Evaluation of the Port of New York & New Jersey Clean Trucks Program Rollback

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Prepared for: Coalition for Healthy Ports (CHP)

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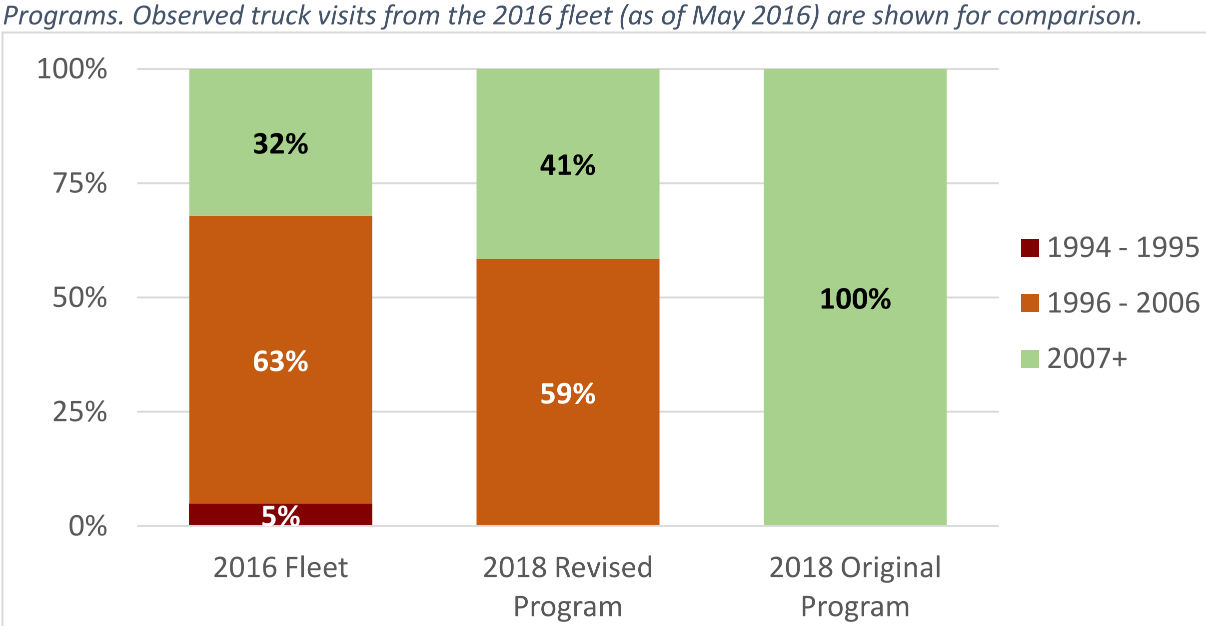
Executive Summary

In 2009, the Port Authority of New York / New Jersey (PANYNJ) issued a Clean Air Strategy (CAS) which outlined a number of measures to reduce air pollution from Port activities. The PANYNJ committed to requiring drayage trucks to be cleaner (to meet or exceed US EPA emissions standards for 2007 on-road heavy duty vehicles or to use alternative fuel or hybrid technology) as of January 1, 2017. However, in 2016 the PANYNJ revised (and significantly rolled back) the clean truck requirements. The rolled back Clean Truck Program requires that drayage trucks have an engine year of 1996 or newer (or use alternative fuel or hybrid technology) as of January 1, 2018. Additionally, trucks registering to access the Port of New York / New Jersey (Port or PONYNJ) after March 1, 2016 must be 2007 engine year or newer.

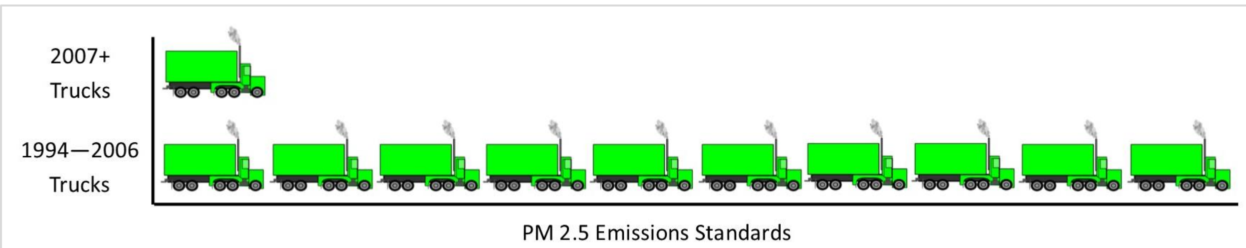
The rolled back Program will have a much smaller effect on cleaning up Port trucks than the original Program. As of May 2016, 68% of the approximately 304,701 truck visits to the Port were completed by trucks that were older than model year 2007. These trucks would be removed from service under the original Clean Truck Program but most can remain in service under the rolled back (revised) Program. Only 5% of Port trucks are older than model year 1996 and will be removed from service under the rolled back Program. In other words, the implementation of the revised Program will result in a far more modest shift in the truck fleet, resulting in a truck fleet that looks very similar to the current fleet (see ES-1 below and Figure 2 and Figure 3 in the main report.)

Executive Summary (ES) - 1: 2018 Port truck fleet visitation estimates for the original and revised Programs. Observed truck visits from the 2016 fleet (as of May 2016) are shown for comparison.



These differences in the fleet's age profile are critical because heavy duty trucks with a model year of 2007 or newer are subject to PM2.5 emissions standards that are far more stringent than those that applied to their older counterparts. For example, 1994 to 2006 model years were permitted to emit ten times as much PM2.5 as 2007 and newer trucks (see ES-2 below). In other words, 2007 and newer trucks have 90% fewer emissions than their pre-2007 counterparts. As a result, the scaled back scope of the revised Program will result in greater truck emissions when compared to emissions that would occur under the original Program due to the continued use of older trucks at Port facilities. These greater emissions will result in greater concentrations of air pollution, which will lead to greater health risks in the surrounding communities. The rollback of the Program will affect air quality and health for years to come.

Executive Summary (ES) - 2: Relative Magnitude of PM2.5 Emissions Standards for Heavy Duty Trucks



The purpose of this analysis is to quantify some of the predicted air quality impacts and one of the public health risks of scaling back the Port's Clean Truck Program. We use the best publically available information to estimate emissions, concentrations, and health risks across eight counties in New Jersey in 2017 and 2018, when the impacts of the rollback will likely be the greatest[1]. There will likely be over 5 million truck calls each year at PONYNJ Terminals in 2017 and 2018. We find that fine particulate matter (PM2.5) emissions, concentrations, and resultant risks for total mortality will be higher with the rolled back Clean Truck Program. Specifically, the increased emissions from 2017 and 2018 alone will result in the following changes:

Truck PM2.5 emissions will be higher by 7 to 8 fold each year:

- Port trucks emit fine particulate matter (PM2.5) while at Port terminals and while moving to and from the Port via routes throughout the region. There will be 11 times more PM2.5 emissions from Port terminals under the rolled back Clean Truck Program in 2017 and 2018 when compared to the original Program. There will be 7 times more emissions along off-terminal truck routes in the study area under the rolled back Clean Truck Program in 2017 and 2018 when compared to the original Program. See Figure 5.

PM2.5 concentrations will increase by up to 1 micrograms per cubic meter (μg/m^3) in some areas:

- Annual mean 24-hour PM2.5 concentrations will increase by up to 1 μ/m^3 in 2017 and 2018 in several areas as a result of the rolled back Program. The greatest increases occur at Port terminals and along major truck routes accessing the terminals. For reference, the current 1-year PM2.5 National Ambient Air Quality Standard is 12 μg/m^3, where an area's ability to achieve the standard is calculated as the annual mean averaged over 3 years. See Figure 8 and Figure 9.

The risks of death due to a year's emissions will increase by over 1 in a million in many areas and by over 25 in a million in some areas:

- In 2017 the risks of all-cause premature mortality are expected to be higher under the revised Clean Truck Program for adults in the study area than they would have been under the more stringent original Clean Truck Program.
    - We estimate that the increase in PM2.5 emissions in 2017 alone will result in risks of premature mortality that increase by a city-wide average of 1 to 10 in a million for adults living in several nearby communities, including the Cities of Bayonne, Elizabeth, and Newark. See Figure 10, Figure 11, and Table 5.
    - Risks also vary within communities. We estimate that the increase in emissions in 2017 alone will result in approximately 400,000 to 700,000 adults in the region experiencing risks of premature mortality that increase by at least 1 in a million, 5,000 to 40,000 residents will experience risks of premature mortality that increase by at least 10 in a million, and 600 to 3,000 adults will experience risks of premature mortality that increase by at least 25 in a million. Essex, Hudson, and Union counties exhibit the greatest increases in risks, with 24 – 39%, 36 – 52%, and 25 – 39% of their adult populations experiencing risks of premature mortality that increase by more than 1 in a million due to increases in PM2.5 emissions in 2017 alone. See ES-3 below and Table 6.

Executive Summary (ES) - 3: Population-level risks of adult premature mortality due to increased exposure to PM2.5 in 2017 alone.

County	Number of adults experiencing increased risks of premature death (95% confidence interval)		
	>1 in a million risk	>10 in a million risk	>25 in a million risk
Bergen	12,000 - 41,000	0 - 170	0 - 0
Essex	110,000 - 200,000	1,500 - 6,700	500 - 1,300
Hudson	130,000 - 230,000	1,500 - 22,000	14 - 770
Middlesex	37,000 - 81,000	370 - 2,700	1.3 - 290
Morris	9,100 - 21,000	720 - 930	0 - 23
Passaic	510 - 4,300	0 - 0	0 - 0
Somerset	160 - 730	0 - 0	0 - 0
Union	82,000 - 140,000	1,400 - 9,800	33 - 750
Total	**380,000 - 710,000**	**5,400 - 42,000**	**550 - 3,100**

- The increased risks of premature mortality that could have been prevented by implementing the more stringent original Clean Truck Program are expected to be similar in 2018.

    - We estimate that the increase in PM2.5 emissions in 2018 alone will result in risks of premature mortality that increase by a city-wide average of 1 to 10 in a million for adults living in several nearby communities, including the Cities of Bayonne, Elizabeth, and Newark. See Figure 12, Figure 13, and Table 5.
    - We estimate that the increase in emissions in 2018 alone will result in approximately 400,000 to 700,000 adults in the region experiencing risks of premature mortality that increase by at least 1 in a million, 4,000 to 30,000 residents will experience risks of premature mortality that increase by at least 10 in a million, and 40 to 2,000 adults will experience risks of premature mortality that increase by at least 25 in a million. Essex, Hudson, and Union counties exhibit the greatest increases in risks, with 22 – 36%, 34 – 49%, and 23 – 37% of their adult populations experiencing risks of premature mortality that increase by more than 1 in a million due to increases in PM2.5 emissions in 2018 alone. See Table 7.

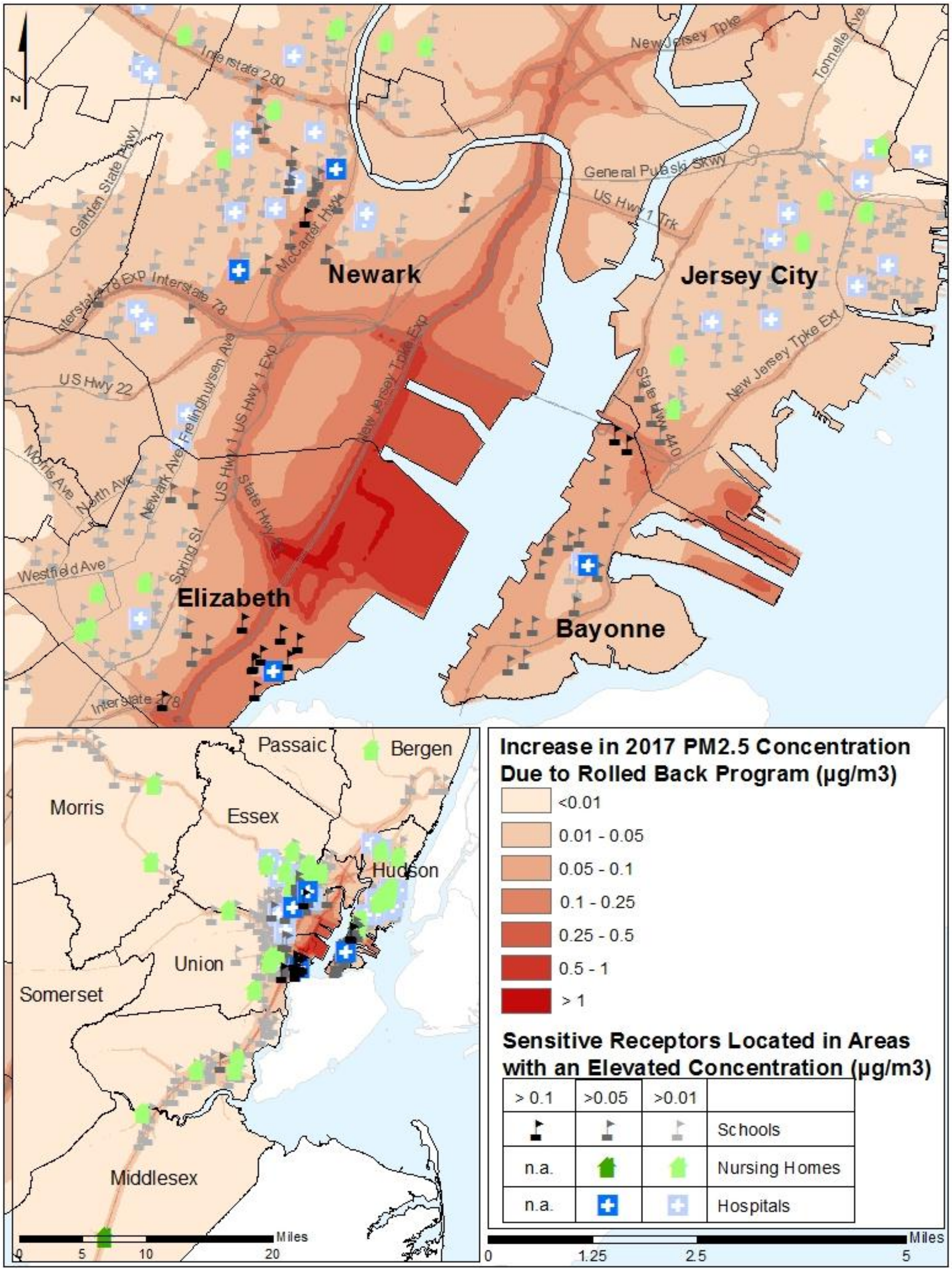
- Approximately 67 – 92% of the elevation in premature mortality risks is associated with ischemic heart disease (primarily heart attacks) while 8 – 16% of is associated with lung cancer.

Due to resource constraints, we note that this study is limited in scope. The estimated effects of the revised Program would be greater if this study included a broader range of pollutants, geographic areas, exposure pathways, health outcomes, and time periods. For example:

- This study focuses only on PM2.5. Emissions of other air pollutants such as nitrogen oxides (NO_x), hydrocarbons, and coarse particulate matter (PM10) are also likely to be greater under the revised Program. Increases in these pollutants may also increase local health risks.
- This analysis of health effects is based on residential location. In addition to experiencing greater exposures to air pollution where they live, people will be exposed to elevated PM2.5 concentrations while driving on roadways with Port truck traffic, and where they work, receive medical care, attend school, or play. For example, there are approximately twelve schools in areas that are expected to experience changes in PM2.5 concentrations that exceed 0.1 $\mu g/m^3$ in 2017. In areas that are expected to experience changes of 0.05 to 0.1 $\mu g/m^3$ there are approximately an additional 41 schools, four hospitals, and one nursing home. In areas that are expected to experience changes of 0.01 to 0.05 $\mu g/m^3$ there are approximately an additional 254 schools, 31 hospitals, and 33 nursing homes. See ES-4 below and Figure 14.

