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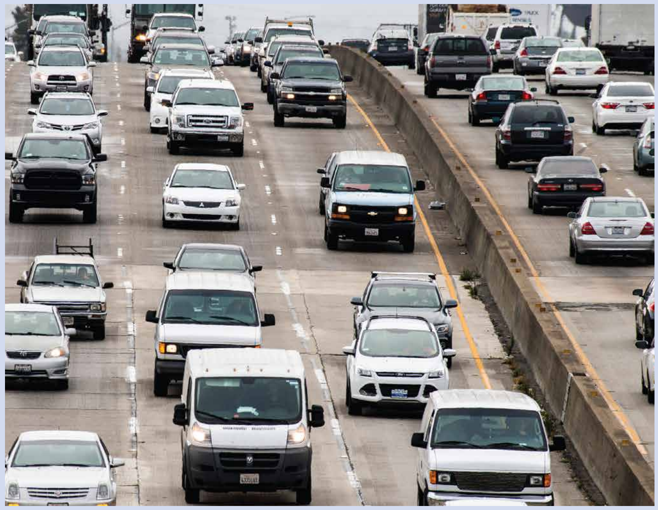

Owning Our Air

The West Oakland Community Action Plan – **Volume 2: Appendices**

October 2019

A joint project of the Bay Area Air Quality Management District and West Oakland Environmental Indicators Project

Bay Area Air Quality Management District

West Oakland Environmental Indicators Project
know which way the wind blows

Owning Our Air:

The West Oakland Community Action Plan

Volume 2

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Appendix A – Technical Support Document

Appendix A – Technical Support Document

Part I: Base Year Emissions Inventory and Air Pollutant Dispersion Modeling

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Notation

Acronyms

AADT	annual average daily traffic
AB	Assembly Bill
ABAG	Association of Bay Area Governments
AERMAP	American Meteorological Society/Environmental Protection Agency Regulatory Model terrain pre-processor
AERMET	American Meteorological Society/Environmental Protection Agency Regulatory Model Meteorological Processor
AERMOD	American Meteorological Society/Environmental Protection Agency Regulatory Model
agl	above ground level
APCS	automated pavement condition survey
ASF	age sensitivity factor
asl	above sea level
AQS	Air Quality System
BAAQMD	Bay Area Air Quality Management District
BAU	business-as-usual
CalEPA	California Environmental Protection Agency
CAPCOA	California Air Pollution Control Officers Association
CAPP	Community Air Protection Program
CARB	California Air Resources Board
CARE	Community Air Risk Evaluation
CAS	Chemical Abstract Service
CEIDARS	California Emissions Inventory Development and Reporting System
CHC	commercial harbor craft
CHE	cargo handling equipment
CHEI	Cargo Handling Equipment Inventory (model)
CMAQ	Community Multi-scale Air Quality (model)
CPF	cancer potency factor
CRW	cancer risk-weighted
CT-EMFAC	Caltrans-EMissions FACtors (model)
DBR	daily breathing rate
DPM	diesel particulate matter
EBMUD	East Bay Municipal Utility District
EC	elemental carbon
ED	exposure duration
EDF	Environmental Defense Fund
EMFAC	EMission FACtors (model)
EPA	Environmental Protection Agency
EZ	exclusion zone
FAH	fraction of time at home
FHWA	U.S. Federal Highway Administration
GVWR	gross vehicle weight rating

HDV	heavy-duty vehicle
HHDT	heavy heavy-duty truck
HRA	health risk assessment
IDW	inverse distance weighting
LDV	light-duty vehicle
LHDT	light heavy-duty truck
LST	local standard time
MSAT	mobile source air toxic
MDV	medium-duty vehicle
MHDT	medium heavy-duty truck
NAD83	North American Datum of 1983
NEI	National Emissions Inventory
NEPA	National Environmental Policy Act
NOAA	National Oceanic and Atmospheric Administration
NT	Non-Truck
OEHHA	Office of Environmental Health Hazard Assessment
OGV	ocean-going vessel
O&M	operation and maintenance
O-D	origin-destination
PeMS	Performance Measurement System
PM	particulate matter
PM_{10}	particulate matter 10 micrometers or less in diameter
$PM_{2.5}$	particulate matter 2.5 micrometers or less in diameter
POM	polycyclic organic matter
POAK	Port of Oakland
PSD	prevention of significant deterioration
QA	quality assure/assurance
SIC	Standard Industrial Classification
SMOKE	Sparse Matrix Operator Kernel Emissions (model)
SRTM	Shuttle Radar Topography Mission
TAC	toxic air contaminants
TIGER	Topographically Integrated Geographic Encoding and Referencing
TOG	total organic gases
TRU	transport refrigeration unit
UP	Union Pacific
USGS	United States Geological Survey
UTM	Universal Transverse Mercator
VHT	vehicle hours traveled
VMT	vehicle miles traveled
WD	weekday
WE	weekend
WETA	Water Emergency Transportation Authority
WOEIP	West Oakland Environmental Indicators Project
WRF	Weather Research and Forecasting (model)

Units

g	gram
kg	kilogram
lb	pound
mg	milligram
ton	U.S. ton (2,000 lb)
tpy	tons per year (U.S. ton/y)
µg	microgram
L	liter
gal	gallon
ft	feet
nmi	nautical mile
m	meter
mi	mile
h	hour
min	minute
s	second
mph	miles per hour (mi/h)
kt	knot (1.15078 mph)
°C	degrees Celsius
°F	degrees Fahrenheit
K	Kelvin
ppm	parts per million
bhp	brake horsepower
hp	horsepower
kW	kilowatt

1. Introduction

The technical work performed to support the West Oakland Community Action Plan pursuant to Assembly Bill 617 is described in this document. The objective of this technical work was to spatially map the contribution of emissions from major emissions sources to pollutant concentrations and estimate cancer risk within the West Oakland community that may potentially impact current and future residents.

1.1 Context

The California State Assembly adopted Assembly Bill (AB) 617 in 2017 (C. Garcia, Chapter 136, Statutes of 2017). The bill established the Community Air Protection Program (CAPP),[1] which focuses on reducing exposure in communities most impacted by air pollution. Local air districts are tasked with partnering with community groups, environmental organizations, regulated communities, and other stakeholders to develop a new community-focused action framework for community protection.

To meet AB 617 statutory requirements, the California Air Resources Board (CARB) was directed to provide "[a] methodology for assessing and identifying the contributing sources or categories of sources, including, but not limited to, stationary and mobile sources, and an estimate of their relative contribution to elevated exposure to air pollution in impacted communities…" (following California Health and Safety Code §44391.2(b)(2)).[2] CARB outlined a general methodology in its *Community Air Protection Program Blueprint* (California Air Resources Board 2018a), and five recommended technical approaches in an accompanying document, *AB 617 Recommended Source Attribution Approaches* (California Air Resources Board 2018a). These approaches include creating "community inventory ratios" (Approach 1), where community-specific emissions inventories are developed and ratios of emissions from different sources are compared, and "community-specific air quality modeling" (Approach 2), which uses the community-specific emissions inventory, meteorological data, and air quality models to estimate the impacts and contributions of emission sources on overall air pollution concentrations within the community.

The Bay Area Air Quality Management District (BAAQMD, the "District") identified West Oakland as a Year 1 community under the CAPP (Bay Area Air Quality Management District 2018). West Oakland is considered one of the most impacted areas in the San Francisco Bay Area due to presence of many sources of diesel particulate matter (DPM). The technical work performed to support the West Oakland Community Action Plan ("Action Plan") pursuant to AB 617 is described in this document. The objective of this technical work was to spatially map the contribution of emissions from major emissions sources to pollutant concentrations within the West Oakland community that may potentially impact current and future. Following CARB's suggested technical approaches, to identify areas with elevated air pollutant concentrations and higher population exposure, a bottom-up air pollutant *emissions inventory* was developed, and *air pollution dispersion modeling* was performed to support a *source apportionment* analysis. This

[1] http://www.baaqmd.gov/community-health/community-health-protection-program.
[2] https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201720180AB617.

document therefore describes how emissions from major source categories were estimated, how the dispersion model was selected and configured, and presents the output from the dispersion model.

1.2 Background and Technical Framework

West Oakland is bounded by three major freeways (I-580, I-880, I-980), is adjacent to large industrial sources and the Port of Oakland (the "Port"), and is the location of a major U.S. Postal Service Distribution Center (**Figure 1-1**). Based on modeling and field studies conducted under the District's Community Air Risk Evaluation Program (CARE), the District identified West Oakland as a community impacted by poor air quality (elevated fine particulate matter and DPM), where residence have poor health outcomes and are subjected to elevated cancer risk.[3]

