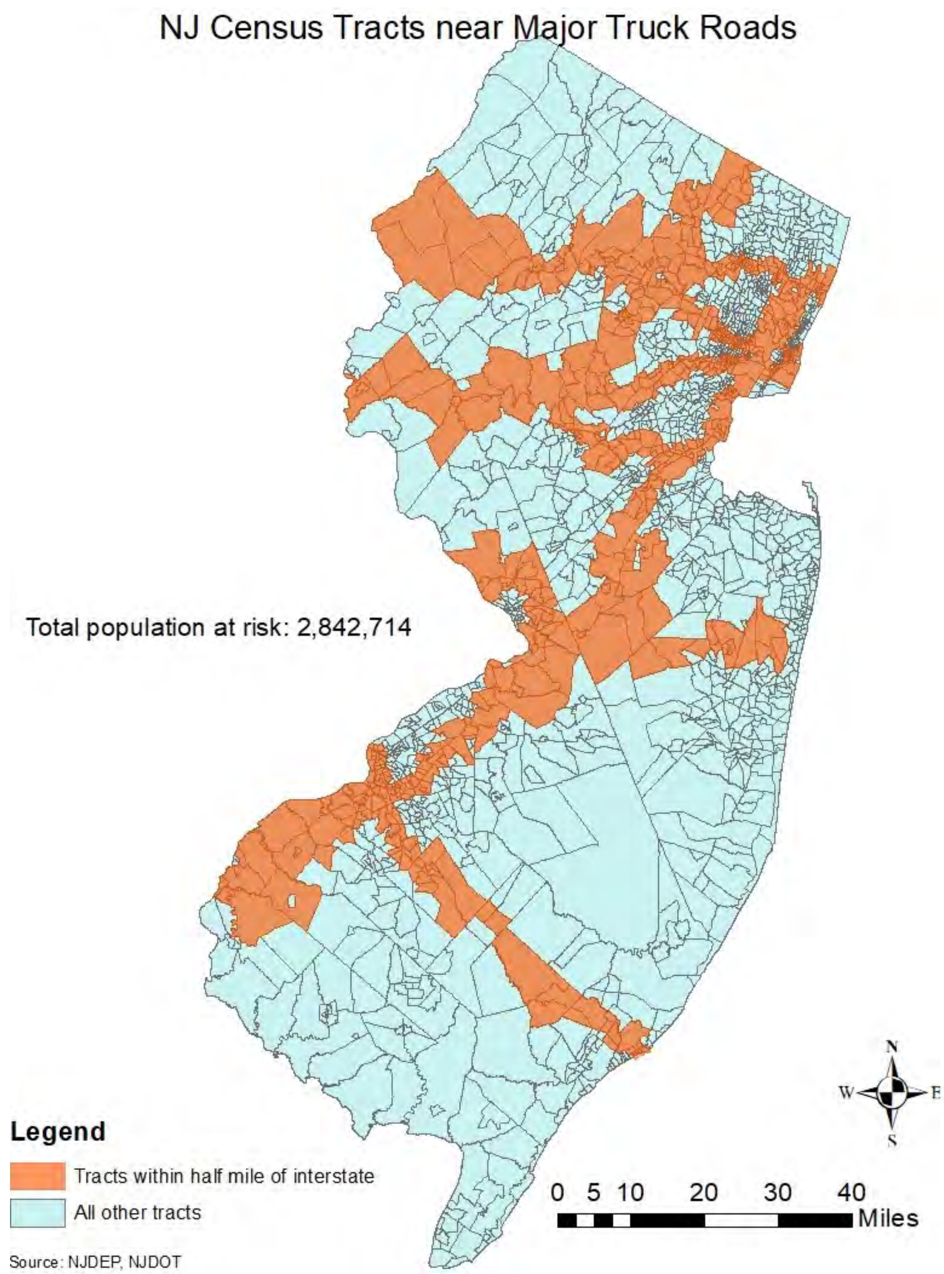

NJ Census Tracts near Major Truck Roads
Total population at risk: 2,842,714
Legend
Tracts within half mile of interstate
All other tracts
Source: NJDEP, NJDOT
N
W
E
S
0 5 10 20 30 40
Miles