- This analysis of health effects is limited to premature mortality among adults. This outcome is estimated based on elevated average exposures over the course of a year. Numerous other health risks associated with short and long-term PM2.5 pollution that were not included in this study include (but are not limited to) acute and chronic bronchitis, asthma exacerbation (including emergency room visits and hospitalizations), nonfatal acute myocardial infarction (heart attacks), upper and lower respiratory symptoms, and hospital admissions for a variety of other respiratory and cardiovascular concerns (including chronic lung disease, pneumonia, congestive heart failure, ischemic heart disease, and cardiac dysrhythmia.)
- This analysis has focused only on the impacts of changes in emissions in the first two years of the Program's implementation (2017 and 2018). However, the effects estimated in 2017 and 2018 are expected to continue, gradually tapering off, for up to 15 or more years into the future. The total cumulative burden of emissions impacts and health risks that occur over this period of time will consequently exceed the more-immediate estimates for 2017 and 2018 only that are presented here. See Figure 15.

Executive Summary (ES) - 4: Schools, nursing homes, and hospitals located in areas expected to experience changes of PM2.5 concentrations greater than 0.01 µg/m^3 in 2017 as a result of the rolled back program.



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Key Terms and Abbreviations

AERMOD: An EPA approved air dispersion model used to simulate the transport of primary air pollutants. Version 15181 is used in this analysis.

BenMAP: Environmental Benefits Mapping and Analysis Program – Community Edition. An EPA model used to simulate health and economic effects of changes in air pollution concentrations. BenMAP-CE v. 1.1 is used in this analysis.

Clean Truck Program (original): Issued by the Port Authority of New York / New Jersey in 2009, this Program required Port drayage trucks to meet emissions standards for 2007 engines starting in 2017. Approximately 68% of truck visits to the Port in May 2016 were completed by trucks that were were 2006 or older.

Clean Truck Program (revised, or rolled back): Issued by the Port Authority of New York / New Jersey in 2016, this Program is a rolled back version of the original Clean Truck Program, requiring Port drayage trucks to meet emissions standards for 1996 engines starting in 2018. This version of the Program affects 5% of Port truck visits. Additionally, trucks newly registering to enter the Port must have 2007 engine year or newer starting March 1, 2016.

CAS: Clean Air Strategy, issued by the Port Authority of New York / New Jersey in 2009.

g/hr: Grams per hour.

g/mile: Grams per mile.

g/start: Grams per start.

hr/truck: Hours per truck.

Ischemic heart disease: Decreased blood flow to the heart.

$\mu g/m^3$: Micrograms per cubic meter.

MOVES: Motor Vehicle Emissions Simulator, EPA's vehicle emissions model. Version 2014a is used in this analysis.

mph: Miles per hour.

National Ambient Air Quality Standard (NAAQS): Air quality standards set by the EPA under the Clean Air Act.

PANYNJ: Port Authority of New York / New Jersey.

PONYNJ or Port: Port of New York / New Jersey.

PM2.5: Fine particulate matter with a diameter of 2.5 micrometers or less.

US EPA or EPA: United States Environmental Protection Agency.

Premature mortality: Death that occurs earlier than expected.

TAZ: Travel Activity Zone, the spatial unit used in a travel demand model.

Background

The Port of New York / New Jersey (Port) moved over 3.6 million containers in 2015, an increase of more than 30% over 2005 levels.[2] As freight traffic has increased, surrounding communities have expressed concerns about the health impacts of air pollution from truck traffic and other Port activities (such as from marine vessels, cargo handling equipment, and locomotives.)

In 2009, the Port Authority of New York / New Jersey (PANYNJ) issued a Clean Air Strategy (CAS) which outlined a number of measures to reduce air pollution from Port activities. Strategies to reduce emissions from Port trucks include operational improvements (e.g. congestion reduction, appointment system, and extended gate hours), truck technology improvements (e.g. funding and rules to encourage or require the use of cleaner trucks), and land use / planning strategies (e.g. promoting development of warehouses and distribution centers closer to the port.)

By 2011, funding for cleaner Port Drayage Trucks[3] (heavy-duty trucks entering and leaving the Port to transport cargo) had contributed to 429 replacements and 31 retrofits targeting older trucks (Bonney 2015b). The PANYNJ also committed to requiring Drayage Trucks to be cleaner (to meet or exceed EPA emissions standards for 2007 on-road heavy duty vehicles or to use alternative fuel or hybrid technology) as of January 1, 2017 (Port Authority of New York and New Jersey 2014, 2015b, a). However, in 2016 the PANYNJ revised (and significantly rolled back) the Clean Truck Program requirements. The rolled back Clean Truck Program requires that Drayage Trucks have an engine year of 1996 or newer (or use alternative fuel or hybrid technology) as of January 1, 2018 (Port Authority of New York and New Jersey 2016a). Additionally, trucks newly registering to access the Port after March 1, 2016 must be 2007 engine year or newer. Trucks already registered that have an engine of 1996 or newer will continue to be permitted to enter the Port under the revised, less stringent Clean Truck Program.

The rolled back Program will result in much smaller reductions in emissions and health risks than the original Program. As of May 2016, 68% of the approximately 304,701 truck visits to the Port were completed by trucks that were older than model year 2007[4]. These trucks would have been removed from service under the original Clean Truck Program but can remain in service under the rolled back Program. Only 5% of Port trucks are older than model year 1996 and will be removed from service under the rolled back Program[5]. In other words, the implementation of the revised Program would result in a far more modest shift in the truck fleet, resulting in a truck fleet that looks very similar to the current fleet. These differences in the fleet's age profile are critical because pre-2007 heavy duty trucks were permitted to emit ten times as much PM2.5 as their newer counterparts (see Figure 1).

The purpose of this analysis is to quantify some of the predicted air quality impacts and one of the increased health risks of rolling back the Port's Clean Truck Program.

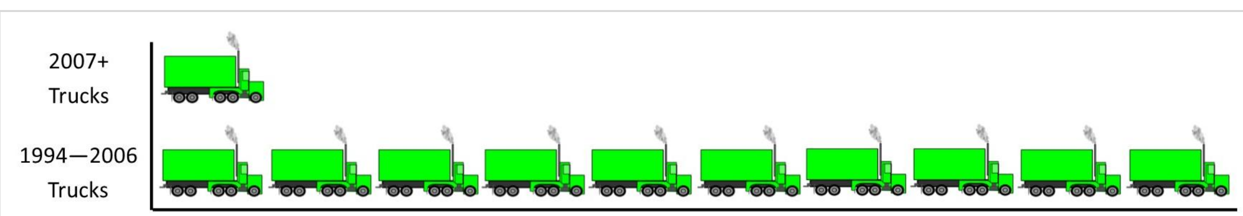

Figure 1: Relative Magnitude of PM2.5 Emissions Standards for Heavy Duty Trucks

Analysis Methods

Overview

One of the main concerns in areas that are proximate to heavy-duty diesel truck traffic is exposure to emissions of fine particulates. We first estimate the emissions of fine particulate matter (particulate matter that is < 2.5 micrometers in diameter, or PM2.5) from Port trucks under the original and revised (rolled back) Clean Trucks Programs. We evaluate emissions from Port terminals and Port truck routes for eight New Jersey counties in the Port area. Using these location-specific emissions estimates, we then estimate the change in PM2.5 concentrations from Port truck traffic that is expected to occur due to the rollback of the Clean Trucks Program. The health risks of this change in concentrations are then evaluated in the communities around the Port in terms of the changes in risks of all-cause premature mortality (for adults).

The scope of our analysis is as follows:

Terminals included[6]	All container, auto, and warehouse terminal activities at four PONYNJ marine terminals: • Port Newark (Newark, NJ), which includes the Port Newark Container Terminal. • Elizabeth Port Authority Marine Terminal (Elizabeth, NJ), which includes the Maher and APM Terminals. • Port Jersey Port Authority Marine Terminal (Jersey City, NJ), which includes the Global Container Terminals Bayonne LP. • Howland Hook Marine Terminal (Staten Island, NY), which includes the Global Container Terminals New York LP.
Vehicles	• Heavy duty diesel vehicles entering and exiting Port terminals to transport goods to and from Port facilities
Activities	• On-terminal starts, idling (short and extended), and driving for the four marine terminals listed above. • Off-terminal driving to and from the four marine terminals listed above.
Spatial scope	• On and off-terminal emissions, concentrations, and health risks limited to eight New Jersey counties (Bergen, Essex, Hudson, Middlesex, Morris, Passaic, Somerset, and Union.) • On-terminal emissions at the Howland Hook Marine Terminal in Staten Island, New York. Off-terminal emissions that occur in New York are not included in the analysis.
Time periods	• 2017 • 2018

Scenarios	• Original Port Clean Truck Program • Revised (rolled back) Port Clean Truck Program
Emissions	• Fine particulate matter (PM2.5)
Concentrations	• 20-meter grid of annual mean of 24-hour concentrations
Health Risks	• All-cause premature mortality (adult)

Emissions

We first estimate emissions from Port trucks under the original and revised (rolled back) Clean Trucks Programs. We use EPA's vehicle emissions model, the Motor Vehicle Emissions Simulator (MOVES2014a), to estimate PM2.5 emissions rates from Port activities. We then pair those emissions rates with estimates of Port truck activities to determine overall emissions on-terminal (from idling, starts, and driving) as well as off-terminal (driving).

Emissions Rates

We estimate PM2.5 emissions rates for starts (as grams per start, or g/start), short and extended idling (as grams per hour, or g/hr) and running (as grams per mile, or g/mile) for truck activities using MOVES. We use Essex County, NJ meteorological data[7] and MOVES2014a default fuel supply data[8]. We evaluate emissions rates for four time periods (AM: 6 am to 9 am, MD: 9 am to 3pm, PM: 3 pm to 6 pm, and NT: 6 pm to 6 am) in January, April, July, and October (representing emission rates from January to March, April to June, July to September, and October to December respectively). We estimate PM2.5 emission rates from exhaust and brake and tire wear. Emissions rates are estimated for each type of activity (starts, short and extended idling, and running). Running emissions are estimated for each road type and each truck travel speed category included in MOVES (as shown in Table 2).

To estimate the impacts of the change in the program, we include program-specific estimates[9] of vehicle ages for the revised Program[10] and original Program[11] in 2017 and 2018[12]. Figure 2 and Figure 3 summarize the estimated fleet visitation age composition for the original and revised Programs in 2017 and 2018, respectively. In each figure the recorded truck visitation data from May 2016 is shown for comparison. The implementation of the original Program would result in a largely updated fleet of trucks accessing Port terminals; in contrast, the fleet updates reflected in the revised Program are far more modest and are expected to result in truck ages that are more similar to the existing fleet.

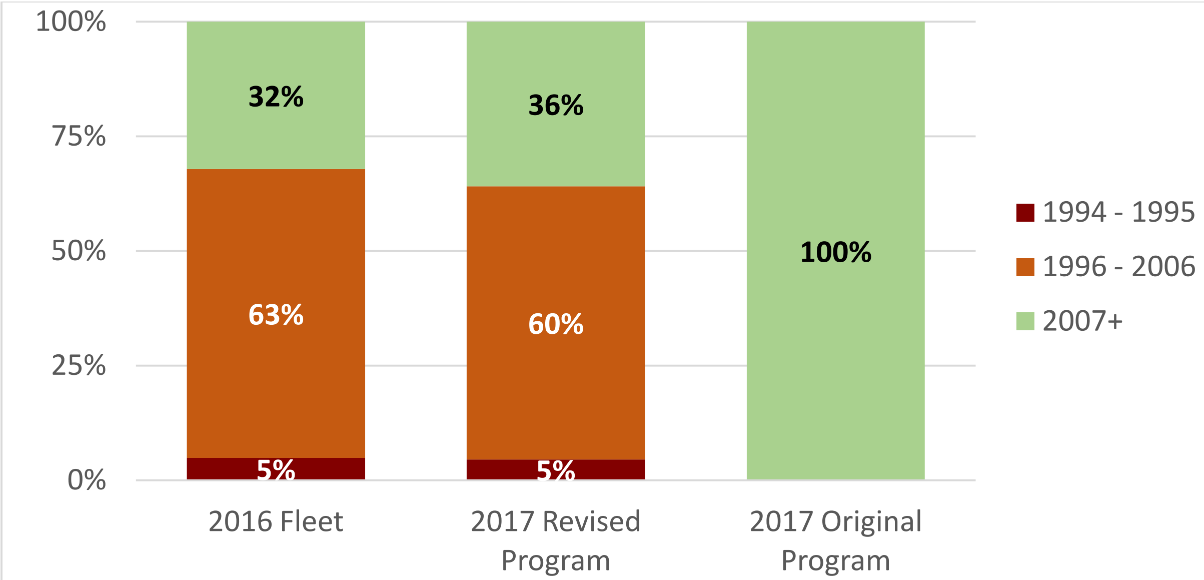

Figure 2: 2017 Port truck fleet visitation estimates for the original and revised Programs. Observed truck visits from the 2016 fleet (as of May 2016) are shown for comparison.

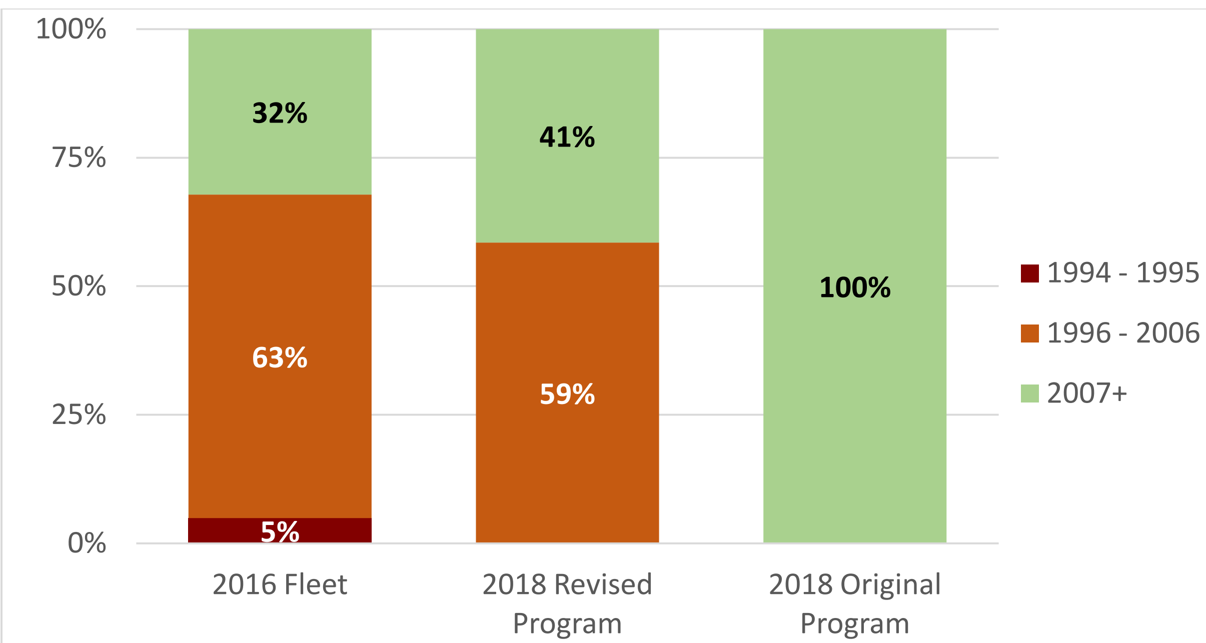

Figure 3: 2018 Port truck fleet visitation estimates for the original and revised Programs. Observed truck visits from the 2016 fleet (as of May 2016) are shown for comparison.