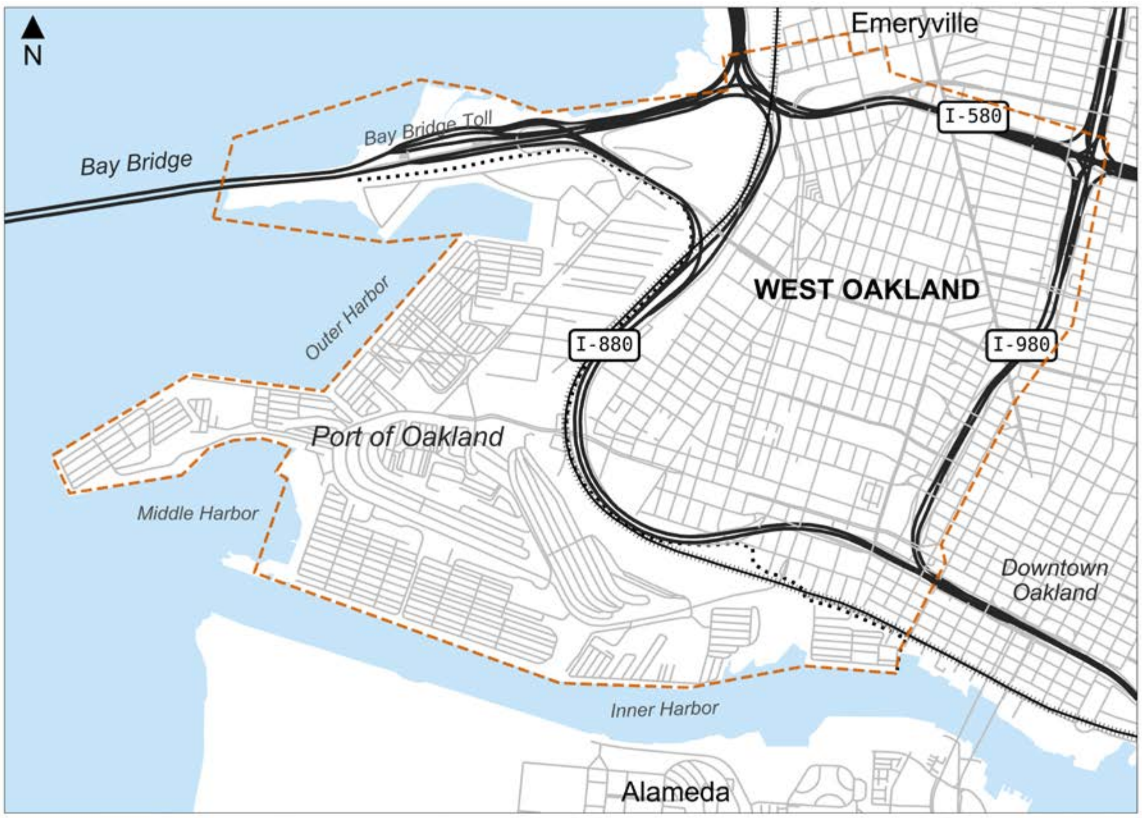

Figure 1-1. Map of the West Oakland. The extents of West Oakland community (dashed red line) and the Port of Oakland (dotted black line), roadways (solid black and grey lines) and rail lines (hatched black lines) are denoted.

Emissions inventories contain information on the quantity of air pollutants that are emitted from specific sources or source categories over a specific period. In this analysis, emissions inventories of fine particulate matter (particulate matter 2.5 micrometers or less in diameter [$PM_{2.5}$]) and toxic

[3] Previous analyses (Bay Area Air Quality Management District 2014) identified impacted areas based on elevated fine particulate matter concentrations and high rates of cancer, incidences of mortality, hospitalization rates, and respiratory illnesses.

air contaminants (TACs) that have documented cancer toxicities (see **Attachment 1**) were developed. The emissions inventory accounts for *primary pollutants* only.[4] $PM_{2.5}$ and TACs are the primary air pollutants which pose the greatest risk to the health of residents in West Oakland and are further described below.

Toxic Air Contaminants (TACs): CARB is responsible for identifying TACs, which are defined as pollutants that "may cause or contribute to an increase in deaths or in serious illness, or which may pose a present or potential hazard to human health."[5] Exposure to TACs can cause serious health effects, including cancer and birth defects. Other adverse health effects can include damage to immune, neurological, reproductive (reduced fertility), developmental, and respiratory systems. TACs are emitted from many sources in the Bay Area, including: diesel engines, vehicles (e.g., cars, trucks), industrial processes, and gas stations. Types of TACs include DPM, lead, benzene, formaldehyde, and hexavalent chromium (a complete list of TACs examined in this analysis is provided in **Attachment 1**). DPM is the most significant TAC in the Bay Area, accounting for ~85% of the cancer risk.

Fine Particulate Matter ($PM_{2.5}$): $PM_{2.5}$ is composed of a mixture of many small airborne particles or liquid droplets. $PM_{2.5}$ originates from a variety of sources, including fossil fuel combustion, residential wood burning and cooking, and natural sources (such as wildfires and re-entrained road dust). Epidemiological studies have established that exposure to $PM_{2.5}$ has serious adverse health impacts (e.g., Cohen and Pope 1995, Krewski *et al.* 2009, Health Effects Institute 2010). $PM_{2.5}$ can enter deep into lungs and the bloodstream. Exposure to $PM_{2.5}$ has negative effects on the respiratory system (such as triggering asthma attacks, aggravating bronchitis, and diminishing lung function), cardiovascular system (and may cause atherosclerosis [hardening of the arteries], ischemic strokes [caused by an obstruction of the blood supply to the brain], and heart attacks). Because of the serious cardiovascular effects of exposure to $PM_{2.5}$, studies have found a clear correlation between exposure to elevated $PM_{2.5}$ levels and mortality. Studies also indicate that exposure to $PM_{2.5}$ may be related to other negative health effects, including impacts on the brain (such as reduced cognitive function), and increased risk of diabetes. Exposure to $PM_{2.5}$ remains the leading public health risk and contributor to premature death from air pollution in the Bay Area. More information on fine PM and associated health effects can be found in the report *Understanding Particulate Matter: Protecting public health in the San Francisco Bay Area*, prepared by the District (Bay Area Air Quality Management District 2012).

The emissions inventory developed for this analysis includes emissions from various local pollutant sources in West Oakland: permitted stationary sources (small and large complex facilities regulated by the District), on-road mobile sources (vehicles on all surface streets and freeways, and

[4] Primary pollutants are those compounds emitted directly into the atmosphere. In dispersion modeling, primary pollutants are also assumed to be nonreactive. *Secondary pollutants* (compounds formed in the atmosphere as a result of chemical reactions) were not included in this analysis because (1) their formation involves complex chemical reactions that cannot be accounted for in the dispersion models, and (2) near-source exposures tend to be driven by emissions of primary pollutants; secondary pollutants form downwind of sources and tend to be distributed at a regional scale.

[5] California Air Resources Board Glossary: https://ww2.arb.ca.gov/about/glossary (accessed January 2019).

extended idling from trucks operating at certain large businesses), marine operations and railyard activity at the Port, locomotives, and commuter ferries and excursion vessels.[6]

Emissions inventories were developed for three years: a ("current") base year (effective 2017), a forecasted near-term future year (2024), and a far-term future year (2029). The base year is used to establish initial concentrations where mitigation strategies may be developed to reduce future-year exposures. The future-year emissions inventories include anticipated reductions from existing regulations and known changes in source activity (*business-as-usual* [BAU] conditions); additional anticipated reductions from presumed implementation of proposed mitigation measures under this Action Plan were also included to show where high levels of air pollution may persist, and additional actions may be warranted. The base year emissions inventory is further described in this document (**Section 2**); forecasted future-year emissions inventories are described in *Appendix A – Technical Support Document Part II: Business-As-Usual Future Year Emissions Inventory and Air Pollutant Dispersion Modeling* ("Part II"), and estimates of reductions from strategies of the Action Plan are described in *Appendix A – Technical Support Document Part III: Community Action Plan Emission Reduction Estimates* ("Part III").

Air pollutant concentrations at a *receptor* (a location where concentrations are sampled) represent the sum of all concentration contributions from many emissions *sources*; that is, the total concentrations at a receptor can be *apportioned* to different sources. From a spatiotemporal perspective, concentrations at a receptor also represent the sum of concentrations due to local sources and those from regional sources. Accordingly, two modeling analyses were performed:

(1) "Regional-scale modeling" was used to provide an estimate of the "background" pollutant concentrations,[7] i.e., the air pollutant concentrations in West Oakland in the absence of any local emission sources in West Oakland. Pollutant concentrations were simulated within 1 km grid cells over the entire Bay Area using a modeling framework consisting of a numerical meteorological model (Weather Research and Forecasting [WRF] model), an emissions inventory model (Sparse Matrix Operator Kernel Emissions [SMOKE] modeling system), and a chemical transport model (Community Multiscale Air Quality [CMAQ] modeling system), where local emissions sources within West Oakland were excluded.

(2) "Community-scale modeling" was used to quantify the local impacts from emissions sources on air pollutant concentrations in West Oakland at a finer spatial scale. Dispersion models use a time-averaged, simplified representation of turbulent atmospheric dispersion to approximate how pollutants are transported and diluted. Critical inputs to the dispersion models are estimates of emissions from major air pollution sources and source characteristics. Dispersion factors were generated using the American Meteorological Society/ Environmental Protection Agency Regulatory Model

[6] Emission estimates from these sources are further described in this document (**Section 2**); emissions from other local sources that were not included are described in **Section 2.1.5** (**Table 2-3**) and discussed in **Section 6.1.6**. Local concentrations are also influenced by pollutant emitted elsewhere (outside of the West Oakland area); the "background" concentrations are addressed in **Section 3.6**.

[7] The regional-scale modeling was also used for a modeling platform evaluation, where modeled air pollutant concentrations were compared to concentrations measured at local air quality monitors within the Bay Area.

(AERMOD) system with a single year of representative meteorological data (2014). Year-specific emissions inventories were then convolved with the dispersion factors to obtain year-specific air pollutant concentrations for the West Oakland community.

Using this approach, the results of the AERMOD dispersion modeling, which only accounts for local emissions sources, could be added to the background concentration from the regional modeling to yield a concentration that approaches the total concentration (**Figure 1-2**).[8] The results from the dispersion modeling can also be thought of as the "additional burden" caused by the local emissions in West Oakland alone. The community-scale modeling using AERMOD is further described in this document (**Section 3**); the regional-scale modeling is briefly described herein (**Section 3.6**), and fully documented elsewhere (Tanrikulu *et al.* 2019a, Tanrikulu *et al.* 2019b).

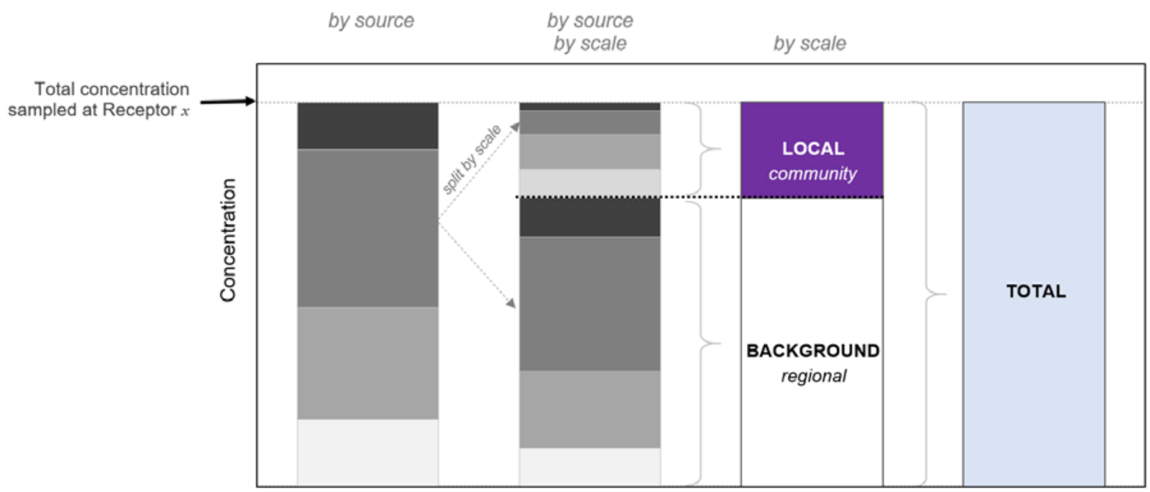

Figure 1-2. Schematic representation of how concentration contributions are disaggregated in a source apportionment analysis using "regional-scale" and "community-scale" modeling. Grey bar sections represent the concentration contributions from different arbitrary source categories.