Fig. 6 **- Demographics of census tracts within .5 mile from National Network roads**

	Tracts .5 mile from National Network	**NJ State**
Total population	2,842,714 (32%)	8,878,503
Under 18	24%	22.1%
Over 65	15%	15.9%
No High School Diploma	7.0%	10.2%
Per Capita Income	$38,387	$42,745
Hispanic	18.9%	20.2%
Non-white	34.6%	32.2%
Below Poverty	13.5%	10.0%

Source: ACS 2019 Estimate

Almost a third of New Jersey's population lives in the census tracts that are partially or wholly within a ½ mile buffer area of these highways. This affected population is more highly representative of many of the states' more vulnerable subgroups. It is slightly younger, with a higher non-white population and a population that is 30% higher in poverty level than the state as a whole, and with a per capita income about 13% lower than the state's.

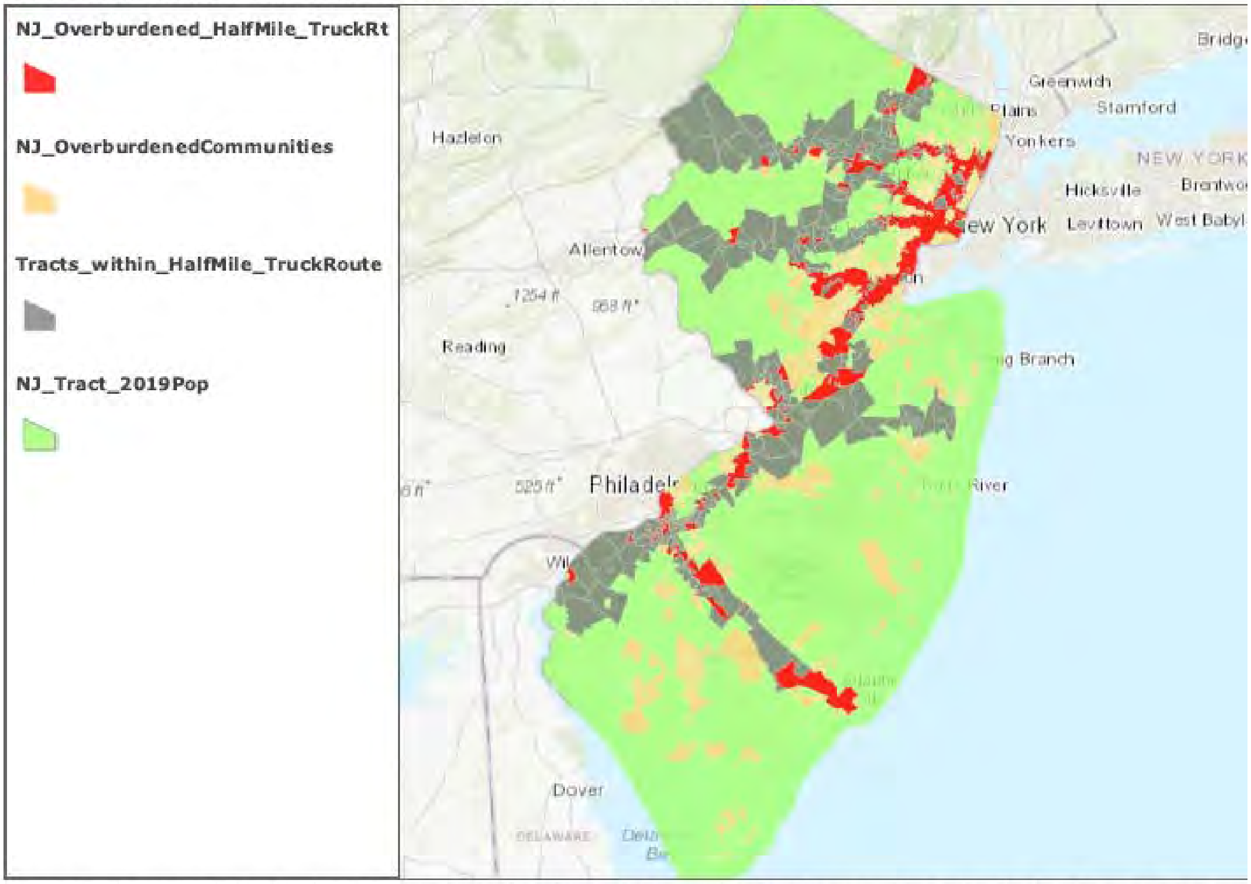
Looking at an overlay of New Jersey's overburdened communities with the census tracts within the ½ mile buffer produces the map (Figure 7) below. New Jersey's Environmental Justice Law, N.J.S.A. 13:1D-157 defines an overburdened community as any census block group in which: (1) at least 35 percent of the households qualify as low-income households; (2) at least 40 percent of the residents identify as minority or as members of a State recognized tribal community; or (3) at least 40 percent of the households have limited English proficiency.[8]