When estimating start emissions, short idle emissions, and running emissions, we assume that 95% of trucks are diesel tractor-trailer combination short haul trucks and 5% are diesel tractor-trailer combination long haul trucks (traveling greater than 200 miles.) [13] To estimate extended idling emissions rates we assume that all trucks are diesel tractor-trailer combination long-haul[14].

Table 1 summarizes the estimated on-terminal PM2.5 emissions rates for the original and revised (rolled back) Clean Trucks Program in 2017 and 2018. Table 2 shows an example of the estimated off-terminal PM2.5 emissions rates (the example shown is urban restricted roads during January morning peak periods). Emissions rates did not vary appreciably by season or time of day. These emissions rates reflect the average emissions per hour, start, or mile for a fleet truck; greater emissions rates in the revised scenario reflect the older fleet of trucks in operation under the revised Program.

Table 1: PM2.5 On-terminal emissions rates.

Year	Scenario	Short Idle (g/hr)	Extended Idle (g/hr)	Starts (g/start)	Running[15] (g/mile)
2017	Original	0.36	0.38	0.002	0.13
2017	Revised	6.28	3.30	0.010	0.68
2018	Original	0.33	0.34	0.001	0.13
2018	Revised	5.93	2.96	0.010	0.59

Table 2: Example PM2.5 Off-terminal emissions rates (January AM peak for urban restricted roads.)

Speed	Emissions (g/mile)			
	2017		2018	
	Original	Revised	Original	Revised
<2.5 mph	0.35	2.50	0.33	2.15
2.5 - 7.5 mph	0.33	1.45	0.32	1.27
7.5 - 12.5 mph	0.19	0.84	0.19	0.73
12.5 - 17.5 mph	0.13	0.67	0.13	0.58
17.5 - 22.5 mph	0.10	0.57	0.09	0.49
22.5 - 27.5 mph	0.09	0.51	0.08	0.44
27.5 - 32.5 mph	0.08	0.47	0.07	0.40
32.5 - 37.5 mph	0.06	0.38	0.06	0.33
37.5 - 42.5 mph	0.05	0.35	0.05	0.30
42.5 - 47.5 mph	0.05	0.32	0.04	0.28
47.5 - 52.5 mph	0.04	0.29	0.04	0.25
52.5 - 57.5 mph	0.03	0.25	0.03	0.21
57.5 - 62.5 mph	0.03	0.23	0.03	0.19
62.5 - 67.5 mph	0.03	0.23	0.03	0.19
67.5 - 72.5 mph	0.03	0.23	0.03	0.19
>72.5 mph	0.03	0.23	0.03	0.20

Truck Activity

We then estimate truck activity by terminal and route. Activities evaluated include on-terminal starts, on-terminal short and extended idling, on-terminal driving, and off-terminal driving. These activity estimates are the same under the original and revised Programs, although the emissions per activity (derived above) differ due to differences in the age of vehicle fleet. The number of trucks in each scenario is the same.

We first estimate future volumes of container, motor vehicle, and bulk and general cargo at the Port assuming steady growth in Port traffic.[16] We then estimate the number of truck calls per associated commodity movement for each facility type[17]. Next, we allocate container[18], motor vehicle[19], and warehouse[20] facility activities to each of the four marine terminals included in this analysis. These estimates are combined to arrive at an estimate of truck calls for warehousing, auto and container facilities at each marine terminal in 2017 and 2018 (see Table 3).

Table 3: Estimated annual truck calls by marine terminal and facility type in 2017 and 2018.

	Warehouses	Auto Terminals	Container Terminals	Total
2017				
Newark	145,241	49,585	609,506	804,332
Elizabeth	36,310	0	2,842,845	2,879,155
Jersey	36,310	25,544	452,905	514,759
Howland Hook	36,310	0	600,409	636,719
Total	290,482	75,129	4,651,241	5,016,852
2018				
Newark	148,114	51,759	644,889	844,761
Elizabeth	37,028	0	3,007,877	3,044,905
Jersey	37,028	26,664	479,197	542,889
Howland Hook	37,028	0	635,264	672,292
Total	296,228	78,422	4,921,254	5,295,903

We then estimate the number of hourly truck calls at each marine terminal for each season of each year. We estimate that 7.8% of the annual TEUs move each month in the first season (January through March), 8.4% per month in the second (April through June), 8.9% per month in the third (July through September), and 8.3% per month in the fourth (October through December)[21]. We also assume that Port-related truck activity occurs uniformly between 6 am and 6pm on 246 weekdays per year.[22]

To estimate on-terminal emissions for each truck call, we use the Port's 2013 Multi-Facility Emissions Inventory (Starcrest Consulting Group 2015) estimates of on-terminal activities (see

Table 4).

Table 4: On-terminal activity rates by facility type. Estimated from information in the Port's 2013 Multi-Facility Emissions Inventory (Starcrest Consulting Group 2015)[23].

	Distance on Facility (miles/truck)	On-terminal Running Speed (mph)	Short Idle (hr/truck)	Extended Idle (hr/truck)	Starts (starts/truck)
Auto Terminals	0.77	15	0	1.39	0
Container Terminals	1.21	15	0.43	0	0.65
Warehouse	0.55	15	0.65	0	0.65

To estimate off-terminal driving activities for each truck call we estimate the routes used. Location-specific emissions locations are critical to providing reasonable estimates of health risks, as health risks are a function of the proximity of emissions to residents. In some cases (particularly around the Ports of Newark and Elizabeth), route information reported in the Port Truck Origin and Destination Survey (Vollmer, Eng-Wong et al. 2006) is only clear very close to the terminal. We therefore estimate Port truck routes using the best available information about truck origins and destinations (for the Port and for the region) combined with travel times on routes between terminals and truck origins and destinations, as described below.

We start by using information about the share of trucks traveling to and from locations across the country from the Port Truck Origin and Destination Survey (Vollmer, Eng-Wong et al. 2006).[24] For most locations (those that are farther from the study area) we assume that trucks travel to and from the survey location's centroid. For the eleven counties nearest to the Port which capture the bulk of Port truck traffic (including the eight study area counties), we use county-wide trip share estimates from the Port Truck Origin and Destination Survey and additionally disaggregate those trips to more spatially detailed locations. These spatially detailed location estimates are based on the 2015 heavy truck origin and destination information estimated in the North Jersey Transportation Planning Authority's (NJTPA's) travel demand model: the New Jersey Regional Transportation Model – Enhanced (NJRTM-E).[25]

We then create a travel network, which we use to estimate the route with the shortest travel time between each terminal and the origins and destinations described above. The travel network is a combination of two datasets. For areas that are included in the NJTPA travel demand model area we use the loaded travel network from the 2015 NJRTM-E. This road network includes travel speeds for four time periods (morning, midday, afternoon, and night) as well as the link type, which is used to exclude routes on which trucks are prohibited. For areas outside of the NJTPA area we use the Federal Highway Administration's Freight Analysis Framework (FAF) network, which includes highway travel speeds. We then estimate the shortest paths (in terms of travel time) for trucks traveling between each terminal and the origins and destinations described above. We pair this information about the share of each terminal's trucks moving on each route with the estimates of terminal activity described on page 17 to arrive at estimated truck traffic volumes across the study area for the morning, midday, and evening peak periods. Figure 4 shows the share of all Port trucks traveling on each route in the study area for the morning peak period. Flow shares in the midday and evening periods are similar.

Estimating Emissions

Finally, we combine the on- and off-terminal activities (which are assumed to be the same under the original and revised Programs) with the emissions rates (which are estimated to differ under the original and revised Programs due to differences in the ages of the trucks) to arrive at estimated hourly emissions for each terminal and off-terminal route for each Program scenario, year, season, and time period. Terminal boundaries are estimated based on the PONYNJ terminal maps (obtained from the PANYNJ[26]) and aerial imagery. Off-terminal routes are assigned to the corresponding routes reflected in the 2015 loaded network from the New Jersey Regional Transportation Model – Enhanced[27]. The modeled network includes the road type, number of lanes, lane widths, and travel speeds for each time period.

Concentrations

Estimated emissions in each scenario (the original and revised Clean Truck Program) derived above were used to estimate the PM2.5 pollution concentrations in 2017 and 2018 that are expected to result from Port trucks in each scenario. The difference in concentrations estimated for each scenario represents the change in PM2.5 concentrations that is expected to result from the rollback of the Clean Trucks Program.

US EPA's AERMOD steady state air dispersion model (version 15181) was used to estimate the concentration of primary emissions of PM2.5 from each roadway segment and from on-terminal truck activities (both modeled as area sources). AERMOD modeling procedures generally followed US EPA PM2.5 quantitative hotspot guidance (USEPA 2015b) except as noted. Due to the large geographic area of the analysis, five years of meteorological data[28] was sampled following the approach described in Rowangould (2015) for modeling large transportation networks. Additionally, roadway segments with fewer than four daily truck trips were excluded from dispersion modeling[29]. The annual mean[30] 24-hour PM2.5 concentrations were estimated along a 20-meter grid across the eight county study area[31].

Health Risks

The changes in annual mean 24-hour PM2.5 concentrations that are expected to result from the differences between the original and revised (rolled-back) Clean Trucks Program (derived above) were used to estimate one of the many health risks that have been associated with the higher PM2.5 emissions allowed by the Clean Truck Program rollback in 2017 and 2018. US EPA's Environmental Benefits Mapping and Analysis Program – Community Edition (BenMAP-CE v. 1.1) was used to estimate risks of adult all-cause premature mortality due to changes in emissions in 2017 and 2018 alone in the eight county study area[32].

Figure 4: Estimated Port truck route shares (AM peak period). Routes with zero traffic are not shown.

Results and Discussion

Emissions

Based on Table 1 we see that emissions rates for on-terminal activities are 4 to 18 times higher in 2017 and 2018 under the rolled back Clean Trucks Program when compared to the original program. Similarly, In Table 2 we see that emissions rates for off-terminal driving are 4 to 8 times higher in 2017 and 2018 under the rolled back Clean Trucks Program when compared to the original Program.

Figure 5 shows the total emissions in 2017 and 2018 for on and off-terminal activities under the original and revised (rolled back) Clean Trucks Program. Overall there will be 11 times more emissions from Port terminals under the rolled back Clean Truck Program in 2017 and 2018 when compared to the original program[33]. There will be 7 times more emissions along off-terminal truck routes in the study area under the rolled back Clean Truck Program in 2017 and 2018 when compared to the original program[34]. Total emissions from Port terminals and along truck routes in the study area will increase by 7.4 to 8 times. We can visualize these differences in the examples shown in Figure 6 and Figure 7, which show the hourly emissions rates (per acre and per mile) for the morning peak period in January 2017 under the original (Figure 6) and revised (Figure 7) Clean Truck Programs. These differences reflect the higher emissions rates of the older truck fleet that accesses the Port under the revised Program. Note that the original and revised Program emissions estimates assume the same amount of truck activity (miles traveled, starts, idling); in both cases we account for steady growth of Port activities.

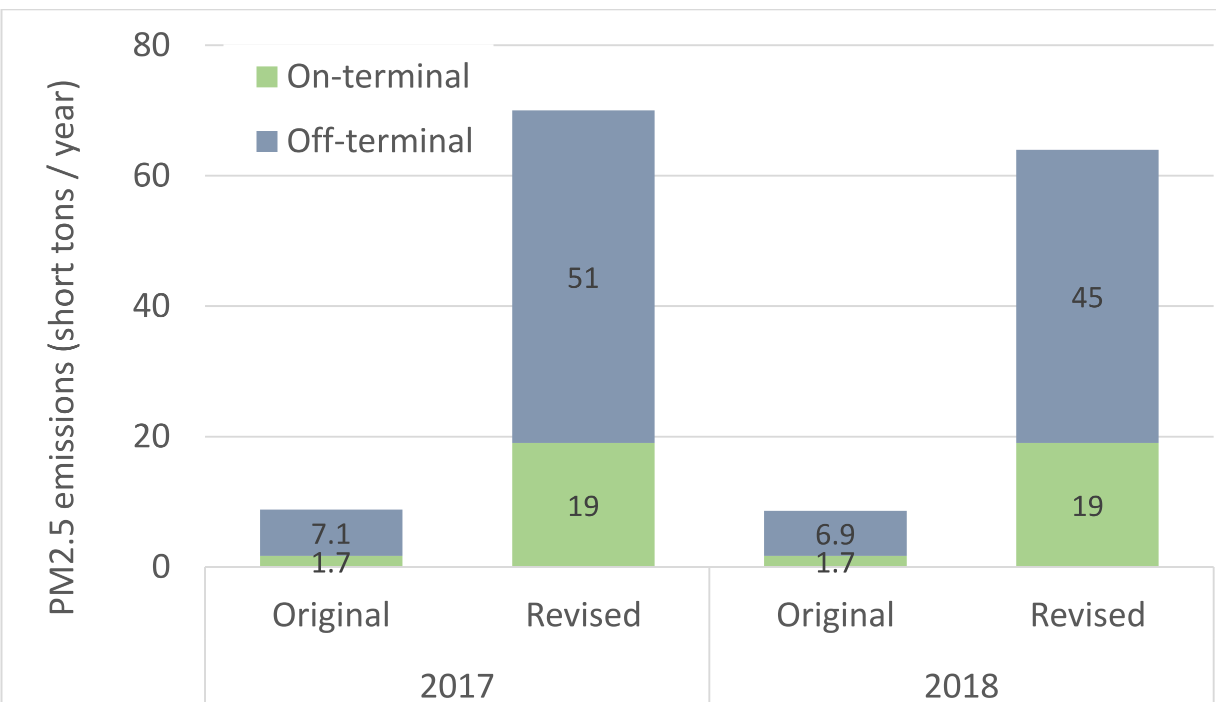

Figure 5: PM2.5 Emissions from Port Trucks under the Original and Revised (Rolled Back) Clean Trucks Program.

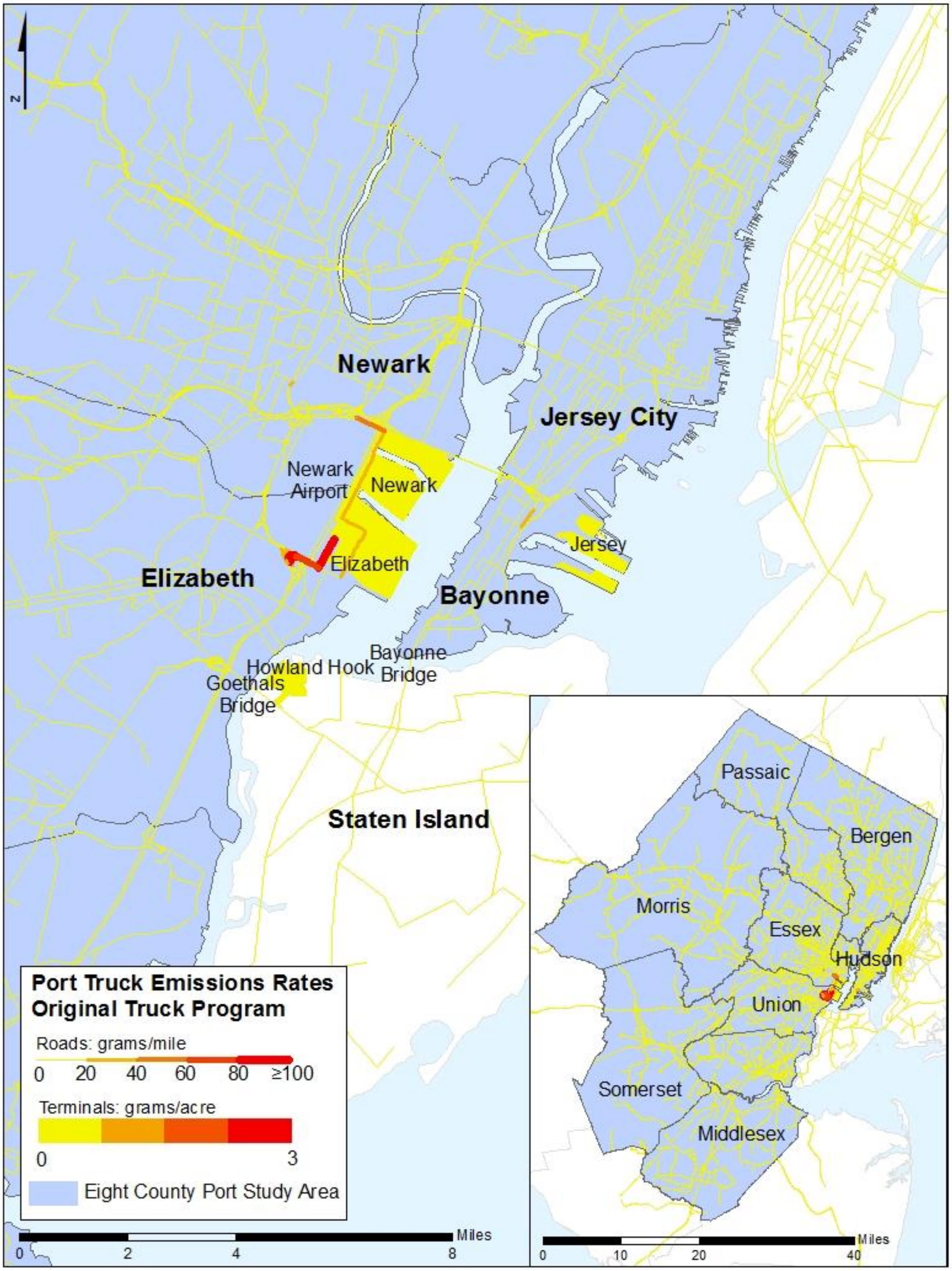

Figure 6: January 2017 AM period PM2.5 hourly emissions rates under the original Clean Trucks Program.