1.3 Objectives

The District, in partnership with the West Oakland Environmental Indicators Project (WOEIP), developed an Action Plan for West Oakland to promote innovative policies to improve air quality. The objective of this technical work was to understand the spatial distribution of pollutant concentrations in West Oakland due to local emissions sources. Collaboration with WOEIP helped the District identify specific goals and action-oriented strategies for West Oakland that will focus on reducing exposure to $PM_{2.5}$, DPM, and TACs. To assist with this effort, the District performed a community-scale analysis to:

[8] A model evaluation can be performed by comparing the total concentration to those observed at monitoring locations within the same domain. This analysis is not discussed in this document.

- Develop a base year emissions inventory and risk assessment for all major emissions sources impacting West Oakland residents;
- Provide source apportionment of (a) emissions and (b) air pollutant concentrations at receptors by source category (i.e., trucks, locomotives, etc.) or source origin (e.g., Port of Oakland, freeways);
- Establish a baseline to track the benefits of future emission reductions on the burden of future new emissions sources.
- Develop a framework for modifying and expanding the emissions inventory for local emissions sources.

In this analysis, an emissions inventory was developed (**Section 2**), air dispersion modeling was performed (**Section 3**), and pollutant concentrations and cancer risk estimates were calculated (**Section 4**). A brief overview of the results (**Section 5**), and a discussion of sources of uncertainty in the methods (**Section 6**) are also presented.

2. Emissions Inventory

The District developed bottom-up emissions inventories for $PM_{2.5}$ and TACs from all emissions sources in West Oakland for which emissions information (quantity, physical characteristics, spatiotemporal resolution) was available and sufficiently resolved at the time of analysis. A summary of the emissions inventory developed for the Action Plan for the base year (effective 2017) is described in this section by source category, including: permitted stationary sources, on-road mobile sources, truck-related businesses, sources due to activity in the Port of Oakland (ocean-going vessels, commercial harbor crafts, cargo handling equipment, Port Trucks at terminals, railyards), locomotives, railyards, and commuter ferries and excursion vessels. Emissions inventories from Port-related sources were based on the *Port of Oakland 2017 Seaport Air Emissions Inventory* (Ramboll 2018), unless otherwise indicated. Specific temporal and spatial allocation information for emissions source categories are discussed in **Section 3**, as they pertain to the emissions and dispersion modeling.

For emissions sources where emission information was not readily available (e.g., woodsmoke, construction), the District developed top-down emissions inventories (see **Table 2-3** and a discussion in **Section 6.1.6**). Emissions from these categories are included in the emissions inventory, but not in subsequent dispersion modeling and risk analysis.

2.1 Development and Overview

2.1.1 Pollutants

AB 617 focuses on evaluating local community risk impacts associated with $PM_{2.5}$ and TACs (which includes DPM), which are the primary air pollutants that pose the greatest risk to the health of residents in West Oakland (California Air Resources Board 2008a). A full list of TACs compounds included in this analysis is provided in **Attachment 1**. In the following emissions inventories and modeling results, DPM is both included in TAC emission estimates and presented separately from $PM_{2.5}$ and TACs. Only $PM_{2.5}$ emissions and concentrations from directly emitted $PM_{2.5}$ and TACs were evaluated; secondary $PM_{2.5}$ and TACs were not included.

2.1.2 Domain

All sources in this analysis were located within the "Source Domain", which encompasses the entire West Oakland community and Port of Oakland, as well as part of downtown Oakland (**Figure 2-1**). For comparison purposes, the extents of the Source Domain were defined such that they correspond to a subset of the two-dimensional grid cells used in the regional-scale modeling analysis (see **Section 3.6**). The Source Domain is 7 km × 5 km. All emission sources discussed in this section are located within the Source Domain; if an emissions source's extents were beyond those of the Source Domain, only the emissions associated with the area within the Source Domain were included in the inventory.

Figure 2-1. Extents of the Source Domain (red dotted lines) used to develop the emissions inventories. The extents of the map represent the extents of the Source Domain. The inner tiles represent the 1 km × 1 km grid cells of the regional-scale modeling.

2.1.3 Emissions Sources and Base Year

The emissions inventory consists of emissions from various source categories, as shown in **Figure 2-2** and **Table 2-1**. These sources include stationary and mobile (on-road, off-road) sources of emissions. Annual emissions estimates were developed for a base year, effective 2017 (i.e., the emissions data from the year closest to 2017 was used for each source category).[9]

In West Oakland, a large number of emissions source types are attributed to activity from the Port of Oakland. The Port is the eighth busiest port in the U.S.[10] and serves as a gateway for intermodal cargo transport. In 2017, the Port consisted of four active marine terminals (TraPac, Nutter (STS/Everport), Oakland International Container Terminal [OICT], and Matson), and two railyards (Burlington Northern Santa Fe [BNSF], and Oakland Global Rail Enterprise [OGRE]). A fifth terminal (the Charles P. Howard terminal, located on the southeastern corner of the Port), is not currently being used as a marine shipping terminal, but rather hosts several operational truck-related companies. Presently, the American Baseball League the Oakland Athletics (the A's) is investigating the possibility of building a baseball stadium on the site that is currently being used for long term Port (drayage) Truck parking.

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[9] Forecasted inventories for 2024 and 2029 are presented in Part II.

[10] Based on 2017 cargo volume data, from: https://www.oaklandseaport.com/performance/facts-figures/ (accessed August 2019).

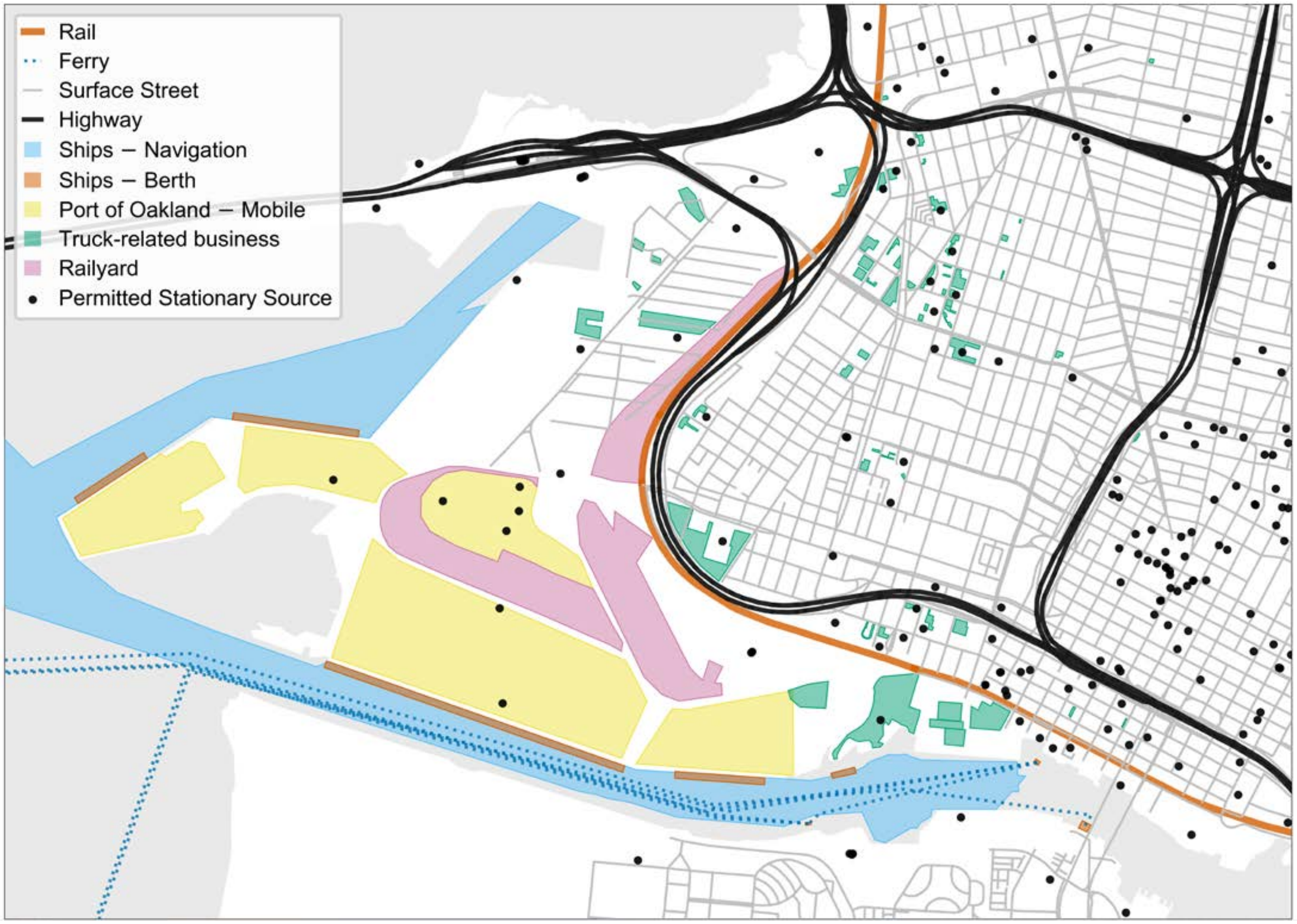

Figure 2-2. Composite of emissions source categories locations for the community-scale modeling in West Oakland. Ships – Navigation encompasses the areas of emissions from ocean-going vessels (maneuvering) and commercial harbor crafts (assist tugs, dredgers, and bunkering tugs and pumps) at the Port, as well as ships transiting to Schnitzer Steel; Ships – Berth includes berthing areas for ships at the Port, Schnitzer Steel, commuter ferries, and excursion vessels. Port of Oakland – Mobile encompasses the areas of emissions from Port Truck activity (idling and transiting) and cargo-handling equipment; Surface Street may include on- and off-ramps. Only permitted stationary sources that were modeled are included.