This analysis reveals that New Jersey's overburdened communities are more highly concentrated in areas close to major highways (58% of census block groups) than in the state as a whole (50% of census block groups).

[8] For more information please visit https://www.nj.gov/dep/ej/communities.html

Figure 7

NJ Overburdened Communities within Half Mile of Truck Routes



Census tracts within a half mile of an interstate route that also qualify as overburdened communities under the New Jersey Environmer

Esri, HERE,

Caveat: This analysis should ideally be performed again for a buffer area within ¼ mile to conform with current research on the area most impacted by air pollutants from vehicles traveling on major highways. A more fine-grained analysis would also include looking at a buffer area around the more widely distributed access routes where trucks move slower and idle more and where they are in closer proximity and have greater health impacts. In the interest of time, this team could not complete those analyses. We suspect that the populations living the closest to these roads are more likely those that are even more socioeconomically disadvantaged, younger and with higher minority proportions than the ½ mile buffer.

2. How will ***noise changes*** from the ACT Program impact health outcomes?

The difference in noise between a ZEV truck and a diesel engine truck are greatest the slower the trucks are moving. Pallas et al, 2014 suggests that the greatest benefit of electric vehicles is in the lower speeds, when electric trucks are notably quieter than diesel engine trucks and when the vehicle is accelerating or braking. (At higher speeds, the "rolling noise" of the wheel on the road is the main source for all vehicles, so there is less difference between ZEVs and diesel.) So electric engines may achieve greatest noise reductions in communities transected by or near local truck routes or congested highways, or shipping areas, where trucks are moving slowly, idling and stopping, starting and braking often.

However, there is also evidence from recent research that low-frequency noise is more harmful than higher frequencies (Alves et al, 2020). Truck traffic increases the sound pressure level of low-frequency sounds and that comes primarily from their engine hum, suggesting that electrifying medium- and heavy-duty vehicles may achieve a slight reduction in low-frequency noise pollution, especially in communities near major truck routes.

Exposure to noise has been associated with a number of negative psychological, physiological, and mental health effects (Moudon, 2009). Noise "annoyance" can be caused by road traffic noise (Moudon, 2009), and the random and intermittent sound level variations caused by trucks accelerating, backing up or braking, for example. A team of researchers examined the noise associated with a proposed distribution center in San Jose, California and found that noise was greater from truck backup alarms, acceleration from stop, airbrakes, and idling, than it was for trucks in "passby", or moving at a constant speed (City of San Jose, 2013).

Physiological impacts of noise include hearing loss, tinnitus, hypertension, ischemic heart disease, and some forms of cardiovascular disease (Alenius, 2001; van Kempen et al., 2002, Matsuoka et al., 2011). Alizadeh (2016) found truck driving to be correlated with hearing loss. Pourabdian (2019) found that 26.8% of studied truck and bus drivers have hearing loss. Hearing loss in the left ear (closer to window/exterior) was more than right ear.