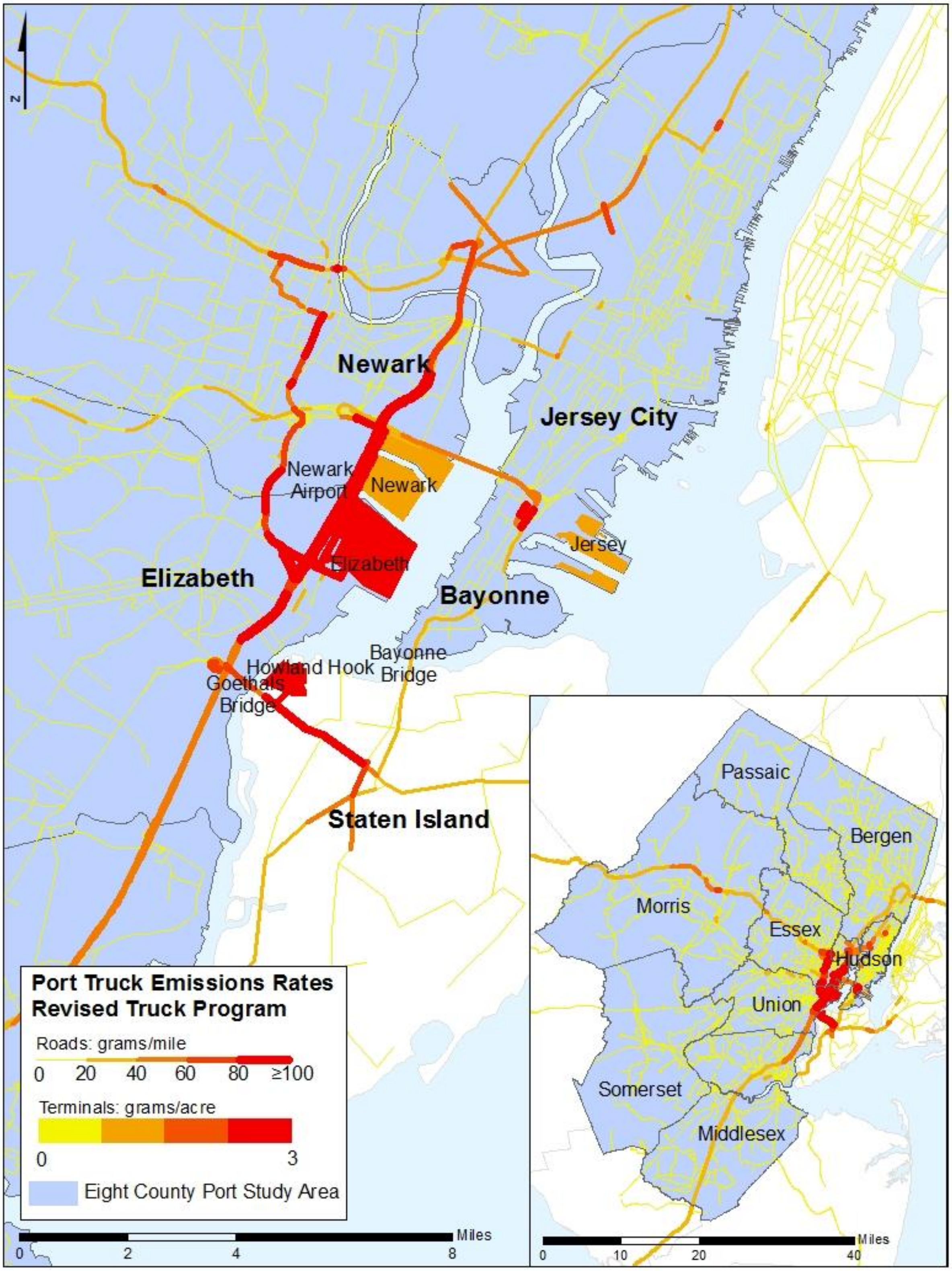

Figure 7: January 2017 AM period PM2.5 hourly emissions rates under the rolled back Clean Trucks Program.

Concentrations

Figure 8 and Figure 9 show the increases in PM2.5 concentrations that are expected to result from the rolled back Clean Truck Program in 2017 and 2018 across the eight county area. As expected, the greatest increases in concentrations are in the vicinity of Port terminals and adjacent to high volume truck routes. Increases in 2018 are similar (although slightly smaller) than in 2017.[35] PM2.5 concentrations will increase by up to 1 μg/m^3 in 2017 and 2018 in several areas as a result of the differences in stringency of the original and rolled back Programs. The greatest increases occur at Port terminals and along major truck routes accessing the terminals. For reference, the current 1-year PM2.5 National Ambient Air Quality Standard is 12 μ/m^3, where levels are calculated as the annual mean averaged over 3 years.

Risks of Premature Mortality for Adults

Quantifying health risks is a critical step when evaluating the effects of a plan or program that affects air quality. The level of "acceptable" health risk depends on the context. One commonly used measure of a severe health risk is a rate per million, with one in a million as a reference point. The risk from exposure to carcinogenic substances is often presented as the risk of developing cancer of over a 70 year lifetime of exposure to the substance. For example, the Clean Air Act references one in a million lifetime cancer risks (42 U.S.C. § 7412 (c)(9)(B)(i) and 42 U.S.C. § 7412(f)(2)(A)) and EPA's National Oil and Hazardous Substances Pollution Contingency Plan sets a generally acceptable level of exposure as one which results in a lifetime cancer risk of between 1 and 100 in a million (40 CFR 300.430).

Like cancer, premature mortality is also a severe health risk. When evaluating premature mortality, we use a one in a million risk of premature mortality over one year of exposure as a reference point. Note that this analysis conservatively presents added risks from one year of exposure due to the challenges of estimating exposures over the course of the program's lifetime; in reality the added risks accumulated over 10 or 20 years (or a 70 year lifetime) would be greater.

We estimate the added risks of all-cause premature mortality for adults across the eight county study area as a result of the higher PM2.5 emissions in 2017 and 2018 that is expected to be allowed by the rolled back Clean Truck Program. Premature mortality risk estimates based on two health impact studies (Krewski, Jerrett M et al. 2009, Lepeule, Laden F et al. 2012) are shown, consistent with USEPA's final regulatory assessment of the National Ambient Air Quality Standards for particulate matter (USEPA 2012)[36].

Results are presented as the increased risk of premature mortality (per million affected individuals) with 95% confidence intervals and are averaged at the municipality level. Figure 10 and Figure 11 show results for 2017, Figure 12 and Figure 13 show results for 2018, and Table 5 presents results for the nine highest risk municipalities in both years. We estimate that the increase in PM2.5 emissions in 2017 alone will result in city-wide average increased risks of premature mortality of 1 to 10 in a million for adults living in several nearby communities, including the Cities of Bayonne, Elizabeth, and Newark. In 2018 these risks will range up to 9 in a million.

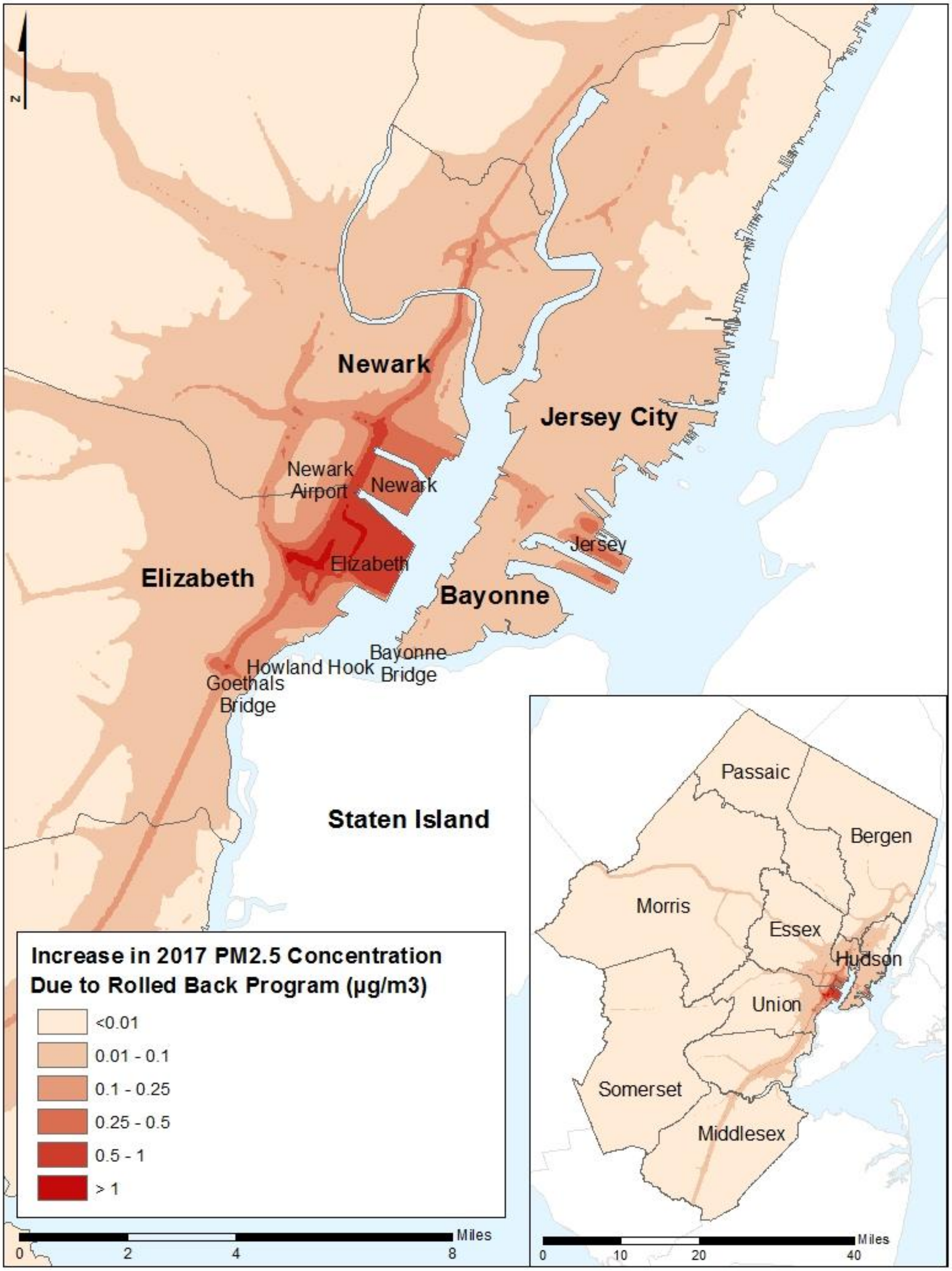

Figure 8: Increase in annual mean 24-hour PM2.5 concentrations that is expected to result from the rolled back Clean Trucks Program in 2017.

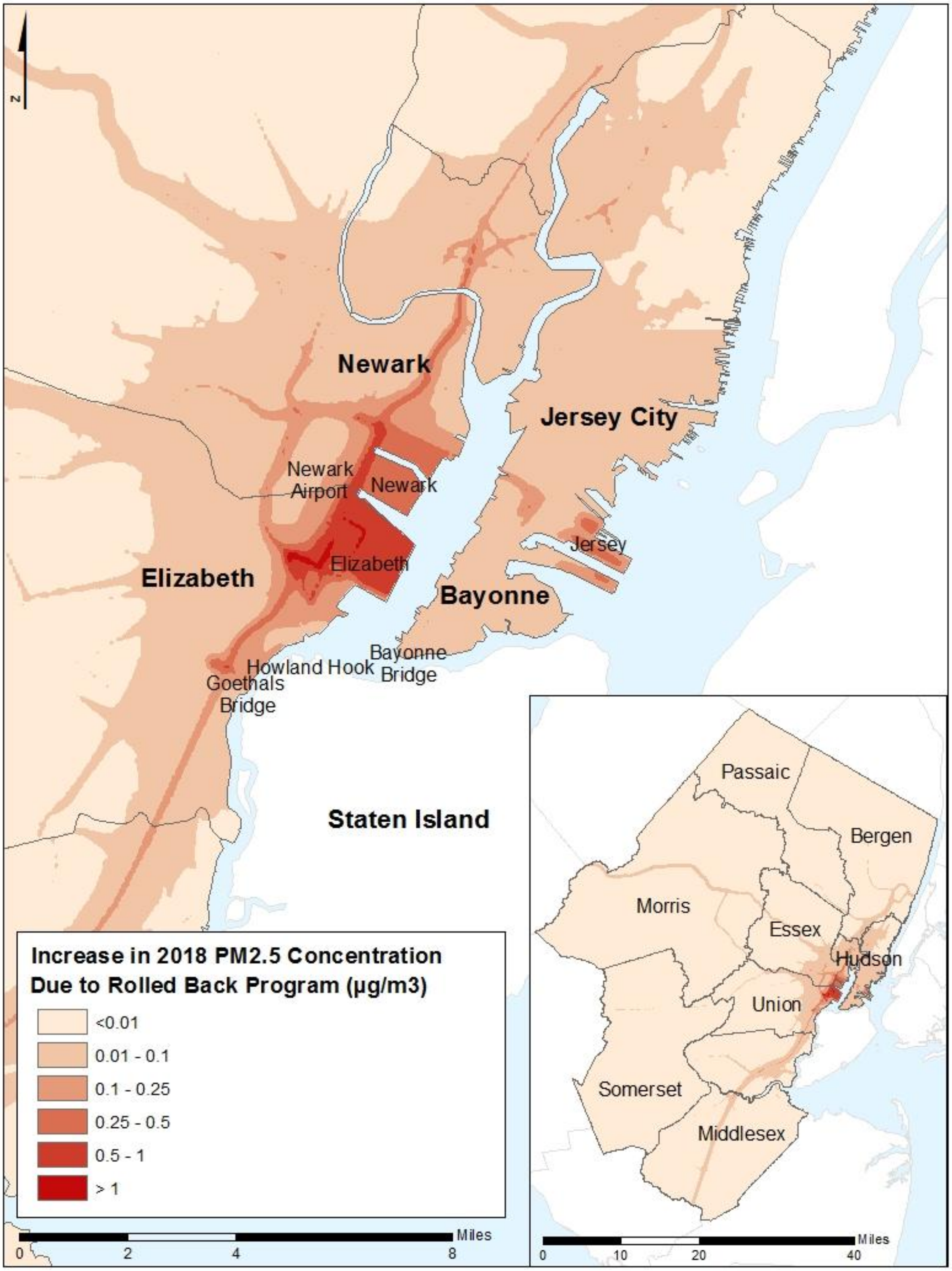

Figure 9: Increase in annual mean 24-hour PM2.5 concentrations that is expected to result from the rolled back Clean Trucks Program in 2018.