Table 2-1. Emission source categories in West Oakland and year of data used to create the 2017 base year emissions inventory. The reference or data sources of the activity data and/or emissions data are indicated. Emissions inventories developed using a bottom-up approach were used for further air dispersion modeling and analyses; emissions inventory developed using a top-down approach are included in the total emissions inventory, but not included in any subsequent modeling.

Approach	Section	Source Category	Year	Reference/Data Source
Bottom-up	2.2	Permitted stationary sources	2015–2018	District (based on 2017 CEIDARS report)
	2.3	On-road mobile sources	2017	Citilabs, StreetLight, Caltrans Truck Volumes, Caltrans PeMS, EMFAC2017, CT-EMFAC2017, Bay Area Air Quality Management District (2009)
	2.4	Truck-related businesses	2018	Bay Area Air Quality Management District (2009), District survey (2018)
	2.5	Ocean-going vessels	2017	Ramboll (2018), Port of Oakland, CARB, California Air Resources Board (2019), District
	2.6	Commercial harbor crafts	2017	Ramboll (2018), Port of Oakland, CARB, Ramboll
	2.7	Cargo handling equipment	2017	Ramboll (2018), Port of Oakland
	2.8	Port Trucks at Terminals	2017	Ramboll (2018), District
	2.9	Locomotives	2017–2018	District (passenger), UP and BNSF (freight)
	2.10	Railyards	2017	Environ International Corporation (2008), UP
	2.11	Commuter ferries and excursion vessels	2018	CARB, WETA, District survey (2018)
Top-down	2.1.4	Other area sources	2017	CEPAM 2016 SIP Emissions Inventory, ABAG, SMOKE
	2.1.4	Non-road sources	2017	CEPAM 2016 SIP Emissions Inventory, ABAG, SMOKE, OFFROAD

Maritime emissions developed for the West Oakland Action Plan were largely based on the *Port of Oakland 2017 Seaport Air Emissions Inventory* developed by Ramboll (2018), herein referred to as the "2017 Port Inventory." The District contracted Ramboll (with prior approval from the Port) to assist in developing further spatial and temporal allocations of emissions associated with Port activities. Most of the emissions inventory information for Port-related sources discussed herein are partially excerpted from Ramboll (2018), including information for: maneuvering from ocean-going vessels (OGVs) (**Section 2.5**), commercial harbor crafts (CHCs) (**Section 2.6**), cargo handling equipment (CHE) (**Section 2.7**), operational emissions from Port Trucks operating at terminals (**Section 2.8**), locomotives (**Section 2.9**), and railyards (**Section 2.10**).

While there are some privately owned terminals and non-maritime activity on Port property, emissions from these sources are not included in the Port source categories. For example, emissions from activities at Schnitzer Steel and from truck fleets operating on Port property were accounted for separately.

Finally, emissions sources and categories that were not included in the community-scale emissions inventory used for air pollution dispersion modeling include:

- residential wood burning (from fireplaces and wood stoves),
- commercial and residential cooking,
- construction activities,
- personal power boats,
- transport refrigeration units (TRUs),[11]
- lawn and home gardening equipment,
- portable combustion engines,
- small artisans or businesses that do not require District permits, and
- the Amtrak Oakland maintenance facility (located near 3rd Street/Adeline Street).

While emissions from these categories are potentially important sources of $PM_{2.5}$ and TACs on a community scale, they are either (a) difficult to analyze (e.g., for wood burning and cooking, the spatial and temporal distribution of emissions are poorly understood), or (b) deemed to be less important than similar sources that are included in the emissions inventory (e.g., emissions from lawn equipment, an off-road mobile source, are many times smaller than emissions from on-road mobile sources; emissions from personal power boats are many times smaller compared to those from ocean-going vessels). The emissions from some of these categories were estimated using top-down approaches (see **Table 2-3**), but were not further included in the air dispersion modeling analysis or risk assessment.

[11] In this analysis, for the community-scale bottom-up emissions inventory, it was assumed that none of the on-road mobile sources across all source categories (all vehicles on all road types, including Port Trucks and trucks operating at truck-related businesses) were TRUs; that is, no emissions from the refrigeration units were estimated for any portion of these fleets. However, emissions from TRUs were estimated in the top-down emissions inventory based on regional-scale data.

2.1.4 Approach

(a) Bottom-up (emissions inventory, air dispersion modeling, and analysis)

A bottom-up emissions inventory involves estimating emissions using (1) emission factors (mass of pollutant emitted per unit of activity), and (2) local activity information of the emission processes (e.g., number of events, duration of activity). Emission factors vary by source type and/or emissions process, and can depend on other factors, such as the source age, model year, control technology, load, fuel type, speed of travel, and ambient conditions, where applicable. Local activity information varies by source and by year (and by season and/or hour, depending on the source). In this analysis, activity data from 2017 (or nearest year available; **Table 2-1**) by source type was used, and then convolved with corresponding emission factors to estimate emissions. The methods used for each source category are described in **Section 2.2–2.11**.

(b) Top-down (emissions inventory only)

A top-down approach was used to develop an emissions inventory for emissions sources for which there was insufficient emissions information (quantity, physical characteristics, spatiotemporal resolution). Emissions from these categories are included in the emissions inventory, but not in subsequent dispersion modeling and risk analysis.

A top-down emissions inventory can be developed by using (1) a large-scale (e.g., county-wide) emissions inventory, and (2) spatial surrogates and/or temporal profiles, which are used to disaggregate total emissions to finer spatiotemporal scales. Top-down emissions inventories were developed for area and non-road sources (see **Table 2-3**) using CARB's regional-scale inventory for Alameda County, the California Emission Projection Analysis Model (CEPAM) 2016 State Implementation Plan (SIP) inventory[12] v1.04, and processing those emissions through SMOKE to generate gridded and speciated emissions data over the West Oakland Source Domain. Specifically:

(1) Gridding: emissions for Alameda County were allocated to model grid cells (**Figure 2-1**) using SMOKE using spatial surrogates (e.g., land use data, economic data) derived from geospatial data from the Association of Bay Area Governments (ABAG) and other data sources (Reid, 2008).

(2) Speciating: emissions of $PM_{2.5}$ and total organic gases (TOG) were speciated into individual chemical species, including TACs. SMOKE disaggregates TOG and $PM_{2.5}$ emissions into a series of model species that are used to represent atmospheric chemistry in photochemical models. Speciation profiles developed for the SAPRC-07 chemical mechanism were applied to TOG emissions from all sources, and profiles developed for the AERO6 aerosol module (AE6) were applied to $PM_{2.5}$ emissions from all sources. The SAPRC-07 mechanism treats some toxic species explicitly, including acetaldehyde, benzene, and formaldehyde. However, other TACs are lumped into model species that act as surrogates for multiple compounds with similar mass and reactivity; for the District's

[12] This inventory can be accessed online via https://www.arb.ca.gov/app/emsinv/fcemssumcat/fcemssumcat2016.php. The 2016 SIP inventory is based on a 2012 base year.

regional modeling, existing SAPRC07 speciation profiles for TOG were modified to treat additional air toxics explicitly (e.g., acrolein and 1,3-butadiene). Once the revised speciation profiles were generated, SMOKE was used to speciate criteria pollutant emissions estimates into individual TAC compounds.

Once the SMOKE processing was complete, emissions associated with grid cells in the West Oakland Source Domain were extracted from SMOKE outputs and summed to obtain the total Source Domain-wide emissions for the source categories.

Although emissions estimated using the top-down approach were not evaluated further in the air dispersion modeling and risk assessment, they help provide a comprehensive understanding of the total local emissions inventory in West Oakland. This component of the emissions inventory complements the air dispersion modeling and risk assessment results, and helps to address areas of uncertainty and future improvements for this analysis (see **Section 6**).

2.1.5 Emissions by Category

Based on the bottom-up emissions inventory, there were 85.91 tpy of $PM_{2.5}$ and 23.91 tpy of DPM emitted in 2017 in West Oakland (**Figure 2-3**). These values represent the total emissions from numerous source categories, as described in the remaining sections and in **Table 2-2**, and are used to perform the community-scale dispersion modeling (using AERMOD) and risk assessment (**Section 4**). The largest portion of $PM_{2.5}$ emissions in West Oakland arises from on-road mobile sources (~53.5%, including Port Trucks, operations at truck-related businesses, and road dust); the Port and permitted stationary sources contribute nearly equal amounts (~25.6% and ~20.8%, respectively). In contrast, most DPM emissions in West Oakland are from activity related to the Port (~66.4%).

As discussed in **Section 2.1.3**, there are several emission sources in West Oakland that could only be estimated using a top-down approach. These emissions sources were namely fuel combustion and commercial area sources, and non-road mobile sources (**Table 2-3**). Emissions from these sources were derived from regional-scale information, but were not included in the air dispersion modeling analysis or risk assessment. Of these emissions sources, only non-road mobile sources emit DPM.

The grand total emissions in West Oakland (**Figure 2-4**) can be estimated by summing the results from the bottom-up emissions inventory (**Table 2-2**) and the top-down emissions inventory (**Table 2-3**). Therefore, the grand total $PM_{2.5}$ emissions in West Oakland were estimated as 129.31 tpy, where the community-scale emissions accounts for 66.4% of these total emissions. Similarly, the grand total DPM emissions were 28.03 tpy, where 85.3% of total DPM emissions are accounted for in the community-scale analysis.