Mental health impacts of noise include anxiety and disrupted sleep (Matsuoka et al., 2011). Sleep disturbance can then impair brain restoration and cardiovascular respite. It also has an effect on mood, fatigue, performance, cognitive abilities, vigilance, and can boost epinephrine levels which contributes to stress and increased risk of injury (Moudon, 2009; Stansfeld and Matheson, 2003; Passchier-Vermeer & Passchier, 2000). Groups that are particularly sensitive to these effects include: the elderly, the sick, and shift workers. Studies are inconclusive in determining whether health effects of noise-related stress have long-term, chronic impacts or if they are transient or reversible in nature. Research indicates there is sufficient evidence for a causal association between noise and disruptions in performance by school children, sleep disturbance, mood, heat rate, hearing loss, and ischemic heart disease (Porter et al., 1998).

Noise adversely affects short and long-term memory and sleep patterns, affecting productivity in the workplace and school. Studies have shown that low-level but chronic noise of moderate traffic can stress children and raise their blood pressure, heart rates, and stress (Centre for Sustainable Transportation, 2004; Evans, et al, 2001)

Environmental justice (EJ) communities also often suffer disproportionately from high levels of noise. EV's improve noise exposure (Walker et al, 2016), and environmental noise like traffic is linked to sleep disturbance, stress and decreased cognitive performance, increasing risks for cardiovascular disease, decreased immune function, mental health decline, among other effects). A potential downside of the quieter EVs, though, is pedestrian awareness for crash avoidance. This Health Note does not examine this potential health impact, but it is something to be looked at in future analyses.

OBSERVATIONS: INCORPORATING HEALTH AND HEALTH EQUITY INTO THE ACT PROGRAM

The literature collected and summarized in this Health Note supports that, in general, there are considerable positive health outcomes from the proposed rule, with a strong emphasis on positive impacts for marginalized populations that suffer the most from health disparities. This analysis points to potential opportunities for continued study of health impacts, and for enhancing positive health impacts and mitigating of any potential negative health impacts as the DEP considers the adoption and implementation of the ACT program and its subsequent regulations.

Key Overall Opportunities and Recommendations:

Support Broader Efforts – In moving toward a transition to cleaner, low carbon fuels and more fuel-efficient vehicles and technologies, it is important to continue to build synergism with the larger northeast region. Achieving vehicle electrification in Philadelphia, New York, even Connecticut and Massachusetts would likely improve air quality for New Jersey. And NJ can be a leader, inspiring these other states to act. As a leader, New Jersey could also convene regional panels or working groups, perhaps working through NESCAUM, to focus on health and health equity impacts of ZEV conversion, expanding partnerships to promote health.

Encourage State and Federal Action to Support Electrification of Vehicles – Other incentives and supports at the state and federal level will be necessary to eliminate some of the barriers and encourage the expansion of electrification. New Jersey can provide rebates and incentives on the purchase of ZEV trucks, and encourage the prioritization of public investments in charging infrastructure throughout the region that will help reduce air pollution, including such things as Truck stop electrification (TSE), which can make it more efficient and practical for freight haulers to adopt ZEVs.

Use a Health Lens Throughout Implementation – This report provides an initial set of insights as to the intersection of health and increases in ZEV/NZEV trucks. Using the items listed in this report as a starting point, the DEP has an opportunity to pursue improvement to the health of NJ residents by continuing to actively identify where opportunities exist to prioritize health and health equity as a driver of implementation.

Monitor and Evaluate Health Impacts – Implementation of this rule presents an excellent opportunity to institute a process of evaluation of health impacts. This could involve identification of expected impacts through an HIA or checklist (see below), collection of relevant baseline health indicators for affected populations, specific changes in emissions, and tracking of changes through time. This would contribute to general knowledge about health impacts of ACT programs, and also help environmental regulatory agencies to better understand co-benefits and costs, and modify implementation to either enhance those co-benefits or reduce costs and negative impacts.

Conduct Additional Studies – From data collected from evaluation and monitoring efforts (see above), additional studies on overall impacts of the program on the social determinants of health would be valuable. Some of these could be:

- Doing an impacted population analysis along the "Access Road" network
- Examining different effects of the emissions reductions within different air basins in New Jersey (north, south, corridor, ports, airport)
- Examining exposure at a finer grain around highways, depending on strength of emission, wind, situations
- Conducting a health impacts analysis (see next bullet) that includes a full set of potential impacts including, for example, the effect of quieter electric trucks on changes in potential for pedestrian crashes, changes in occupational exposures to air pollutants, and jobs impacts of the shift from gasoline/diesel to electrification.