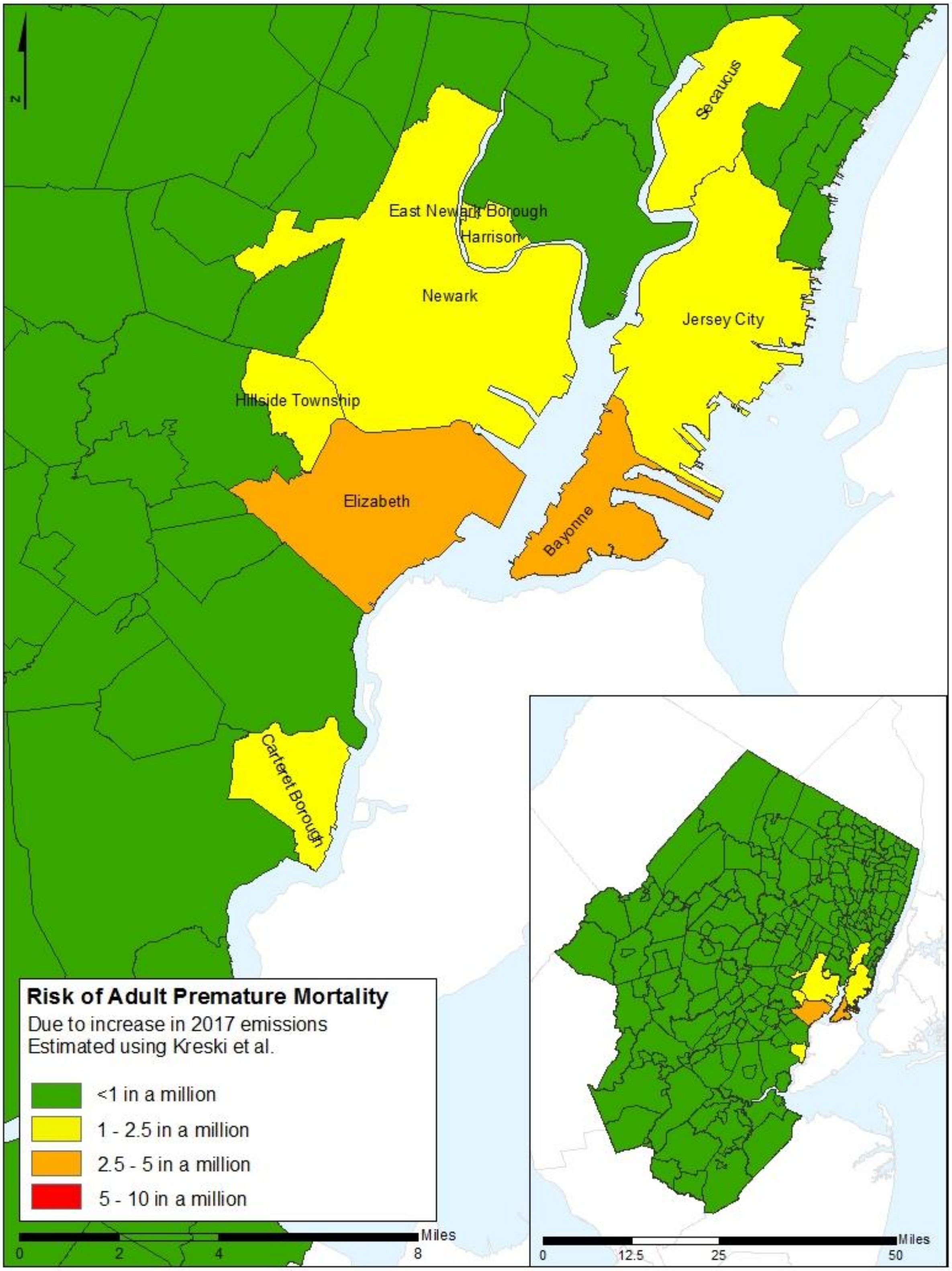

Figure 10: Risks of premature mortality due to increase in 2017 PM2.5 emissions that could have been prevented by implementing the original instead of the revised Clean Truck Program, as estimated using Krewski et al. (2009). Krewski et al. estimates affect adults aged 30 and up.

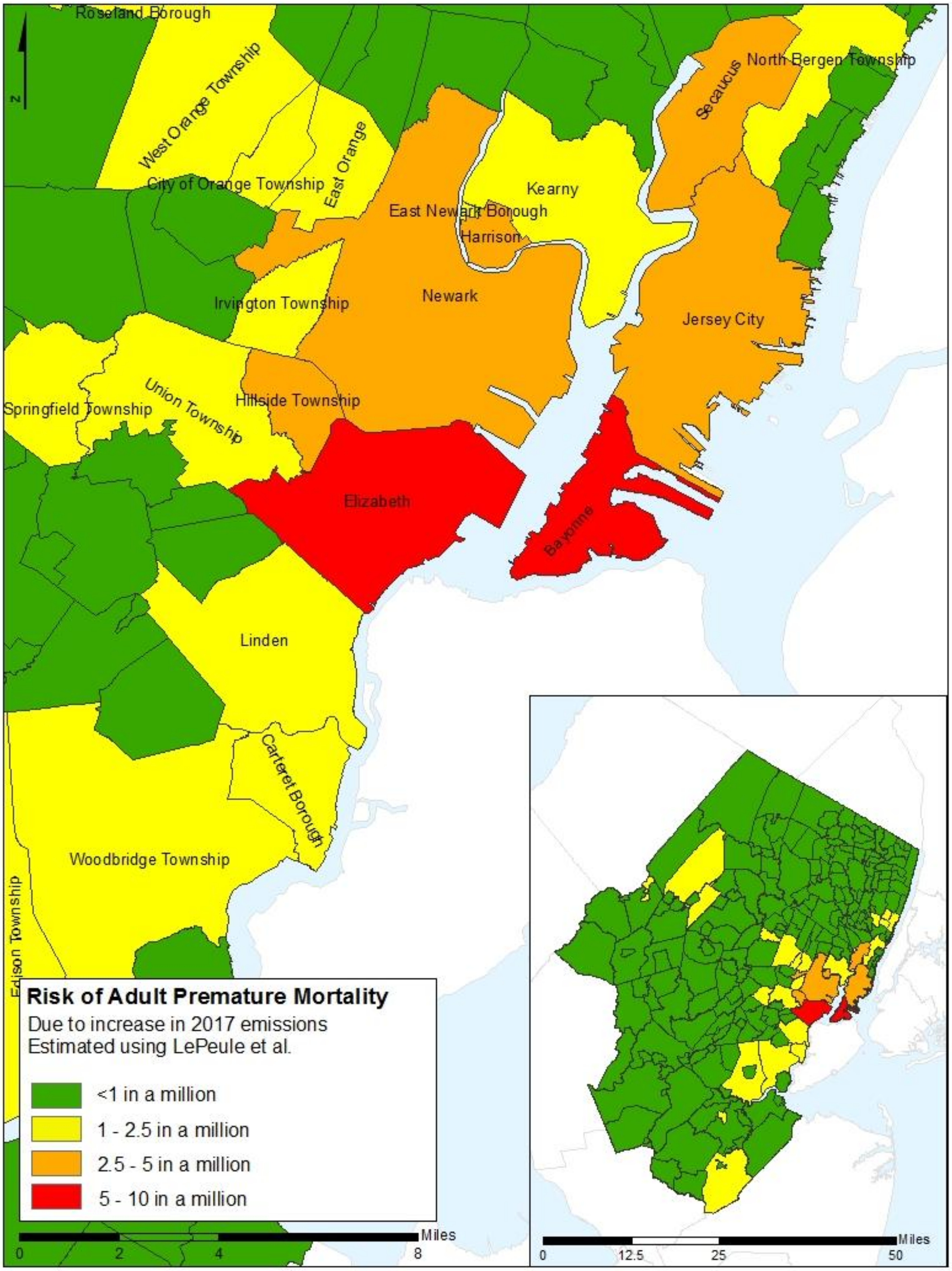

Figure 11: Risks of premature mortality due to increase in 2017 PM2.5 emissions that could have been prevented by implementing the original instead of the revised Clean Truck Program, as estimated using LePeule et al. (2012). LePuele et al. estimates affect adults aged 25 and up.

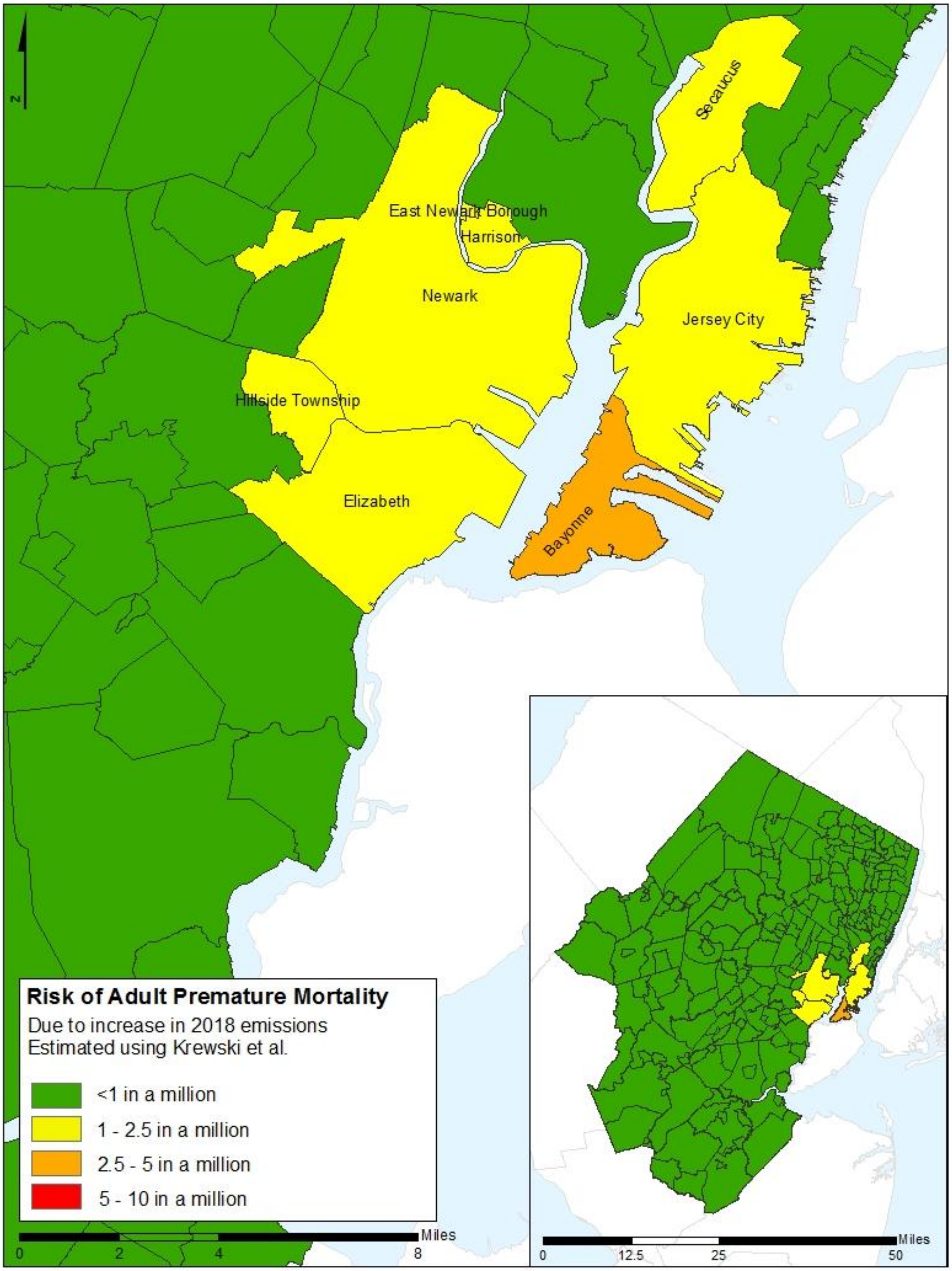

Figure 12: Risks of premature mortality due to increase in 2018 PM2.5 emissions that could have been prevented by implementing the original instead of the revised Clean Truck Program, as estimated using Krewski et al. (2009). Krewski et al estimates affect adults aged 30 and up.

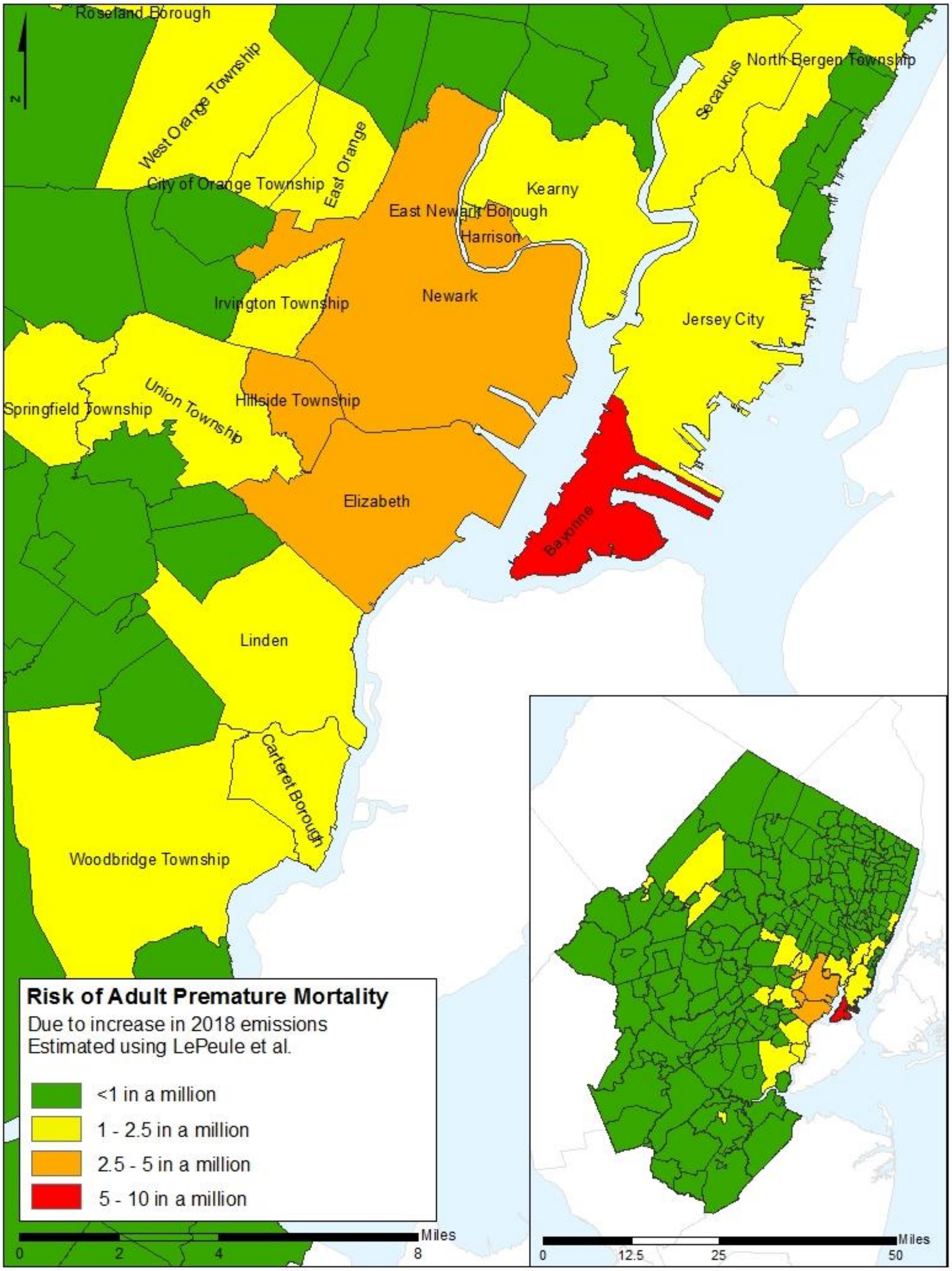

Figure 13: Risks of premature mortality due to increase in 2018 PM2.5 emissions that could have been prevented by implementing the original instead of the revised Clean Truck Program, as estimated using LePeule et al. (2012). LePuele et al. estimates affect adults aged 25 and up.