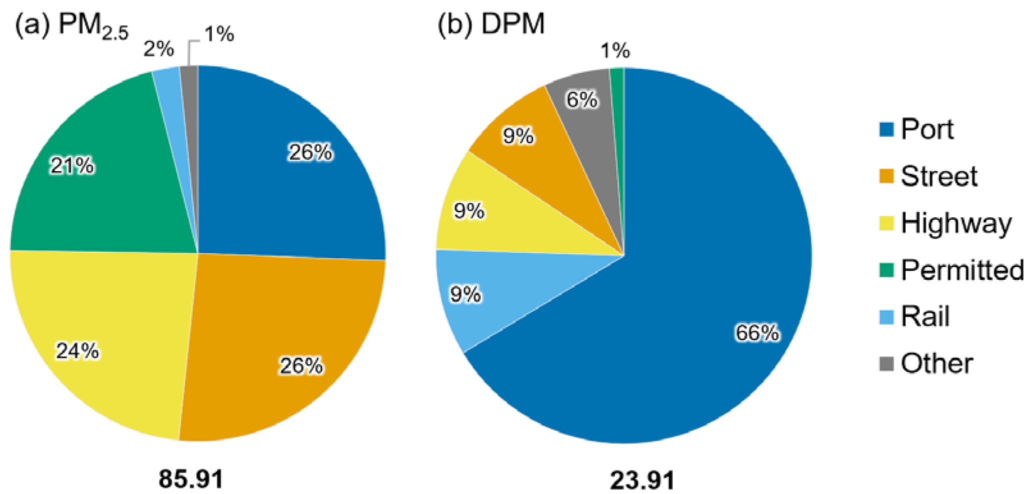

Figure 2-3. Emissions of (a) $PM_{2.5}$ and (b) DPM by source category included in the 2017 community-scale (bottom-up) West Oakland emissions inventory within the Source Domain. Emissions from Highway and Street are composed of emissions from all on-road mobile sources except Port Trucks, which are attributed to the Port category. The total emissions (tpy) of each pollutant is displayed below their respective pie chart. Source categories are further described in **Table 2-2**.

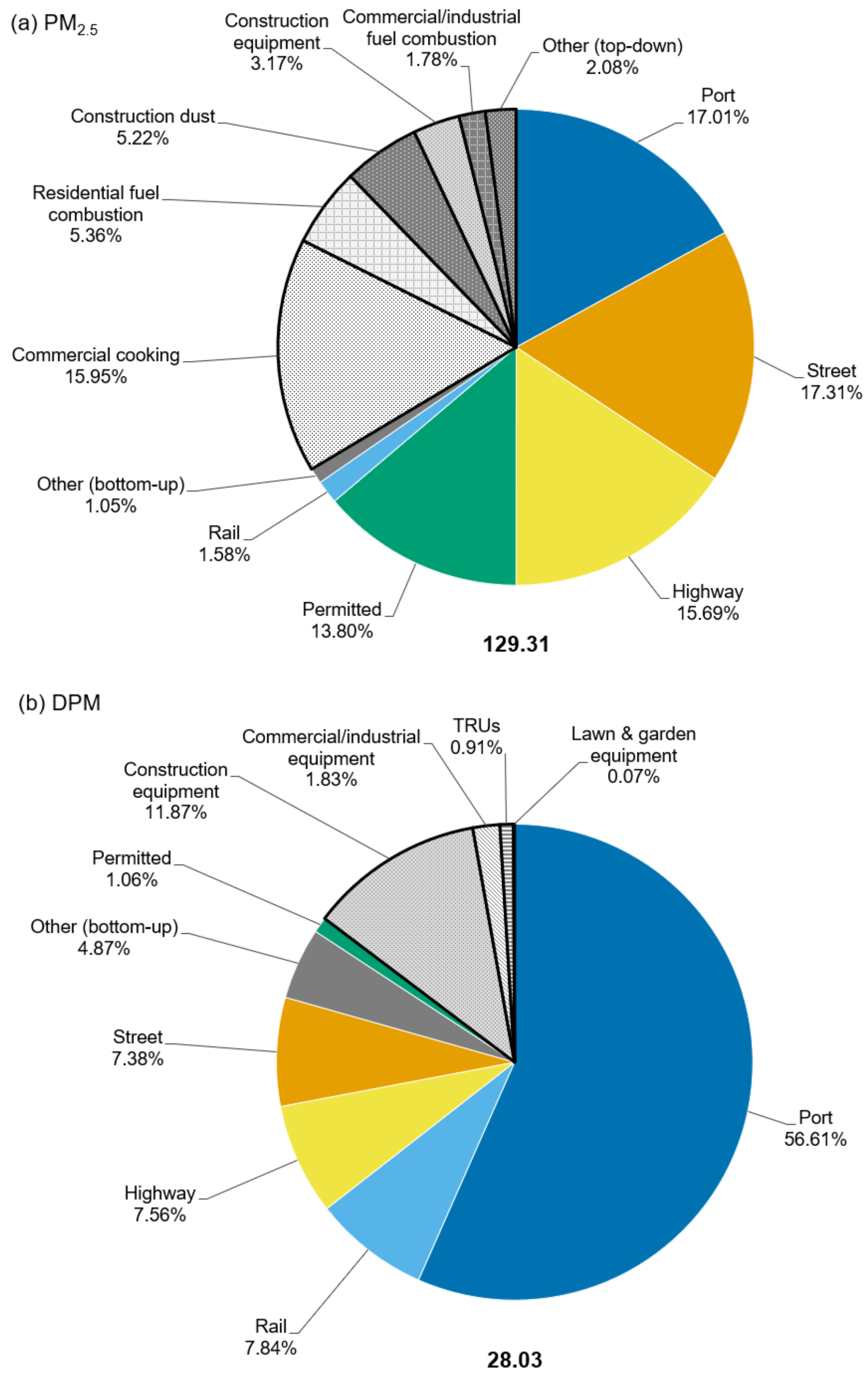

Figure 2-4. Total Emissions of (a) $PM_{2.5}$ and (b) DPM by source category in the West Oakland Source Domain. Emissions included in the community-scale emissions inventory (bottom-up) are colored, whereas and those omitted from further modeling (top-down) are greyscale. The total emissions (tpy) of each pollutant is displayed below their respective pie chart. Source categories for the community-scale emissions inventory are further described in **Table 2-2**. "Other (top-down)" emissions (panel (a) only) represents the total emissions from: commercial/industrial equipment, TRUs, lawn and garden equipment, industrial processes, and other area and non-road sources that are not otherwise indicated.

Table 2-2. Emissions by Source Category within the Source Domain. Cancer risk-weighted (CRW) emissions represent the total of DPM and other TAC emissions weighted by corresponding cancer risk (where applicable; see **Section 4.1.3**). Percentage (%) of emissions are reported as a total of the modeled inventory ("Total"). "Port Truck" emissions represent the total emissions, regardless of location (i.e., within the Port, on Highways and Surface Streets).

Source Category	$PM_{2.5}$		DPM		Cancer risk-weighted TACs	
	tpy	% of total	tpy	% of total	CRW tpy	% of total
Highway	**20.29**	**23.6**	**2.12**	**8.9**	**1,791**	**9.4**
Non-Trucks	12.22	14.2	0.19	0.8	331	1.7
LHDT	0.41	0.5	0.09	0.4	69	0.4
MHDT/HHDT	2.48	2.9	1.84	7.7	1,392	7.3
Road dust	5.17	6.0	-	-	-	-
Surface Streets	**22.38**	**26.1**	**2.07**	**8.6**	**1,692**	**8.9**
Non-Trucks	4.82	5.6	0.09	0.4	183	1.0
LHDT	0.35	0.4	0.09	0.4	76	0.4
MHDT/HHDT	2.44	2.8	1.88	7.9	1,434	7.5
Road dust	14.77	17.2	-	-	-	-
Port	**21.99**	**25.6**	**15.87**	**66.4**	**11,831**	**62.0**
OGV – maneuvering	3.94	4.6	3.84	16.1	2,859	15.0
OGV – berthing	7.83	9.1	4.31	18.0	3,212	16.8
Dredging	1.12	1.3	1.16	4.9	864	4.5
Assist Tugs	3.82	4.4	3.94	16.5	2,932	15.4
Bunkering (tugs, pumps)	0.27	0.3	0.28	1.2	209	1.1
CHE	1.59	1.9	1.58	6.6	1,177	6.2
Port Trucks	0.93	1.1	0.50	2.1	372	2.0
Road dust	2.25	2.6	-	-	-	-
Railyard – OGRE	0.07	0.1	0.08	0.3	57	0.3
Railyard – BNSF	0.17	0.2	0.18	0.8	136	0.7
Rail	**2.04**	**2.4**	**2.20**	**8.6**	**1,637**	**8.6**
Locomotives	1.02	1.2	1.09	4.5	810	4.2
Railyard – UP	1.02	1.2	1.11	4.6	826	4.3
Permitted	**17.84**	**20.8**	**0.30**	**1.2**	**1,101**	**5.8**
CA Waste (10th Street)	0.46	0.5	0.00	0.0	-	-
California Cereal	0.58	0.7	0.00	0.0	< 1	< 0.1
CASS	0.72	0.8	0.00	0.0	< 1	< 0.1
Dynegy	1.96	2.3	< 0.01	< 0.1	1	< 0.1
EBMUD	3.99	4.6	0.09	0.4	110	0.6
Pinnacle Ag Services	1.48	1.7	0.00	0.0	-	-
Schnitzer Steel – stationary	5.20	6.1	0.00	0.0	823	4.3
Sierra Pacific	0.91	1.1	0.00	0.0	-	-
Other	2.53	2.9	0.21	0.8	168	0.9
Other	**1.36**	**1.6**	**1.36**	**5.7**	**1,016**	**5.3**
Ferry/Excursion vessels	0.91	1.1	0.93	3.9	695	3.6
Schnitzer Steel – OGV	0.30	0.4	0.30	1.3	225	1.2
Schnitzer Steel – trucks	0.04	< 0.1	0.01	< 0.1	8	< 0.1
Truck-related businesses	0.11	0.1	0.12	0.5	87	0.5
Total	**85.91**	**100.0**	**23.91**	**100.0**	**19,054**	**100.0**

Table 2-3. Total emissions by Source Category within the Source Domain based on regional-scale emissions inventory (not included in community-scale bottom-up emissions inventory). Cancer risk-weighted emissions represent the total of DPM and other TAC emissions weighted by their corresponding cancer risk (see **Section 4.1.3**). Percentage (%) of emissions are reported as a total of the inventory ("Total"). "Port Truck" emissions represent the total emissions, regardless of location (i.e., within the Port, on Highways and Surface Streets).