Consider Health Impact Assessment (HIA) for Other Aspects of Rollout - As the rule is considered, and as presumed implementation begins, DEP could look toward Health Impact Assessments as a way to bring health to the table as part of the decision-making process in several ways: engaging health professionals in the discussion, using available tools/literature/science to project the magnitude and distribution of direct and indirect health outcomes. For example, as a part of the program is being designed for implementation, an HIA could assess specific aspects of the program design for impacts on different subpopulations (workers, drivers, neighborhoods along route) and on various intermediate impacts created by changes in the social determinants of health (jobs, exposures, accidents, etc.). HIA is a nationally recognized, evidence-based approach that is designed to consider potential health outcomes during the decision-making process so modifications can be made to promote positive health outcomes and mitigate negative ones. By design, HIA has a strong focus on engaging the populations most affected by a decision, including populations and communities that are under resourced and traditionally underrepresented.

Coordinate with HEALTHY NJ 2030 - Every decade, the state Department of Health launches a new set of science-based, 10-year state objectives with the goal of improving the health of all New Jerseyans. The development of Healthy New Jersey 2030 (HNJ2030) includes establishing a framework for the initiative—the vision, mission, foundational principles, plan of action, and overarching goals—and identifying new objectives. This effort serves as the long-term strategic planning effort for health for the state and presents a tremendous opportunity for DEP to engage with NJDOH on collaboration with regard to integration of health into this and other rules affecting population health.[9]

Increase Share of Renewable Electricity Generation - To achieve maximum emissions reductions through adoption of EV's and reduce health equity considerations caused by pollution exposure shifts from power use areas to power generation locations, the electricity generation mix should become increasingly higher in renewable energy, with consideration of local power generation. Such a transition is consistent with the goals of the New Jersey Energy Master Plan and this HIA points to the critical need to advance such a transition affirmatively and expeditiously.

Examine Battery Life-Cycle Issues - More research of the life-cycle costs and impacts of EV's and EV batteries is necessary to fully understand health impacts through their manufacture, use and disposal. Battery recycling could be considered as a new business opportunity for New Jersey, provided potential health, safety, and environmental issues are addressed.

Use Health Checklist for Evaluation during DEP ACT Implementation - If there is not sufficient time or resources to conduct a full or rapid HIA study prior to implementing this rule, a checklist tool could be implemented in consultation with the public health sector. Checklists are practical tools to assist with evaluating the impacts of implementation of plans, policies, projects and programs. The following set of questions related to potential health impacts of an ACT program is not an exhaustive list, rather it is provided by the authors as a template and starting point for consideration by the DEP.

A more exhaustive checklist could be developed through a rigorous process including a cross-sector collaboration of health, economic, energy and environmental organizations with input from community-based organizations that represent environmental justice communities. A model for implementation of such a checklist could include a team process with representatives from relevant fields like transportation, environment, socioeconomics and health, addressing applicable questions from the list below regarding specific implementation plans under consideration. Results could inform modifications in plans that result in enhancement of benefits, mitigation of negative impacts or shifting of impacts away from vulnerable communities.

---

[9] See: https://healthy.nj.gov/2030/

Figure 8
Health and Health Equity Checklist for Advance Clean Truck Program

1. Is there explicit language connecting the program to human health outcomes or health equity considerations?
2. How is the program including public health experts in the decision-making process?
3. How is the program engaging local stakeholders and how often? Does the public engagement reflect the diversity of the community and reduce barriers to participation (e.g. provide food, childcare, transit-access, translation)?
4. Where will the program be situated? How will it affect houses, schools, or other places where people congregate? In what ways is the land currently used (e.g., housing, agricultural, recreational, cultural uses)? Is there suitable alternative location for these activities?
5. What are the socioeconomic characteristics of the affected community? Will the program affect a community that already suffers from a disproportionate environmental burden?
6. How will the project affect transportation costs and other household expenses? How will this affect low-income populations?
7. What types of and how many jobs will be provided (e.g. temporary or permanent; high-skill or low-skill, benefits available)? Where will hires come from?
8. How will air emissions be monitored? What populations will be most affected by the exposure?
9. How will the current background noise level change with this program, and how will noise changes be monitored?
10. Does current or future land use development associated with the program consider impacts on overburdened communities, and attempt to incorporate neighborhood commercial and/or mixed-used development and density to encourage non-motorized transportation?
11. Is the life cycle cost/benefit associated with new or changed production/manufacturing outputs considered and evaluated for health impacts?