Table 5: Estimated city-wide average increase in the risk of premature mortality for the nine highest risk municipalities due to additional PM2.5 emissions in 2017 and 2018. Krewski et al. (2009) estimates affect adults aged 30 and up and LePuele et al. (2012) estimates affect adults aged 25 and up.

Municipality	**Number of affected adults**		**City-wide average risk of premature mortality per million affected adults (95% confidence interval)**			
			2017		**2018**	
	Krewski et al. (2009)	**LePeule et al.** (2012)	**Krewski et al.** (2009)	**LePeule et al.** (2012)	**Krewski et al.** (2009)	**LePeule et al.** (2012)
Bayonne City	38,786	43,244	4.9 (3.3 - 6.5)	10 (5 - 14.9)	4.6 (3.1 - 6.1)	9.3 (4.6 - 13.9)
Elizabeth City	69,209	79,730	2.7 (1.8 - 3.6)	5.4 (2.7 - 8.1)	2.5 (1.7 - 3.3)	4.9 (2.4 - 7.4)
Newark City	149,272	173,009	1.8 (1.2 - 2.4)	3.7 (1.8 - 5.5)	1.7 (1.1 - 2.2)	3.3 (1.6 – 5.0)
Harrison Town	7,913	9,408	1.8 (1.2 - 2.3)	3.4 (1.7 - 5.1)	1.6 (1.1 - 2.1)	3.0 (1.5 - 4.5)
Hillside Township	13,115	14,484	1.4 (0.93 - 1.8)	2.8 (1.4 - 4.3)	1.3 (0.86 - 1.7)	2.4 (1.2 - 3.6)
Jersey City	139,568	168,007	1.4 (0.92 - 1.8)	2.6 (1.3 - 3.9)	1.3 (0.85 - 1.7)	2.6 (1.3 - 3.9)
Secaucus Town	10,679	11,839	1.3 (0.88 - 1.7)	2.6 (1.3 – 4.0)	1.2 (0.78 - 1.5)	2.4 (1.2 - 3.5)
East Newark Borough	1,250	1,492	1.3 (0.85 - 1.7)	2.4 (1.2 - 3.6)	1.1 (0.76 - 1.5)	2.1 (1.1 - 3.2)
Carteret Borough	12,670	14,219	1.1 (0.75 - 1.5)	2.2 (1.1 - 3.4)	1 (0.67 - 1.3)	2.0 (1.0 – 3.0)

Note that these municipality-level averages combine areas of higher and lower risk. To identify the most at-risk residents (without averaging areas of high and low risk) we also examine estimates at the population level for each county in the study area. The increase in emissions in 2017 alone is estimated to result in approximately 400,000 to 700,000 adults in the region experiencing increased risks of premature mortality of at least 1 in a million, 5,000 to 40,000 residents are estimated to experience risks of premature mortality that increase by at least 10 in a million, and 600 to 3,000 adults are estimated to experience risks of premature mortality that increase by at least 25 in a million (Table 6). Essex, Hudson, and Union counties exhibit the greatest increases in risks, with 24 – 39%, 36 – 52%, and 25 – 39% of their adult populations respectively experiencing increased risks of premature mortality of more than 1 in a million due to increases in PM2.5 emissions in 2017 alone[37].

Conducting a similar population level analysis for 2018, we find that the increase in emissions in 2018 alone is estimated to result in approximately 400,000 to 700,000 adults in the region experiencing increased risks of premature mortality of at least 1 in a million, 4,000 to 30,000 residents are estimated to experience risks of premature mortality that increase by at least 10 in a million, and 40 to 2,000 adults are estimated to experience risks of premature mortality that increase by at least 25 in a million (Table 7). Essex, Hudson, and Union counties exhibit the greatest increases in risks, with 22 – 36%, 34 – 49%, and 23 – 37% of their adult populations respectively experiencing increased risks of premature mortality of more than 1 in a million due to increases in PM2.5 emissions in 2018 alone.

These premature mortality estimates represent the increased risks of death from all causes. We estimate that approximately 67 – 92% of adult premature death due to increased PM2.5 are attributable to increased risk of ischemic heart disease while approximately 8 – 16% of adult premature deaths are attributable to increased risk of lung cancer.[38]

Potential Exposure at Non-Residential Locations

The analysis presented above estimates health risks based on PM2.5 exposures where people live. In addition to experiencing elevated exposures where they live, people can be exposed to elevated PM2.5 concentrations while driving, where they work, receive medical care, attend school, or play. For example, Port workers and truck drivers are likely to experience greater PM2.5 exposure as a result of the revised Program. Figure 14 illustrates examples of the types of locations where sensitive receptors such as children, the elderly, and those with existing health conditions are expected to experience elevated exposure. Based on approximate school, hospital, and nursing home data posted by the New Jersey Geographic Information Network, there are approximately twelve schools in areas that are expected to experience changes in PM2.5 concentrations that exceed 0.1 $\mu g/m^3$ in 2017. In areas that are expected to experience changes of 0.05 to 0.1 $\mu g/m^3$ there are approximately an additional 41 schools, four hospitals, and one nursing home. In areas that are expected to experience changes of 0.01 to 0.05 $\mu g/m^3$ there are approximately an additional 254 schools, 31 hospitals, and 33 nursing homes.

Table 6: Population-level risks of adult premature mortality due to increased exposure to PM2.5 in 2017.

County	Number of adults experiencing increased risks of premature death (95% confidence interval)						Total Adult Population	
	>1 in a million risk		**>10 in a million risk**		**>25 in a million risk**			
	Krewski et al. (2009)	**LePeule et al.** (2012)	**Krewski et al.** (2009)	**LePeule et al.** (2012)	**Krewski et al.** (2009)	**LePeule et al.** (2012)	**Krewski et al.** (2009)	**LePeule et al.** (2012)
Bergen	12,000 (7,300 – 17,000)	41,000 (14,000 – 68,000)	0 (0 - 0)	170 (0 – 1,500)	0 (0 - 0)	0 (0 - 0)	578,879	629,369
Essex	110,000 (82,000 – 130,000)	200,000 (130,000 – 260,000)	1,500 (1,300 – 1,900)	6,700 (1,500 – 22,000)	500 (0 - 1000)	1,300 (500 – 1,900)	458,208	511,024
Hudson	130,000 (97,000 – 160,000)	230,000 (150,000 – 270,000)	1,500 (210 – 5,800)	22,000 (2,300 – 47,000)	14 (0 - 73)	770 (15 – 5,400)	368,201	435,583
Middlesex	37,000 (22,000 – 49,000)	81,000 (41,000 – 110,000)	370 (16 - 790)	2,700 (410 – 6,200)	1.3 (0 - 1.3)	290 (1.3 - 640)	465,159	516,667
Morris	9,100 (6,200 – 12,000)	21,000 (10,000 – 32,000)	720 (0 - 750)	930 (0 – 1,300)	0 (0 - 0)	23 (0 - 760)	309,796	334,706
Passaic	510 (21 - 850)	4,300 (560 – 5,900)	0 (0 - 0)	0 (0 - 3.3)	0 (0 - 0)	0 (0 - 0)	288,664	321,928
Somerset	160 (16 - 210)	730 (200 – 2,500)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	197,137	213,842
Union	82,000 (57,000 – 98,000)	14,0000 (93,000 – 170,000)	1,400 (300 – 3,000)	9,800 (1,600 – 22,000)	33 (0 - 260)	750 (36 – 3,000)	322,486	356,237
Total	**380,000 (270,000 – 470,000)**	**710,000 (43,000 – 93,000)**	**5,400 (1,800 – 12,000)**	**42,000 (5,800 – 100,000)**	**550 (0 – 1,300)**	**3,100 (550 – 12,000)**	2,988,531	3,319,355

Table 7: Population-level risks of adult premature mortality due to increased exposure to PM2.5 in 2018.

County	**Number of adults experiencing increased risks of premature death (95% confidence interval)**						**Total Adult Population**	
	>1 in a million risk		**>10 in a million risk**		**>25 in a million risk**		**Krewski et al.** (2009)	**LePeule et al.** (2012)
	Krewski et al. (2009)	**LePeule et al.** (2012)	**Krewski et al.** (2009)	**LePeule et al.** (2012)	**Krewski et al.** (2009)	**LePeule et al.** (2012)		
Bergen	11,000 (5,700 – 15,000)	33,000 (13,000 – 57,000)	0 (0 - 0)	170 (0 – 1,200)	0 (0 - 0)	0 (0 - 0)	578,879	629,369
Essex	100,000 (75,000 – 120,000)	180,000 (120,000 – 240,000)	1,300 (1,000 – 1,800)	4,700 (1,400 – 16,000)	0 (500 - 500)	1,300 (0 – 1,900)	458,208	511,024
Hudson	120,000 (90,000 – 150,000)	210,000 (140,000 – 260,000)	1,400 (94 - 4500)	19,000 (1,500 – 42,000)	10 (0 - 73)	590 (0 – 3,800)	368,201	435,583
Middlesex	32,000 (19,000 – 43,000)	71,000 (36,000 – 100,000)	360 (15 - 550)	1,800 (380 – 45,00)	0 (1.3 - 1.3)	20 (0 - 440)	465,159	516,667
Morris	8,100 (5,400 – 10,000)	19,000 (8,700 – 29,000)	21 (0 - 750)	900 (650 – 1,200)	0 (0 - 0)	0 (0 - 760)	309,796	334,706
Passaic	290 (19 - 680)	3,900 (340 – 5,300)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	288,664	321,928
Somerset	42 (16 - 200)	730 (130 – 2,100)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	197,137	213,842
Union	75,000 (51,000 – 91,000)	130,000 (85,000 – 160,000)	1,100 (300 – 2,600)	8,300 (1,200 – 19,000)	33 (36 - 190)	480 (0 – 2,000)	322,486	356,237
Total	**350,000 (250,000 – 440,000)**	**660,000 (400,000 – 860,000)**	**4,200 (1,400 – 10,000)**	**35,000 (5,200 – 83,000)**	**43 (540 - 760)**	**2,400 (0 – 8,900)**	**2,988,531**	**3,319,355**

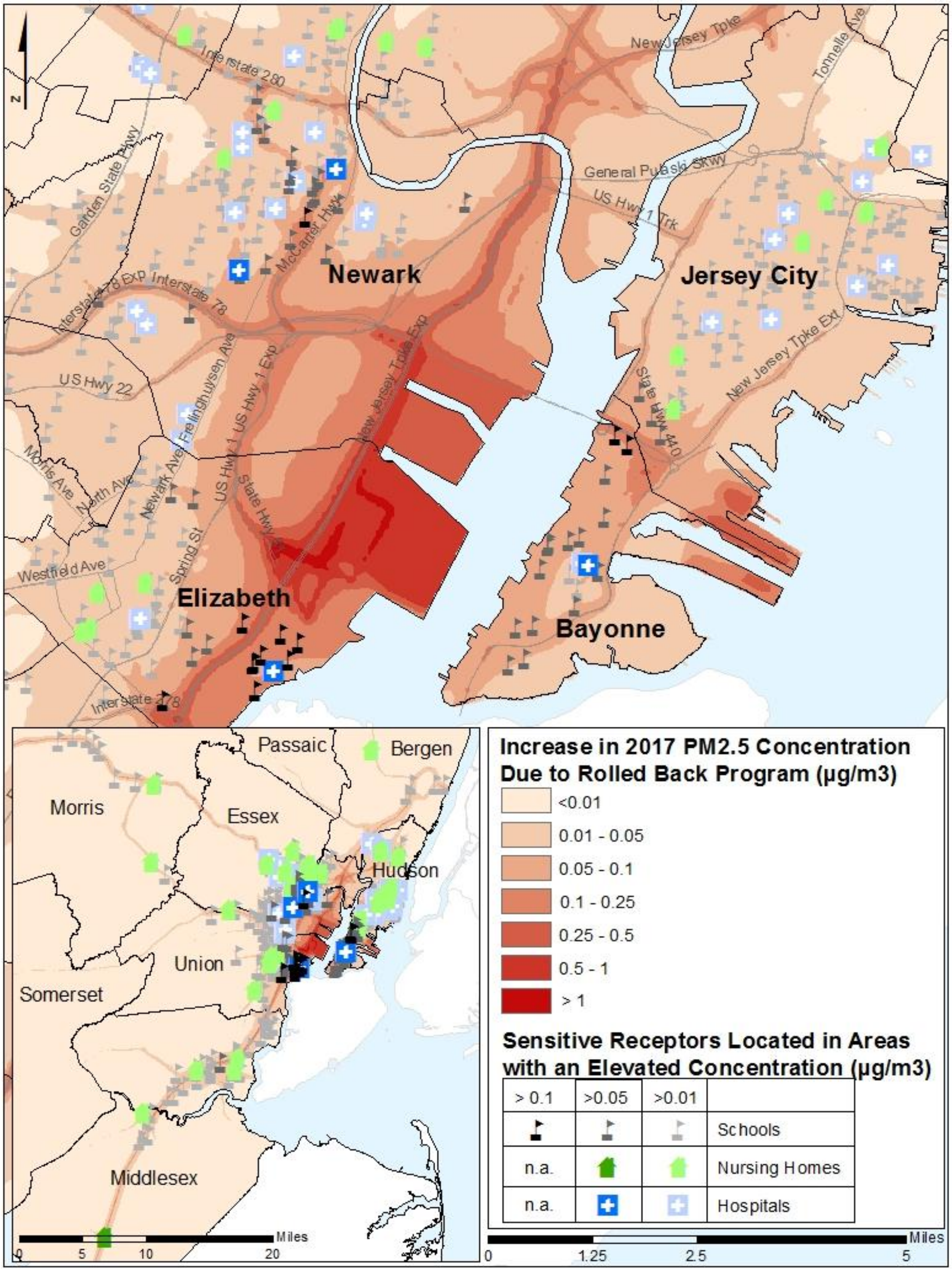

Figure 14: Schools, nursing homes, and hospitals located in areas expected to experience changes of PM2.5 concentrations greater than 0.01 µg/m^3 in 2017 as a result of the rolled back program. Facility data is approximate and is obtained from New Jersey Geographic Information Network. The map area focuses on the most affected communities.

Future Trends

As Port-related traffic grows (resulting in more emissions), truck per-mile and per-hour emissions rates will gradually improve as older vehicles are replaced with newer vehicles (resulting in fewer emissions). The original Clean Truck Program would have greatly accelerated the turnover of the vehicle fleet, resulting in the use of cleaner vehicles sooner than will occur under the revised (rolled back) Program. The analysis presented in this report only captures impacts and risks that will occur due to changes in emissions in 2017 and 2018. These first two years are expected to result in the greatest emissions impacts and the greatest health risks over the course of the rollback's lifetime.