Source Category	**$PM_{2.5}$**		**DPM**		**Cancer risk-weighted TACs**	
	tpy	**% of total**	**tpy**	**% of total**	**CRW tpy**	**% of total**
Area	**30.40**	**70.0**	**-**	**-**	**413**	**11.0**
Commercial cooking	20.63	47.5	-	-	9	0.2
Food and agriculture	-	-	-	-	13	0.4
Fuel combustion – residential	6.93	16.0	-	-	18	0.5
Fuel combustion – Commercial/industrial	2.30	5.3	-	-	17	0.5
Industrial processes	0.03	0.1	-	-	176	4.7
Solvent use	0.00	0.0	-	-	125	3.3
Consumer products	0.00	0.0	-	-	41	1.1
Other	0.50	1.2	-	-	13	0.4
Non-road	**13.00**	**30.0**	**4.12**	**100.0**	**3,358**	**89.0**
Construction – equipment	4.10	9.5	3.33	80.8	2,501	66.3
Construction – dust	6.74	15.5	-	-	-	-
Commercial/industrial equipment	1.17	2.7	0.51	12.5	436	11.6
Lawn and garden equipment	0.12	0.3	0.02	0.5	79	2.1
TRUs	0.24	0.5	0.26	6.2	192	5.1
Other	0.63	1.4	0.00	0.0	151	4.0
Total	**43.40**	**100.0**	**4.12**	**100.0**	**3,771**	**100.0**

2.2 Permitted Stationary Sources

Stationary sources of air pollution are regulated and subject to permitted conditions established by the District. These include complex sources such as metal smelting, wastewater treatment plants, and smaller facilities, such as diesel generators, gasoline dispensing facilities (GDFs, or gas stations), and boilers. The District maintains a database of its permitted sources and their associated characteristics and emissions. These emissions are determined either through direct measurement (via source tests) or by engineering calculation (based on process throughput and industry emission factors). Emission values are updated annually or bi-annually, depending on their permit cycle. Emissions from all permitted facilities are reported annually to CARB under the California Emissions Inventory Development and Reporting System (CEIDARS)[13] and, subsequently, reported to the U.S. Environmental Protection Agency (EPA) to supplement the National Emissions Inventory (NEI) database.[14] The 2017 CEIDARS report was used as the basis to assemble emissions for permitted facilities located in West Oakland and surrounding areas (encompassing zip codes 94607, 94608, 94609, 94612, 94615, and 94501). The inventory was developed for $PM_{2.5}$ and TACs, including DPM.

Quality assurance (QA) was performed and updates were made to the report to include newly permitted facilities and removed facilities that closed after 2017. Another important improvement was the addition of GDFs to the point-source inventory. Historically, emissions from GDFs have been aggregated and reported as part of county-level area totals in CEIDARS. The emissions inventory for West Oakland includes 32 GDFs geolocated with actual or permitted throughputs, which were used to estimate their emissions individually.

The District made other updates to the emissions estimates in the 2017 CEIDARS report, mainly to ensure that the latest emissions factors, source test results, and methods used to estimate emissions were incorporated. In most of these cases, the individual facility's emissions were revised by specific facility source (e.g., Custom Alloy Scrap Sales [CASS], East Bay Municipal Utility District [EBMUD], and Schnitzer Steel; **Table 2-4**). Otherwise, source specifications and associated emissions from entire source categories were updated (**Table 2-4**).

Certain categories of permitted stationary sources were not included in the community-scale emissions inventory, such as portable engines, other portable equipment, and registered restaurants,[15] since their operations are intermittent and their emissions are generally not well characterized.[16] Dry cleaners were also excluded since pollutants currently emitted from these sources do not contribute to cancer risk.[17] Other permitted stationary sources were excluded from this analysis for one of the following reasons:

[13] CEIDARS data for individual stationary sources are available through CARB's Facility Search Tool website: https://ww3.arb.ca.gov/ei/disclaim.htm. Data online may not reflect changes made by the District (e.g., **Table 2-4**).
[14] https://www.epa.gov/air-emissions-inventories.
[15] One restaurant with charbroiling operations was included since emissions information was available.
[16] These emissions sources are permitted by the District, but emissions data are not collected. Portable engines and equipment change location over time, and therefore could not be geolocated. Emissions from these sources are included in the top-down emissions inventory instead.
[17] All dry cleaners in the Source Domain used petroleum-based solvents, and therefore did not have associated cancerous TAC emissions.

Table 2-4. Updates performed to permitted stationary sources in the 2017 CEIDARS report. The name of the facility or category of the source is provided, with the plant number (P), source ID, and information regarding updates to the emission factors (EF) and/or emissions.

Name/Category	P	ID	Source Description	Updates
CASS	146	1	furnace	Emissions increased to reflect source test results.
		2	furnace	Emissions were decreased by using updated EFs.
		7	material handling	Emissions increased.
Schnitzer Steel	208	6	shredder	Emissions increased based on source test results (reported for Stack 15, identified as Source 6).
		–	–	Fugitive emissions included.
EBMUD	591	100	wet treatment process	Emissions decreased based on influent testing.
		37 – 39	standby generator	Emissions for DPM increased by using default EFs.
		52	portable emergency electric generator	Source removed from the inventory since it is no longer in use.
		–	–	Other carcinogenic pollutants associated with diesel fuel were excluded since DPM is a surrogate for all toxic compounds collectively emitted during diesel oil combustion.
Central Concrete	1253	1	aggregate piles	Emissions were decreased by using updated EFs.
		2	cement silo	Emissions were decreased by using updated EFs.
		3	conveyors	Emissions were decreased by using updated EFs.
		4	cement batcher	Emissions were decreased by using updated EFs.
Dynergy	11887	1 – 6	gas turbine	Emissions were decreased by using updated EFs.
Sierra Pacific	18268	1, 2	aggregate handling	Emissions were decreased by using updated EFs.
		3	silo	Emissions were decreased by using updated EFs.
		4	truck loading	Emissions were decreased by using updated EFs.
		5	conveyor	Emissions were decreased by using updated EFs.
standby generators and fire pumps	–	–	–	DPM was used as a surrogate to represent all carcinogenic compounds that may be emitted from combustion of diesel fuel. However, other toxic compounds were included in the analysis if the generators burned natural gas or digester gas.

- There were no associated $PM_{2.5}$ emissions and/or TAC emissions available, or these emissions could not be estimated based on data available; and/or
- There were no $PM_{2.5}$ emissions and TAC emissions were non-cancerous.

While the permitted stationary source database originally contained 430 individual sources among 205 unique facilities, only 322 sources had associated emissions of $PM_{2.5}$ or cancerous TACs among 170 unique facilities. These 322 sources were modeled in this analysis (**Table 2-5**). The final list of facilities included in this analysis is provided in **Attachment 2**. Less than half (~42%) of these sources had known release heights (required for dispersion modeling; see **Section 3.1**), and only ~34% had complete dispersion modeling parameters.[18]

Table 2-5. Summary of data completeness for permitted stationary sources in West Oakland. The final inventory reflects the number of sources modeled in this analysis that had associated emissions of $PM_{2.5}$ and/or TACs that contribute to cancer risk.

Inventory	Record type	Number of records
Original	Number of permitted stationary sources	430
	Number of unique facilities	205
Final	Number of permitted stationary sources	322
	Number of unique facilities	170
	Sources with known release heights	134
	Sources with complete dispersion modeling parameters	110

The majority of permitted stationary sources in West Oakland are located on the eastern side of the modeling domain (**Figure 2-5**). GDFs are the most evenly spatially distributed. Back-up generators are clustered in the downtown Oakland area, as many multi-story buildings (such as hotels or offices) have emergency generators. Coffee roasters are mainly located in the industrial area south of I-880, whereas cement-related facilities are located in the northwest quadrant of the West Oakland community. Other sources are associated with industrial activities and tend to be located near main arterial roadways such as 7th Street, West Grand Avenue, and Peralta Street.

[18] A complete set of release parameters for point sources includes: stack height, stack diameter, gas exit temperature, and gas exit flow rate. A complete set of release parameters for volume sources includes: stack height, and initial lateral dispersion coefficient (which can be estimated from the stack diameter).

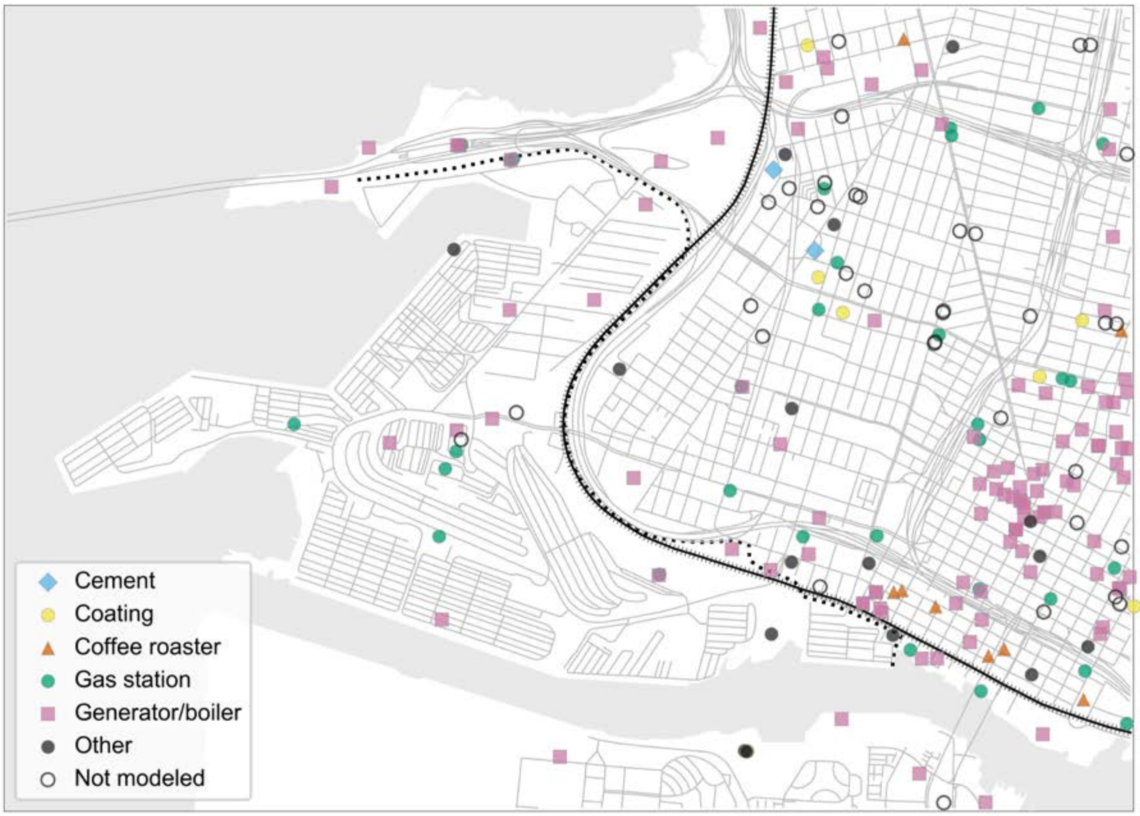

Figure 2-5. Location of permitted stationary sources in West Oakland. "Generator/boiler" indicates either a generator (primary or standby), boiler, generator and boiler, or generator and fire pump. "Other" sources include: charbroilers, cremators, electric shredders, furnaces, grain systems, microturbines, printing presses, recycling, sandblasting, smoke houses, soil vapor extraction, and turbines. Sources that were "Not modeled" were excluded because either $PM_{2.5}$ emissions were not available, or because the TACs that are emitted do not contribute to cancer risk.