Concluding Comments:

The New Jersey Climate Change Alliance provides these comments to NJDEP with the intention of highlight the importance of bringing a "health lens" to the development of climate change policy in New Jersey. We hope this study and its related insights will assist DEP in considering how to maximize benefits to health and health equity as it moves forward with finalization of the rule and begins to develop and implement its regulations. The Alliance and the Rutgers University research team stand ready to help in advancing health-informed climate policies and programs. The state's public health leaders actively support the concept of Health in All Policies in New Jersey, including in the environment and transportation sectors, opening up opportunities for building cross-sector partnerships to advance efforts to more systematically consider health and health equity outcomes of emissions reduction programs in New Jersey.

Bibliography

Articles and Reports referenced or cited:

Alenius, K. 2001. Consideration of Health Aspects in Environmental Impact Assessments for Roads. National Institute of Public Health, Sweden.

Alizadeh A, et al. 2001. “Noise-induced hearing loss in bus and truck drivers in Mazandaran province.” Int J Occup Saf Ergon. 2016;22(2):193-8.

Allen, P., et al. 2020. *Newark community impacts of mobile source emissions.* M. J. Bradley & Associates. http://www.njeja.org/wp-content/uploads/2021/04/NewarkCommunityImpacts_MJBA.pdf

Alves, JA, et al. 2020. “Low-frequency noise and its main effects on human Health—A review of the literature between 2016 and 2019.” *Applied Sciences, 10*(15), 5205.

Bae CHC, et al. 2007. “The exposure of disadvantaged populations in freeway air-pollution sheds: a case study of the Seattle and Portland regions.” *Environment and Planning B-Planning & Design*. 34(1):154-70.

Bhatia, R., et al. 2012. “Enhancing Health Benefits of Residential Energy Efficiency Programs: A Health Impact Assessment”. San Fransciso Department of Public Health.

Centre for Sustainable Transportation. 2004. *Child-friendly Transport Planning*. Available at: http://cst.uwinnipeg.ca/documents/Child_friendly.pdf

City of San Jose. 2013. *Envision San José 2040*. Retrieved from: http://www.sanjoseca.gov/DocumentCenter/Home/View/474

Cooke, David. 2020. *California Moves Forward to Address Pollution from Heavy-Duty Trucks*. Union of Concerned Scientist, The Equation.

Delucchi, M. A., et al. 2014. "An Assessment of Electric Vehicles: Technology, Infrastructure Requirements, Greenhouse-Gas Emissions, Petroleum use, Material use, Lifetime Cost, Consumer Acceptance and Policy Initiatives." *Philosophical Transactions of the Royal Society A: Mathematical, Physical & Engineering Sciences* 372 (2006): 1-27.

Evans GW, et al. 2001. “Community noise exposure and stress in children.” *Journal of the Acoustical Society of America*, 109(3):1023-7.

Ferrero, E., et al. 2016. "Impact of the Electric Vehicles on the air pollution from a highway. *Applied Energy*, 169:450-459.

Filleul L, et al. 2005. “Twenty-five year mortality and air pollution: results from the French PAARC survey.” *Occup Environ Med*, 62(7):453e60.

Fischer, P. H., et al. 2000. Traffic-related differences in outdoor and indoor concentrations of particles and volatile organic compounds in Amsterdam. *Atmospheric Environment*, *34*(22), 3713–3722.

Frey, H. C. 2018. "Trends in Onroad Transportation Energy and Emissions." *Journal of the Air & Waste Management Association (1995)* 68 (6): 514-563.