However, we anticipate that risks will continue to accrue in the years that follow 2018. While the computational resources required to evaluate PM2.5 concentrations and health risks for several years into the future are prohibitive, we are able to approximate the trajectory of total emissions in order to provide qualitative insight about potential future trends in concentrations and health risks. We assess the total emissions (from on-terminal and off-terminal activities) in 2022, 2026, and 2030 using methods that are similar to the methods used for 2017 and 2018.[39] We note that this trajectory is approximate as any uncertainties in assumptions used may be greater in future years.

Overall we find that the impact of the rolled back Clean Truck Program on total Port truck emissions continues into the future. The greatest impacts occur initially and will likely lessen over the course of the next 15 years or more (see Figure 15.) We expect that concentration and health risk impacts would lessen on a similar timeline, although we caution that that the relationship between emissions and health risks is not linear so the shape of the trajectory of health risks would differ.

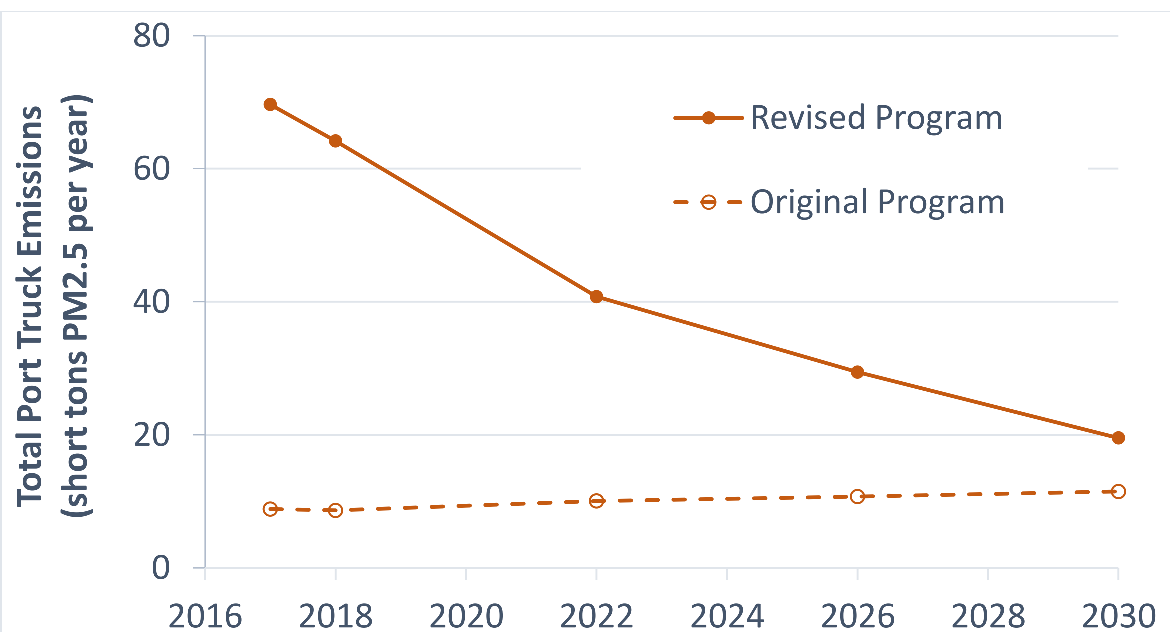

Figure 15: Future trends in Port truck emissions under the original and revised (rolled back) Clean Truck Programs.

Limitations

As noted, due to time and resource constraints the scope of this analysis was limited to consideration of air quality impacts from a single pollutant category (PM2.5) on one health outcome (premature death) over two years (2017 and 2018) within an eight-county area of New Jersey. In each step of this analysis and within this limited scope, we strove for accuracy and transparency. However as with any modeling exercise, the estimates presented here are imperfect due to constraints in computational power and available data.

Truck activity is estimated using the best available publically available information. We note that the share of warehouse and auto activities allocated to each terminal is less certain than estimates of the share of container activities, although this likely has a relatively small impact on our on-terminal emissions estimates because the majority of truck traffic is tied to container activities. Additionally, if there are major divergences from current trends in on-dock rail and overall Port volumes in future years then our projections of truck volumes would fail to capture these differences. Our on-terminal activity estimates (speeds, idling time, time on-terminal) are based on the information presented in the Port's 2013 Multi-Facility Emissions Inventory (Starcrest Consulting Group 2015) although the data and the methods supporting those assumptions are sparse. For example, the estimate of idling times is based on asking terminal operators about typical behavior and noting that responses are consistent with site observations and reports that signs and driver reminders not to idle have reduced idling behavior in recent years. It is unclear whether this is consistent with driver behavior across the board, or with a news report of major delays and start/stop traffic reported at the GCT Bayonne terminal in 2015 (Bonney 2015a). Off-terminal travel speeds are estimated based on the NJRTM-E model outputs, which may differ from actual speeds in some areas.

Route estimates are subject to the errors built into the Port Truck Origin and Destination Survey (Vollmer, Eng-Wong et al. 2006) and the NJRTM-E. For example, we are unable to capture changes in truck origin/destination patterns that have occurred since the Port Truck Origin and Destination Survey and the data used to build the NJRTM-E were collected. Similarly, if trucks diverge from the fastest routes, traffic speeds differ from the modeled speeds, or if trucks use non-truck routes, our analysis would not account for those variations in route behavior. Additionally, in a few locations the NJRTM-E road network locations appear to be approximated. We strove to minimize the impacts of these types of errors by presenting health results in the aggregate (at the municipality level or totaled for similarly exposed populations) rather than for each Census block across the region. Additionally, the last leg of each route is essentially missing, as our routes include travel to each modelled travel activity zone (TAZ) but not travel within the origin or destination TAZ due to a lack of available information. We were also unable to account for truck idling and queuing activities that occur at non-Port origins or destinations (e.g. at any off-terminal warehouses, chassis yards, or rail yards) due to a lack of information.

The estimates of fleet emissions rates depend on the MOVES fleet projection tool's assumptions about fleet turnover rates, which may differ from actual fleet turnover for Port trucks.

The dispersion analysis used to estimate PM2.5 concentrations is subject to the limitations of AERMOD's ability to predict pollution transport. Estimated PM2.5 concentrations include only primary (but not secondary) formation of PM2.5. Additionally, due to the computational demands of the spatially detailed dispersion modeling used, the PM2.5 concentration outputs are constrained to annual mean values (rather than short term peak values). This limits the range of health impacts that can be assessed. For example, with annual mean PM2.5 concentration estimates, we are able to assess premature mortality risks but are unable to assess asthma hospitalizations that occur with peak events. US EPA's BenMAP also models several other health risks associated with short and long-term PM2.5 pollution that we were not able to include in this analysis, including bronchitis, emergency room visits for asthma, lower and upper respiratory symptoms, nonfatal acute mycardial infarction, and hospital admissions for a variety of respiratory and cardiovascular concerns (including chronic lung disease, pneumonia, asthma, congestive heart failure, ischemic heart disease, and cardiac dysrhythmia.)

Additionally, our exposure calculations only account for where people live. We do not consider where people work or travel throughout the day. For example, the risks to students in nearby schools, patients in nearby hospitals, and workers and truck drivers who spend a lot of time at Port terminals have not been accounted for in these estimates.

Health risk estimates are subject to the limitations of the assumed population and baseline mortality data available in BenMAP. Additionally, the health risks estimated in this report assume that diesel PM2.5 emitted by Port trucks is the same as PM2.5 emitted by other sources (e.g. other mobile or stationary sources that are typical in the areas used to derive the health risk relationships). To the extent that diesel particulate matter may differ in composition and risks posed, this analysis does not account for those differences. There is also uncertainty in our knowledge of the health risks associated with exposure to PM2.5; to mitigate this limitation the health risk estimates here are from two well regarded studies and we also present the 95% confidence intervals, as derived in EPA's BenMAP.

Additionally, there are other types of emissions from truck activity in addition to PM2.5 that are not accounted for in this analysis. Emissions of other air pollutants such as nitrogen oxides (NO_x), hydrocarbons, and coarse particulate matter (PM10) are also likely to be greater under the revised Program. Increases in these pollutants would also likely contribute to increased local health risks.

Finally, due to computational limitations and uncertainties about activities in future years, this analysis was limited to the health impacts that are expected to occur due to PM2.5 emissions in 2017 and 2018 alone. In reality, the rolled back Clean Truck Program is expected to result in elevated emissions that gradually taper off over a period of up to 15 years or more.

Conclusions

Under the revised (rolled back) Clean Truck Program, most older (and higher emitting) Port trucks will still be allowed to access the Port. As a result, the rolled back Clean Truck Program will allow increased pollution from PM2.5 near the Port of New York and New Jersey when compared with the original Clean Trucks Program.

This analysis quantified predicted air quality impacts and one of the many health risks associated with scaling back the Port's Clean Truck Program. We use the best publically available information to estimate PM2.5 emissions, concentrations, and associated health risks across eight counties in New Jersey. The analysis focuses on 2017 and 2018, the first two years of the rolled back Program, when the impacts of the rolled back Program will likely be the greatest.

We find that PM2.5 emissions, concentrations, and risks of premature death will increase as a result of the rolled back Clean Truck Program when compared to the original Clean Truck Program. Port truck emissions of PM2.5 will increase by 7 to 8 fold in 2017 and 2018 as a result of the rolled back Program. This will result in increases of PM2.5 concentrations by up to 1 μ/m^3 in some areas. The risks of death will increase by over 25 in a million in some areas due to increases of emissions in 2017 alone. These increases in risks will be similar in 2018. Elevated pollution levels and health risks will likely continue to accrue for up to 15 years or more after the Program has been rolled back.

We note that these findings are limited in scope due to resource constraints. The magnitude of estimated effects of the revised Program would be greater if this study had included a broader geographic region, a longer period of time, and a wider range of pollutants, exposure pathways, and health outcomes. Despite the limited scope of this analysis, we estimate that the risks of serious adverse health outcomes will increase as a result of the rollback of the Clean Truck Program.

References

Bonney, J. (2015a). NY-NJ port terminal battles congestion. Journal of Commerce. Newark, NJ, The JOC Group, Inc.

Bonney, J. (2015b). NY-NJ port's truck replacement program shifts into gear. Journal of Commerce. Newark, NJ, The JOC Group, Inc.

Dockery, D. W., J. Cunningham, A. I. Damokosh, L. M. Neas, J. D. Spengler, P. Koutrakis, J. H. Ware, M. Raizenne and F. E. Speizer (1996). "Health Effects of Acid Aerosols on North American Children: Respiratory Symptoms." Environmental Health Perspectives **104**(5): 500-505.

Halcrow, Gannett Fleming, MDS Transmodal, Duncan Maritime, Moffatt & Nichol Engineers, Zetlin Strategic Communications and Hirani Engineering (2005). CPIP Consortium Port of New York & New Jersey Comprehensive Port Improvement Plan.

Krewski, D., Jerrett M, Burnett RT, Ma R, Hughes E, S. Y, Turner MC, Pope CA 3rd, Thurston G, Calle EE, Thun MJ, Beckerman B, DeLuca P, Finkelstein N, Ito K, Moore DK, Newbold KB, Ramsay T, Ross Z, Shin H and Tempalski B (2009). Extended follow-up and spatial analysis of the American Cancer Society study linking particulate air pollution and mortality. HEI Research Report, 140. Boston, MA, Health Effects Institute.

Lepeule, J., Laden F, Dockery D and J. Schwartz (2012). "Chronic exposure to fine particles and mortality: an extended follow-up of the Harvard Six Cities study from 1974 to 2009." Environ Health Perspectives **120**(7): 965-970.

Port Authority of New York and New Jersey (2014). Naming Rules and Regulations Applying At Port Authority Marine Terminals And Rates and Charges Applicable For the Use of Public Areas At Port Authority Marine Terminals. New York, NY. **FMC Schedule No. PA 10, published September 2014**.

Port Authority of New York and New Jersey (2015a). Naming Rules and Regulations Applying At Port Authority Marine Terminals And Rates and Charges Applicable For the Use of Public Areas At Port Authority Marine Terminals. New York, NY. **FMC Schedule No. PA 10, published September 2015**.

Port Authority of New York and New Jersey (2015b). Naming Rules and Regulations Applying At Port Authority Marine Terminals And Rates and Charges Applicable For the Use of Public Areas At Port Authority Marine Terminals. New York, NY. **FMC Schedule No. PA 10, published November 2015**.

Port Authority of New York and New Jersey (2016a). Naming Rules and Regulations Applying At Port Authority Marine Terminals And Rates and Charges Applicable For the Use of Public Areas At Port Authority Marine Terminals. New York, NY. **FMC Schedule No. PA 10, published March 2016**.

Port Authority of New York and New Jersey (2016b). PortTruckPass Comprehensive Report, May 2016.

Roman, H. A., Walker KD, Walsh Tl, Conner L, Richmond HM, Hubbell BJ and Kinney PL (2008). "Expert judgment assessment of the mortality impact of changes in ambient fine particulate matter in the U.S." Environmental Science and Technology, **42**(7): 2268-2274.

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.

Starcrest Consulting Group, L. (2015). The Port of New York and New Jersey Port Commerce Department 2013 Multi-Facility Emissions Inventory, Prepared for the Port Authority of New York and New Jersey.

The Port Authority of New York and New Jersey (2013). A Clean Air Strategy for the Port of New York & New Jersey, 2013 Implementation Report, December 2013.

USEPA (2012). Regulatory Impact Analysis for the Final Revisions to the National Ambient Air Quality Standards for Particulate Matter. Office of Air Quality Planning and Standards Health and Environmental Impacts Division. Research Triangle Park, NC. **EPA-452/R-12-005, December 2012**.

USEPA (2015a). MOVES Technical Guidance: Using MOVES to Prepare Emission Inventories for State Implementation Plans and Transportation Conformity. Transportation and Climate Division Office of Transportation and Air Quality. **EPA-420-B-15-007, January 2015**.

USEPA (2015b). Transportation Conformity Guidance for Quantitative Hot-spot Analyses in PM2.5 and PM10 Nonattainment and Maintenance Areas. . Transportation and Climate Division Office of Transportation and Air Quality. **EPA-420-B-15-084, November 2015**

Vollmer, T. A. Eng-Wong, Stump/Hausman, New Jersey Institute of Technology and Stevens Institute of Technology (2006). Port Authority Marine Container Terminals Truck Origin-Destination Survey 2005 (Draft Report, Revised 2/27/2006). Prepared for the Port Authority of New York and New Jersey.

[1] The more stringent (original) Clean Trucks Program accelerates the turnover of the truck fleet by requiring more rapid replacement of older trucks with newer cleaner trucks. Under the rolled back Clean Trucks Program fleet turnover will occur more slowly, but the fleet will eventually reflect newer and cleaner trucks as older trucks are replaced by newer trucks for other reasons. As a result, the greatest differences in emissions between the original and revised Clean Trucks Programs will occur in the initial years of implementation, with differences attenuating over time. The rate of this attentutation is estimated in Figure 15 in the Results and Discussion: Future Trends section of this report.

[2] Estimated from http://www.panynj.gov/port/pdf/2015-Trade%20Stats-summary-Web.pdf.

[3] The clean truck program described here applies to trucks registered with the Port's Drayage Truck Registry. The Port's Drayage Truck Registry includes on-road trucks that serve the Port Authority Terminals with a GVWR of >33,000 lbs and excludes Yard Trucks, Military Tactical Support Vehicles, and Dedicated Use Vehicles (Port Authority of New York and New Jersey 2014, 2015b, a, 2016a).

[4] Estimated from May 2016 PortTruckPass data (Port Authority of New York and New Jersey 2016b).

[5] Estimated from May 2016 PortTruckPass data (Port Authority of New York and New Jersey 2016b).