2.3 On-Road Mobile Sources

The approach for developing an emissions inventory from on-road mobile sources depended on location: due to data availability, those from roadways within terminals at the Port were developed separately (by Ramboll (2018); see **Section 2.8**) from those within the rest of the Port area and West Oakland community. In this section, the process for developing a bottom-up emissions inventory for the remaining roadways is presented.

Emissions from vehicles travelling on roadways in urban environments tend to occur near *sensitive receptors*,[19] and have been shown to have a high intake fractions (ratio of inhaled to emitted pollutants; Marshall *et al.* 2005). For this analysis, a bottom-up emissions inventory of $PM_{2.5}$ and TAC pollutants was developed using annual average daily emission profiles for each roadway segment (or roadway "link"[20]) within the West Oakland Source Domain. Annual average daily emission profiles were developed by vehicle category and by day type: weekday (WD) (Monday–Friday) and weekend (WE) (Saturday–Sunday). Traffic varies significantly by day of week; typically, total daily traffic is higher on weekdays, with slower fleet average speeds, and peak traffic periods by day type may also vary due to commuting.

Pollutants are emitted from on-road mobile sources due to the following processes:

- *Operational* emissions result from the consumption and combustion of fuel or from wear of vehicle-related materials.[21] The emissions processes include:
  - Running exhaust, when pollutants are emitted from the tailpipe of the vehicle as the fuel is combusted;
  - Running loss, when fuel vapors escape from the fuel system during operation;
  - Tire wear, when PM is emitted as a result of a vehicle's tires wearing on the road surface; and
  - Brake wear, when PM is emitted as a result of wearing of brake discs as the vehicle's brakes are applied.

  In California, emission factors from these processes are typically estimated by using the EMission FACtors (EMFAC) model,[22] which is developed and maintained by CARB. In this analysis, operational on-road mobile source emission included the four processes listed above,[23] as defined in the latest version of EMFAC,[24] EMFAC2017 (v1.0.2) (California Air Resources Board 2017b).

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[19] Sensitive receptors are locations where occupants are more susceptible to adverse health effects of air pollution exposure, including schools, hospitals, daycare facilities, elderly housing, etc.

[20] A link is a section of roadway where either roadway attributes or travel activity are constant along the length of the section.

[21] In this analysis, no vehicles were treated as TRUs; that is, emissions from refrigeration units on trucks (Port Trucks or non-Port Trucks) were not included.

[22] Additional information on EMFAC and mobile source emissions estimates are available at https://ww3.arb.ca.gov/msei/msei.htm.

[23] Other emission processes from on-road mobile sources, such as from start exhaust, resting evaporative loss, and others (see California Air Resources Board 2017b), were not included in the bottom-up inventory; for Alameda County, these emissions are generally a small portion of the total emissions for $PM_{2.5}$ and DPM.

[24] EMFAC2017 is a trip-based mobile source emissions model. As such, running exhaust emission factors also account for idling events (and other processes, such as crankcase exhaust) during normal vehicle operation (California Air Resources Board 2015), such as a vehicle idling while queuing at an intersection for a limited amount of time. Therefore, idling exhaust emissions were not explicitly calculated for on-road mobile sources. Extended idling events of heavy-duty vehicles were accounted for separately (see **Section 2.4**).

- *Re-entrained road dust* emissions are particulate matter from resuspended road surface material (dust) that is entrained by vehicles traveling on roads. Currently, road dust emission factors are estimated following CARB's methodology for paved road dust (California Air Resources Board 2016), which is based on the EPA Air Pollution (AP) report *AP-42 Compilation of Air Pollutant Emissions Factors, Volume I* (or simply "AP-42") Chapter 13.2.1 Paved Roads (U.S. Environmental Protection Agency 2011). Entrained road dust on paved roadways can be significant source of $PM_{2.5}$, especially as the relative proportion of emissions from other vehicle processes decreases over time (Reid *et al.* 2016).

Bottom-up emissions inventories from on-road mobile sources can be calculated at different levels of aggregation. For example, emissions may be calculated by individual vehicle types (e.g., passenger car, motorcycles), or by vehicle categories (e.g., Non-Trucks, which includes passenger cars and motorcycles and other non-truck vehicles; **Table 2-6**). EMFAC2017 groups all vehicle classes into three categories: Non-Truck, Truck 1, and Truck 2.

Table 2-6. Emission source and vehicle categories from on-road mobile sources. Vehicle categories are generally based on gross vehicle weight rating (GVWR) and EMFAC2017 (see California Air Resources Board 2017a). Non-POAK-Truck 2 is abbreviated as NPT2.

Emissions Category	Vehicle Category	Description/Vehicle Types
Operational	Non-Truck	Passenger cars, passenger trucks, medium-duty trucks (GVWR ≤ 8,500 lb), buses, motorcycles, motor homes, motor coaches.
	Truck 1	Light-Heavy Duty Trucks (LHDT) (GVWR 8,501–14,000 lbs)
	POAK	Heavy-Heavy Duty Diesel Drayage Truck in Bay Area (GVWR > 33,000 lb) (referred to as "Port Trucks" or "drayage trucks" here).
	NPT2	Medium-Heavy Duty Trucks (MHDT) (GVWR 14,001–33,000 lb) and Heavy-Heavy Duty Trucks (HHDT) (GVWR > 33,000 lb), excluding Port Trucks.
Road dust	All	Entrained road dust (PM_{10} and $PM_{2.5}$) on paved roads.

In this analysis, operational emissions were namely estimated by vehicle category (**Table 2-6**) based on the vehicle categorization EMFAC2017, as well as analysis needs (so that potential mitigation measures can be applied to specific source categories within the source apportionment). The EMFAC2017 default Non-Truck and Truck 1 results were used, but the default Truck 2 category was further divided into two categories: Port Trucks (POAK),[25] and the remaining EMFAC2017 Truck 2 vehicles (Non-POAK-Truck 2).[26] This was done because Port Trucks have historically been significant source of DPM in West Oakland (California Air Resources Board 2008a); however, POAK emission factors in EMFAC2017 suggest a much cleaner Port Truck fleet because of CARB's Drayage Truck Regulation (California Air Resources

[25] In this analysis, the terms "Port Trucks" and "Drayage Trucks" are interchangeable. Port Trucks refer to those vehicles whose engines are subject to CARB's Drayage Truck Regulation (California Air Resources Board 2011b), regardless of vehicle activity location (Port terminal, railyard, business; within terminals, or between terminals and other destinations), or activity type (short-hauling or otherwise).

[26] Default EMFAC2017 fleet information was used for each of these categories, which includes an inter-category fleet mix, and model year and vehicle age distributions.

Board 2011b). Finally, the total of all truck-related categories – Truck 1, POAK, and Non-POAK-Truck 2 – may be referred to collectively as "Trucks".

To develop a bottom-up link-level emissions inventory for on-road mobile sources, the data needed are (1) roadway attributes, (2) vehicle travel activity, and (3) corresponding emissions factors (by vehicle emissions process and category). In this analysis, the majority of the roadway attributes and travel activity data were purchased from Citilabs (Streetlytics platform).[27] A set of shapefiles containing the geographic location, travel activity (volume and speed), and roadways attributes of roadway segments in Alameda County was obtained for 2016 by hour of day for four seasons and four day types (Monday–Thursday, Friday, Saturday, and Sunday). To use this dataset to develop an emissions inventory and to support AERMOD dispersion modeling:

(1) The roadway network was clipped to the Source Domain; some roadway segments were shortened and their lengths recalculated, while other segments had to be manually extended to meet the edge of the domain (namely, the roadway segments representing the San Francisco-Oakland Bay Bridge).
(2) Roadway segments were excluded in Port terminal areas.
(3) Corresponding roadway segments that represented the total 2-way directional traffic were merged, so that the resulting line geometry represented the approximate centerline of the roadway.[28] As a result, there were 6,861 roadway segments in the West Oakland Source Domain.
(4) By performing (3), the number of lanes and hourly traffic volume in both directions were added, and the hourly traffic speeds were averaged (weighted by hourly volume).
(5) The data was then aggregated into two day types: WD, representing travel activity from Monday–Friday, and WE, representing travel activity from Saturday-Sunday. These data were averaged across all seasons to obtain an annual average diurnal profiles.

A description of the parameters from Citilabs and other data sources used to develop a vehicle-type (Non-Truck/Truck) and day-type (WD/WE) specific emissions inventory are described in the following sections.

2.3.1 Roadway Attributes

The geometry of each roadway link is used to perform AERMOD dispersion modeling, while the associated roadway attributes are used to estimate emissions from on-road mobile sources. The roadway attributes required include: roadway length, road type, and number of lanes. A description of these attributes and how they are used to support developing the emissions inventory and/or dispersion modeling are provided in **Table 2-7**.