Fuertes E., et al. 2016. "Traffic-related air pollution and hyperactivity/inattention, dyslexia and dyscalculia in adolescents of the German GINIplus and LISAplus birth cohorts." *Environ Int*. 97:85-92.

Gabbatiss, J. 2018. "Electric vehicles already able to cut greenhouse gas emissions by half." *The Independent.*

Gaskins AJ, et al. 2018. "Residential proximity to major roadways and traffic in relation to outcomes of in vitro fertilization." doi: 10.1016/*j.envint*.2018.03.029, 115:239-246.

Glazener, A. and H. Khreis. 2019. "Transforming our Cities: Best Practices Towards Clean Air and Active Transportation." *Current Environmental Health Reports* 6 (1): 22-37.

Gilliland F. et al. 2017. "The Effects of Policy-Driven Air Quality Improvements on Children's Respiratory Health." Res Rep Health Eff Inst. 2017 Jan;(190):1-75.

Jochem, P. et al. 2016. "External Costs of Electric Vehicles." *Transportation Research: Part D* 42: 60-76.

Karner, A. et al. 2010. "Near-roadway air quality: synthesizing the findings from real-world data." *Environmental Science & Technology*, *44*(14), 5334–5344.

Kennedy CM. et al. 2018. "Associations of mobile source air pollution during the first year of life with childhood pneumonia, bronchiolitis, and otitis media." *Environ Epidemiol.* Mar;2(1):e007

Lanari M. et al. 2016. Exposure to vehicular traffic is associated to a higher risk of hospitalization for bronchiolitis during the first year of life. *Minerva Pediatra*, 68(6):391-397.

Matsuoka, M., et al. 2011. "Global Trade Impacts: Addressing the Health, Social and Environmental Consequences of Moving International Freight through Our Communities." *UEP Faculty & UEPI Staff Scholarship*. Retrieved from http://scholar.oxy.edu/uep_faculty/411

Matt F. et al. 2016. "Acute respiratory response to traffic-related air pollution during physical activity performance." *Environ Int*. Dec;97:45-55.

McLaren, J. et al. 2016. "CO2 Emissions Associated with Electric Vehicle Charging: The Impact of Electricity Generation Mix, Charging Infrastructure Availability and Vehicle Type." *Electricity Journal* 29 (5): 72-88.

Miles, R., & Jacobs, D. E. 2008. “Future Directions in Housing and Public Health: Findings From Europe With Broader Implications for Planners.” *Journal of the American Planning Association*, *74*(1), 77–89.

Miller MR & Newby DE. 2020. “Air pollution and cardiovascular disease: car sick.” *Cardiovasc Res*. 116(2):279-294.

Moudon, A. V. 2009. “Real noise from the urban environment: how ambient community noise affects health and what can be done about it.” *American Journal of Preventive Medicine*, *37*(2), 167–171.

NJDEP. 2021. Proposed Amendment: N.J.A.C. 7:27A-3.10, Proposed New Rules: N.J.A.C. 7:27-31 and 33**,** DEP Docket Number: 05-21-03. Proposal Number: PRN 2021-036.

Nichols, BG, et al. 2015. "Air Quality Impacts of Electric Vehicle Adoption in Texas." *Transportation Research: Part D* 34: 208-218.

Nopmongcol, U., et al. 2017. "Air Quality Impacts of Electrifying Vehicles and Equipment Across the United States." *Environmental Science & Technology* 51 (5): 2830-2837.

Olsson D, et al. 2015. “Traffic pollution at the home address and pregnancy outcomes in Stockholm, Sweden.“ 5(8):e007034

Pallas, M. A., et al. 2014. “Noise emission assessment of a hybrid electric mid-size truck.” *Applied Acoustics*, *76*, 280–29.

Park, SS, et al. 2016. "Investigating the Real-World Emission Characteristics of Light-Duty Gasoline Vehicles and their Relationship to Local Socioeconomic Conditions in Three Communities in Los Angeles, California." *Journal of the Air & Waste Management Association,* 66 (10): 1031-1044.

Passchier-VW., & Passchier, W.F. 200. Noise exposure and public health. *Environmental Health Perspectives*, *108*(Suppl 1), 123–131.