[6] We omit Brooklyn Port Authority Marine Terminal (Brooklyn, NY) because truck activities are not well characterized (it was omitted from the Port Truck Origin and Destination Survey (Vollmer, Eng-Wong et al. 2006) and container activity (which drives the vast majority of trucking activity) is small (estimated in the Comprehensive characterized (it was omitted from the Port Truck Origin and Destination Survey (Vollmer, Eng-Wong et al. 2006)and container activity(which drives the vast majority of trucking activity) is small (estimated in the Comprehensive Port Improvement Plan (Halcrow, Gannett Fleming et al. 2005) at 2.1% of portwide container activity and up to 3.2% in 2020 based on land area).

[7] Meteorological data obtained from the New Jersey 2011 Periodic Emissions Inventory, dated June 2015.

[8] Following MOVES Technical Guidance (USEPA 2015a).

[9] The PANYNJ has implemented and committed to implement several truck emissions reduction programs in addition to the truck replacement program described here. The 2013 Clean Air Strategy Implementation Report (The Port Authority of New York and New Jersey 2013) describes the Emission Reduction Fund, the SmartWay-type Partnership, and the Freight Movement Study as implemented. The Hunt's Point Voluntary Truck Program is in progress. The Truck Appointment System and Public Private Partnerships are committed. These programs are not modeled explicitly because they have either already been implemented (and so are already reflected in the fleet profile) or they do not have quantifiable impacts at this time.

[10] The vehicle age distribution that would occur in 2017 under the revised program is estimated based on the existing age distribution and expected turnover. We started with the age distribution represented by the Port visits in May 2016. MOVES requires that trucks be no less than 0 years old so we assumed that the 0.08% of trucks that are reported as model year 2017 are 2016 vehicles. This vehicle age profile was assigned to short and long haul vehicle types for entry into MOVES. We then used the Age Distribution Projection Tool for MOVES 2014 (available at https://www3.epa.gov/otaq/models/moves/documents/age-distribution-projection-tool-moves2014.xlsm) to project the vehicle ages in 2017.

[11] The vehicle age distribution that would occur in 2017 under the original program is estimated based on the existing age distribution, expected turnover, and the constraints of the program. We started with the age distribution estimated for the revised program (which assumes no entry constraints in 2017). We then removed all age fractions that were 2006 and older to represent the entry constraint. We reassigned the removed fraction of vehicles to model years 2007 to 2017 in proportion to the age fractions for those years to approximate the desirability and availability of vehicles of each age.

[12] For the original program the 2018 vehicle age distribution is estimated using the 2017 age distribution (described above) and the Age Distribution Projection Tool for MOVES 2014. For the revised program the 2018 vehicle age distribution is estimated using the 2017 age distribution and the Age Distribution Projection Tool for MOVES with the subsequent removal of 1994 and 1995 vehicles. The removed vehicles are reassigned to model years 1996 to 2017 in proportion to the age fractions for those years. All model years older than 2007 exhibit an overall reduction in their fleet share.

[13] The combination trucks category in MOVES refers to tractor-trailer combination trucks. All trucks are assumed to be diesel based on the observation that 99.9% of truck visits are diesel vehicles in December 2015, and January, February, March, and April 2016. The share of short vs long haul trucks is based on the approximate travel distances between all port terminals and their origins and destinations for trucks, as reported in the Port Truck Origin and Destination Survey (Vollmer, Eng-Wong et al. 2006).

[14] MOVES estimates extended idle emissions for long-haul combination trucks only.

[15] On-terminal running emissions assume that trucks travel 15 mph on urban unrestricted roads.

[16] Future movements of each cargo type are estimated using a linear regression of each cargo total from 1991 to 2015 (using data from http://www.panynj.gov/port/pdf/2015-Trade%20Stats-summary-Web.pdf and http://www.panynj.gov/port/pdf/port-trade-statistics-summary-2001-2011.pdf). 2017 and 2018 cargo levels are projected to be 93,818,290 and 95,674,120 metric tons/yr for general and bulk cargo; 857,765 and 876,160 units per year for motor vehicles; and 5,756,924 and 5,919,310 non-rail TEUs per year for containers (container TEUs are adjusted to omit containers moved by on-dock rail, assuming 1.7 TEUs per lift).

[17] Total truck calls for each facility type (summed from Table 3.22 of the Port's 2013 Multi-Facility Emissions Inventory (Starcrest Consulting Group 2015)) are divided by the associated freight activity for 2013 (obtained from

http://www.panynj.gov/port/pdf/2015-Trade%20Stats-summary-Web.pdf). Auto terminal truck activity is estimated based on motor vehicle units handled: 0.090 truck calls per motor vehicle unit handled. Warehouse truck activity is estimated based on tons of bulk and general cargo: 0.0031 truck calls per metric ton of bulk and general cargo. Container terminal truck activity is estimated based on container TEUs (adjusted to omit containers moved by on-dock rail, assuming 1.7 TEUs per lift): 0.83 truck calls per non-rail TEU.

[18] Although the Port's 2013 Multi-Facility Emissions Inventory (Starcrest Consulting Group 2015) provides a breakdown of truck calls for each facility, it does not indicate which facility is located at each marine terminal and we were unable to obtain this information from the Port. Container activity is allocated based on the average of Comprehensive Port Improvement Plan (Halcrow, Gannett Fleming et al. 2005) 2000 cargo activities and 2020 predicted activities as shown in Table 9.1 (which are based on land area) for each facility type at each terminal (13.4%, 62.5%, 8.4%, 13.2%, and 2.7% at Ports Newark, Elizabeth, Jersey, Howland Hook, and Red Hook respectively). These values are also roughly consistent with CPIP assessed capacity, and the cargo shares reflected in the Port Truck Origin and Destination Survey (Vollmer, Eng-Wong et al. 2006). We confirmed that these terminals continue to accommodate container activity, as confirmed at http://www.panynj.gov/port/containerized-cargo.html. To arrive at truck activity shares for container facilities, these container activity shares were adjusted to account for ExpressRail service (approximately 14% of TEUs were moved by ExpressRail, as estimated from http://www.panynj.gov/port/pdf/2015-Trade%20Stats-summary-Web.pdf assuming 1.7 TEUs per lift). According to http://www.panynj.gov/port/express-rail.html ExpressRail is present at Newark, Elizabeth, and Howland Hook. After adjusting for rail activity, we estimate that 13.1%, 61.1%, 9.7%, 12.9%, and 3.1% of container truck movements occur at container facilities at Port Newark, Elizabeth, Jersey, Howland Hook, and Red Hook terminals respectively.

[19] Although the Port's 2013 Multi-Facility Emissions Inventory (Starcrest Consulting Group 2015) provides a breakdown of truck calls for each facility, it does not indicate which facility is located at each marine terminal and we were unable to obtain this information from the Port. 66% of auto activity is assumed to occur at Port Newark and 34% is assumed to occur at Port Jersey. This estimate is based on an even split of auto terminal activities between the two Port Newark and the one Port Jersey auto terminals (listed in the Port's 2013 Multi-Facility Emissions Inventory (Starcrest Consulting Group 2015) and here http://www.panynj.gov/port/vehicle-shipping-processing.html). It is also consistent with the Comprehensive Port Improvement Plan (Halcrow, Gannett Fleming et al. 2005) 2020 predicted cargo activities (which are based on land area) at Port Newark and Port Jersey.

[20] Although the Port's 2013 Multi-Facility Emissions Inventory (Starcrest Consulting Group 2015) provides a breakdown of truck calls for each facility, it does not indicate which facility is located at each marine terminal and we were unable to obtain this information from the Port. 50% of warehouse activity is assumed to occur at Port Newark and 12.% is assumed to occur at Port Elizabeth, Port Jersey, Howland Hook, and Red Hook. This estimate is based on an even split of warehouse terminal activities based on the number of facilities at each terminal, as listed at http://www.panynj.gov/port/distribution-warehousing.html.

[21] Seasonal traffic shares are based on average monthly shares of container traffic from 2005 to 2015, as shown at http://www.panynj.gov/port/monthly-loaded-containers.html.

[22] These are approximate estimates that are intended to capture the majority of typical activity. Four terminals open at 6am (APM Elizabeth, GCT Bayonne, Maher, Port Newark Container Terminal) while GCT New York (Staten Island) opens at 8am. Three terminals close at 4pm (GCT Bayonne, GCT New York, APM Port Elizabeth). Port Newark Container terminal clsoes at 6pm and Maher Terminals closes at 7pm. Truck travel to and from the Port may also occur for some period before and after terminals open. The PONYNJ has 13 holidays per year, APM Port Elizabeth and GCT New York have 17 holidays per year, and Maher Terminals have 16 holidays per year.

[23] There are two minor errors in the on-terminal assumptions. First, the truck speed at auto terminals should be 5 mph instead of 15 mph to be consistent with the 2013 MFEI. Second, the short-idle of trucks at the container terminals should be 0.46 hours instead of 0.43 hours to be consistent with the 2013 MFEI. As a result, this report underestimates on-terminal emissions. Because auto-terminal activity is a small part of on-terminal activity and on-terminal emissions are dwarfed by off-terminal emissions, we do not expect these errors to substantially affect the estimates presented here.

[24] The Port Truck Origin and Destination Survey (Vollmer, Eng-Wong et al. 2006) summarizes truck origins and destinations for trucks traveling to and from 46 areas across the US. More distant locations are grouped into groups of states (e.g. Pacific Northwest) while closer locations are aggregated at the county and regional level (e.g. Essex County or Western Massachusetts). The Port Truck Origin and Destination Survey (Vollmer, Eng-Wong et al. 2006) breaks out origins and destinations for Elizabeth/Newark, Jersey City, and Howland Hook terminals.

[25] We identify four travel analysis zones (TAZs) that correspond to the four terminals (one each for Elizabeth, Newark, and Howland Hook and three for Jersey). Using the origin-destination data for heavy trucks from the 2015 NJRTM-E, we then estimate the share of each terminal's trucks that travel to and from each of 1430 travel analysis zones (TAZs) in 11 nearby counties: 8 in New Jersey (Bergen, Essex, Hudson, Middlesex, Morris, Passaic, Somerset, and Union) and three in New York (Kings, New York, Richmond). According to the Port Truck Origin and Destination Survey (Vollmer, Eng-Wong et al. 2006), approximately 80% of Port trips travel to and from these eleven counties. We then scale those trip shares so that the share of each terminal's trips going to and from each of the 11 counties matches the corresponding county level estimates in the Port Truck Origin and Destination Survey. In other words, if the Port Truck Origin and Destination Survey indicates that 10% of trucks leaving Terminal Z travel to County A, and the NJTRM-E estimates that 2% of trips traveling from Terminal Z to County A end in TAZ B, then we estimate that 10%*2%= 0.2% of the trips leaving Terminal Z travel to TAZ B.

[26] Tear off maps sent from Nicholas Raspanti of PANYNJ to Amy Goldsmith of Clean Water Action, 5/12/2016.

[27] Centroid connector road types (which are included in the model to connect TAZ centroids to the network) are excluded from these estimates because they do not correspond to actual route locations.

[28] Meteorological data for Newark Airport processed with AERMET was obtained from NYDEC.

[29] Routes with fewer than four daily trucks accounted for a large portion of the roadway network and greatly increased the computational time required to estimate pollution concentrations, but they had a very small impact on near roadway air quality (concentrations were less than 0.005 ug/m^3 right on top of the roadway.)

[30] The computational resources that would be required to estimate 5 years of daily data (rather than the annual mean estimated from sampled meteorological data) are prohibitive given the large geographic area and the fine spatial grid of receptors evaluated.

[31] AERMOD was run for a 100m grid of receptors which were then spatially interpolated using empirical Bayesian Kriging in ArcGIS to a raster with a 20m resolution.

[32] Our dispersion modeling results are aggregated to Census blocks as the mean of all 20m grid located points within in each Census block. We use 2010 population and age data (estimated from the 2010 Census using BenMAP's PopGrid) and 2010 health incidence data built into BenMAP (available at the county level for premature mortality). We use the health impact functions and pooling methods described in USEPA's final regulatory assessment of the National Ambient Air Quality Standards for particulate matter (USEPA 2012) with inputs from the EPA's BenMAP default PM2.5 configuration and pooling setup applied to our New Jersey case. We restrict this analysis to the risk of premature mortality due to the robust body of health research tying premature mortality to PM2.5 exposure and the limitation of the annual mean estimates of 24-hour PM2.5 concentrations estimated in our dispersion analysis (which is consistent with long-term exposures underlying much of that research).

[33] On-terminal emissions totals include Port Newark, Elizabeth Port Authority Marine Terminal, and Port Jersey Port Authority Marine Terminal in New Jersey and Howland Hook Marine Terminal in Staten Island, New York.

[34] Off-terminal emissions totals include roads located in the eight county study area.

[35] The original Program would have restricted older trucks starting in 2017 while the revised Program is more modest in that it i) restricts only the oldest trucks and ii) has a later start date (2018). As a result, differences in emissions estimated in 2017 reflect differences between the original Program restrictions and an unrestricted scenario, while the 2018 comparison reflects the difference in the stringency of the truck restrictions under the two Programs.

[36] Estimates derived using these two health impact functions are comparable to estimates based on functions derived by experts. The estimated risks of premature mortality (per million affected adults with 95% confidence interval shown in parentheses) due to PM2.5 emissions increases in 2017 averaged across the entire eight county area is as follows:

Krewski et al. (2009)	0.49 (0.33 - 0.64)
LePeule et al. (2012)	1.0 (0.5 - 1.5)
Expert A	1.3 (0.15 - 2.6)
Expert B	1.1 (0.089 - 2.2)
Expert C	1.0 (0.24 - 1.8)
Expert D	0.70 (0.0 - 1.2)
Expert E	1.6 (0.59 - 2.6)
Expert F	0.96 (0.43 - 1.4)
Expert G	0.58 (0.0 - 1.1)
Expert H	0.73 (0.0 - 2.1)
Expert I	0.99 (0.0 - 1.8)
Expert J	0.80 (0.062 - 1.9)
Expert K	0.12 (0.0 - 0.54)
Expert L	0.78 (0.0 - 1.8)

As in the USEPA's final regulatory assessment of the National Ambient Air Quality Standards for particulate matter (USEPA 2012), the increases in premature mortality estimated based on health impact functions that are derived from expert elicitation (Roman, Walker KD et al. 2008) largely fall within the same range as estimates from Krewski et al. (2009) and LePeule et al. (2012) shown in the Table above. Krewski et al. (2009) and the expert elicitations estimate risks for adults aged 30 and up (including 2,988,531 individuals) and LePeule et al. (2012) estimates risks for adults aged 25 and up (including 3,319,354 individuals).

[37] Estimated by dividing the county-level point estimates of the number of people experiencing a greater than 1 in a million risk (estimated from Krewski, Jerrett M et al. 2009, Lepeule, Laden F et al. 2012) and dividing by the total adult population for the county. This estimate does not account for the 95% confidence interval.

[38] Krewski et al. (2009) also provides estimates of two subcategories of premature mortality. For the eight county area in 2017 we estimate that the risk of premature mortality due to ischemic heart disease is 0.37 in a million (95% confidence interval 0.30 - 0.43) and the risk due to lung cancer is 0.064 (95% confidence interval 0.027 – 0.10). These risks are included in the all cause mortality estimates shown in footnote 36 (and are not additional); risks from ischemic heart disease and lung cancer comprise 67 – 92% and 8 – 16% of adult premature mortality risks, respectively, in 2017. A similar analysis of 2018 risks yields estimates of 68 – 91% of deaths from ischemic heart disease and 8 – 16% of deaths from lung cancer.

[39] We extrapolate the linear trend in Port truck growth that was used to predict activity levels in 2017 and 2018. We assume that activity shares at each terminal are the same as in 2017 and 2018. We use the same truck route and speed data assumptions (based on the modeled 2015 network) that we used to estimate emissions in 2017 and 2018. We again use the MOVES fleet projection tool (based on 2018 values estimated earlier) to project the vehicle fleet. We reran MOVES for each future year evaluated.