Perez, L., et al. 2015. "Transport-Related Measures to Mitigate Climate Change in Basel, Switzerland: A Health-Effectiveness Comparison Study." *Environment International* 85: 111-119.

Peters DR, et al. 2020. “Public Health and Climate Benefits and Trade-Offs of U.S. Vehicle Electrification.” *GeoHealth*, 4(10):e2020GH000275.

Porter, ND., et al. 1998. *Health effect-based noise assessment methods: a review and feasibility study*. National Physical Laboratory. Great Britain, Centre for Mechanical and Acoustical Metrology. Retrieved from http://www.persona.uk.com/ashton/Core_docs/New/D50.pdf.

Poullikkas, A. 2015. "Sustainable Options for Electric Vehicle Technologies." *Renewable & Sustainable Energy Reviews* 41: 1277-1287.

Pourabdian S., et al. 2019. “Prevalence hearing loss of truck and bus drivers in a cross-sectional study of 65533 subjects.” *Environ Health Prev Med.* 24(1):78.

Price K, et al. 2012. “Risk of Childhood Asthma Prevalence Attributable to Residential Proximity to Major Roads in Montreal, Canada, ” *Canadian Journal of Public Health-Revue* 103(2):113-8.

Requia, W., et al. 2017. "Carbon Dioxide Emissions of Plug-in Hybrid Electric Vehicles: A Life-Cycle Analysis in Eight Canadian Cities." *Renewable & Sustainable Energy Reviews* 78: 1390-1396.

Requia, W., et al. 2018. "How Clean are Electric Vehicles? Evidence-Based Review of the Effects of Electric Mobility on Air Pollutants, Greenhouse Gas Emissions and Human Health." *Atmospheric Environment* 185: 64-77.

Rowangould, G. M. (2015). A new approach for evaluating regional exposure to particulate matter emissions from motor vehicles. *Transportation Research Part D: Transport and Environment*, *34*, 307–317.

Saelens, B., et al. 2003. “Environmental correlates of walking and cycling: Findings form the transportation, urban design and planning literature.” *Annals of Behavioral Medicine,* 25(2), 80-91.

Salvi A., et al. 2019. “Neurobehavioral Consequences of Traffic-Related Air Pollution.” *Frontiers in Neuroscience*, 13:1232.

Shi, X., et al. 2016. "Electric Vehicle Transformation in Beijing and the Comparative Eco-Environmental Impacts: A Case Study of Electric and Gasoline Powered Taxis." *Journal of Cleaner Production* 137: 449-460.

Stansfeld, S.A. and M. P. Matheson. 2003. “Noise pollution: non-auditory effects on health.” *British Medical Bulletin*, 68: 243-257.

Stieb DM., et al. 2016. “A national study of the association between traffic-related air pollution and adverse pregnancy outcomes in Canada, 1999-2008.” *Environ Res*. 148:513-526.

Sunyer J., et al. 2015. “Association between traffic-related air pollution in schools and cognitive development in primary school children: a prospective cohort study.” *PLoS Med*. 2015 Mar 3;12(3):e1001792.

U.S. Environmental Protection Agency (USEPA). 2003. *Framework for Cumulative Risk Assessment*. In: Forum RA, editor. Washington, DC2003.

USEPA. 2016. *Greenhouse Gas Emissions and Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles—Phase 2, Regulatory Impact Analysis*, pp. 6-6 to 6-6.

van Kempen, E. E., et al. 2002. "The association between noise exposure and blood pressure and ischemic heart disease: a meta-analysis." *Environmental Health Perspectives*, *110*(3), 307–317.

Vardoulakis, S., et al. 2015. "Impact of Climate Change on the Domestic Indoor Environment and Associated Health Risks in the UK." *Environment International* 85: 299-313.

Woodcock et al., 2009. "Public health benefits of strategies to reduce greenhouse-gas emissions: urban land transport," *Lancet*, 374 (9705), pp. 1930-1943.

Wu, X et al. 2020. "Air pollution and COVID-19 mortality in the United States: Strengths and limitations of an ecological regression analysis." *Science advances*, 6(45), eabd4049.