The road type assigned to each roadway segment was mainly based on the roadway functional class provided by Citilabs (based on HERE), which is defined as "a hierarchical network [index] used to determine a logical and efficient route for a traveler."[29] These classes were matched to corresponding U.S. Federal Highway Administration (FHWA) Road Types, which are based on

[27] http://www.citilabs.com/.
[28] The District did not QA the location of the roadway segment centerlines.
[29] See http://marketing.citilabs.com/hubfs/Here_Attributes.pdf (accessed February 2019).

level of service and are used to determine roadway widths, and CARB Road Types, which are based on "anticipated usage, modes of usage, and silt loading potential" (California Air Resources Board 2016) and are used to determine roadway surface silt loading factors (**Table 2-8**). Because of the mismatch between roadway classification systems, freeway on- and off-ramps, which are assigned to multiple functional classes, can then be assigned to numerous CARB and FHWA road types; for simplicity, the District did not adjust these assignments.[30] Additionally, roadway segments were also assigned to road category ("Highway" and "Surface Street"; **Table 2-8**) which were created to align with available data and the source apportionment approach.

Table 2-7. Roadway attributes and associated data sources used for estimate emissions from on-road mobile sources.

Parameter	Purpose	Reference/ Data Source
Roadway Length	Determine (a) geographic locations of roadways (used in AERMOD dispersion modeling; **Section 3.4.3**), and (b) calculate vehicle miles traveled (VMT) used in estimating emissions.	Citilabs (updated by the District)
Road Type	Determine (a) roadway width (used in AERMOD dispersion modeling; **Section 3.4.3**), and (b) silt loading (to calculate road dust emissions).	Citilabs, California Air Resources Board (2016)
Number of Lanes	Determine total width of roadway (used in AERMOD dispersion modeling; **Section 3.4.3**).	Citilabs (updated by the District)

Table 2-8. Cross-reference of road type classification schemes used in this analysis. Functional Class were obtained from Citilabs and mapped to CARB Road Type (based on California Air Resources Board (2016), used to determine silt loading factors for estimating road dust emissions), FHWA Road Type (based on FHWA and American Association of State Highway and Transportation Officials (2018), used to determine roadway width), and Road Category (used in this analysis for source apportionment).

Functional Class	CARB Road Type	FHWA Road Type	Road Category
2 - Major Highways	Freeway	Freeway	Highway
3 - Minor Highways	Major/Collector	Arterial	Surface Street
4 - Minor Streets	Major/Collector	Arterial	Surface Street
5 - Local Roads	Local	Local	Surface Street

Finally, truck route type was assigned to each roadway segment based on information obtained from the City of Oakland:[31] (1) prohibited truck routes, (2) major truck routes, or (3) neither

[30] This results in a conservative estimate for road dust emissions; on- and off-ramps are then assigned to arterial and local roads, which typically have more dust (higher silt loading factors) than freeways.

[31] See City of Oakland Truck Routes and Prohibited Streets: https://www.oaklandca.gov/resources/truck-routes-and-prohibited-streets.

(**Figure 2-6**). These route designations were used to determine fleet mix information (see **Section 2.3.2(b)**).

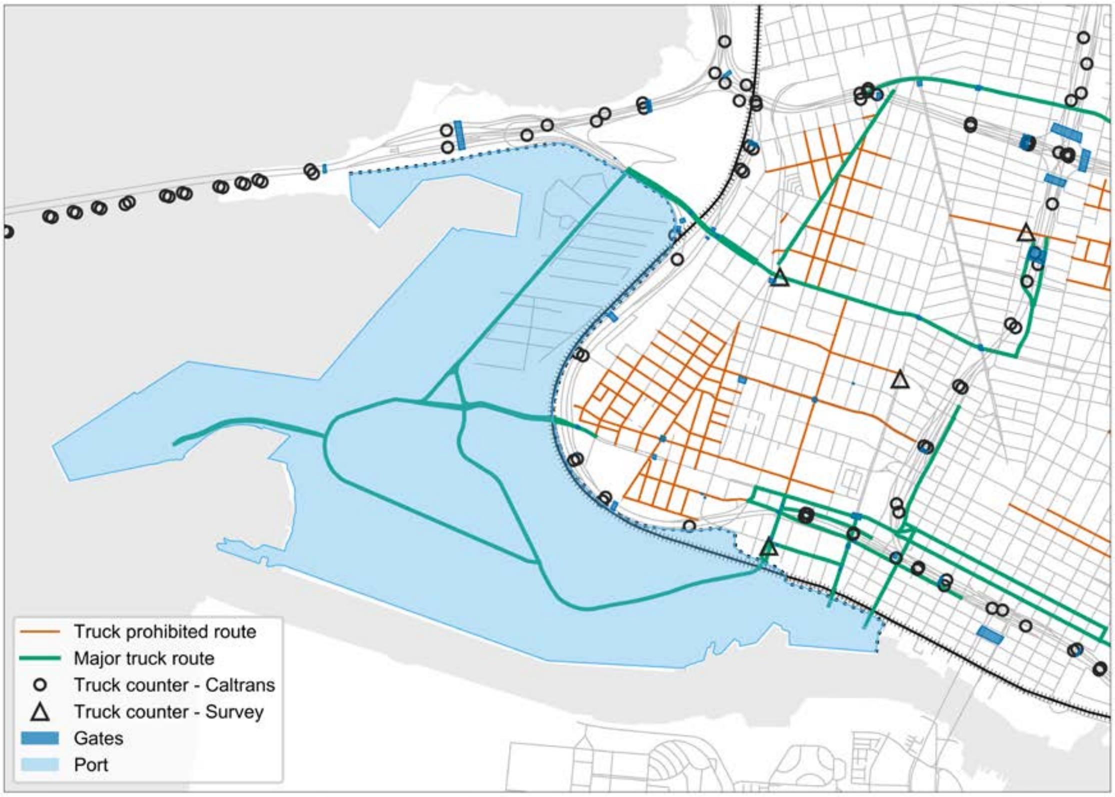

Figure 2-6. Roadway network and data sources used to develop the emissions inventory for on-road mobile sources. The roadways (solid lines, provided by Citilabs), traffic counters (open symbols), Port boundary (dashed line), and gates (blue polygons, used in the StreetLight InSight platform) are plotted. Caltrans truck counters may appear off of the Bay Bridge because the bridge was reconstructed (completed ~2013) and the location of the counters were not updated in PeMS. Only roadway segments modeled as volume sources in AERMOD are plotted (i.e., some roadways in the Port terminal areas are not displayed, since they were accounted for in the Port emissions inventory; see **Section 2.8**).

For the resulting 2-way merged roadway network, QA was performed on the number of lanes only for roadways where (a) there was one lane in either direction, and (b) the total 2-way AADT ≥ 5000.[32] The District updated the number of lanes of 274 roadway segments (4% of the roadway dataset). If the number of lanes for a segment was not a whole number (integer), the value was rounded down (e.g., 4.5 lanes was rounded to 4 lanes), as the fractional lane often corresponded to roadway sections designated for street parking.

[32] According to the District's current California Environmental Quality Act guidelines, a roadway with AADT < 10,000 is likely not a significant source. In this analysis, AADT ≥ 5,000 was used to determine which roadways should be reviewed, to be conservative (Bay Area Air Quality Management District 2017).

2.3.2 Travel Activity

Vehicle travel activity data characterizes the type of fleet and how that fleet travels on a roadway. Emissions are estimated based on these parameters, which include: volume, speed, fleet mix, and fleet average vehicle weight (**Table 2-9**). These parameters are further described below.

Table 2-9. Travel activity parameters and associated data sources used for estimate emissions from on-road mobile sources. Parameters can vary hourly and by roadway link.

Parameter	Description	Purpose	Reference/ Data Source
Volume	Average total traffic fleet volume.	Calculate VMT and VHT, which are used to estimate emissions from all processes (operational and road dust).	Citilabs
Speed	Average total traffic fleet speed.	(a) Estimate running exhaust emissions (emission factors are speed-dependent), and (b) estimate VHT.	Citilabs
Fleet Mix	Composition of vehicle fleet (i.e., volume fraction for each vehicle category).	Apportion fleet-total VMT to each vehicle category.	StreetLight, Caltrans Truck Traffic Volumes, Caltrans PeMS, Bay Area Air Quality Management District (2009)
Fleet average vehicle weight	Volume-weighted average weight of vehicle in fleet	Estimate road dust emission factors.	CT-EMFAC2017

(a) Volume and Speed

For each link, traffic volume and speed can be used to calculate:

- Vehicle miles travelled (VMT): the mileage of all vehicles traveling on a link over a specific period (e.g., hourly, daily). That is, VMT is the product of volume (unitless) and link length (mi). VMT is used to estimate emissions that are based on gram-per-mile (g/mi) emission factors (running exhaust, tire wear, brake wear, road dust).
- Vehicle hours traveled (VHT): the travel time of all vehicles traveling on a link over a specific period (e.g., hourly, daily). VHT is estimated by dividing VMT (mi) by speed (mph). VHT is used to estimate emissions due to running loss.

Hourly total fleet volume and speed data by roadway link and day type were obtained from Citilabs. Due to availability, this data was based on 2016 travel activity; to create a 2017 base year activity data set, the District then adjusted the total volumes (and therefore VMT and VHT) by a growth factor (0.6%) derived from the Alameda County VMT information in EMFAC2017. For each roadway link, hourly VMT and VHT were calculated, and VMT was then allocated to vehicle types (**Table 2-6**) by using fleet mix information (see below).

(b) Fleet Mix

The annual average fleet mix by WD and WE were developed in two steps: (1) by deriving volume-based fleet mix fractions of Non-Truck, Truck 1 and Truck 2, and then (2) by splitting the Truck 2 fraction into POAK and Non-POAK-Truck 2. Due to data availability, fleet mix information for step (1) was developed by road category, as follows:

- For Highways: the fractions of Non-Truck, Truck 1 and Truck 2 were first derived from the 2016 Truck Traffic Volumes (Truck AADT) from the California Department of Transportation (Caltrans).[33] The dataset contains traffic counts by axles at specific locations on freeways. Counts were then be allocated to Non-Truck, Truck 1, and Truck 2. However, given the limited spatial coverage of the counters (e.g., there are no counters on I-880), a second dataset was compiled to further develop fleet mix information, based on Caltrans Performance Measurement System (PeMS)[34] counters. PeMS data contains total traffic flow and truck flow at specific locations on freeways. Data was obtained for 2016 and used to derive total truck fractions[35] along remaining highway roadway segments. As PeMS truck flow represents the total traffic flow of all Trucks, the truck fraction from PeMS was split into fractions of Truck 1 and Truck 2 based on VMT from EMFAC2017 (for 2017 Alameda County) by truck category. The resulting truck fractions were assigned to highway links based on their spatial proximity to Caltrans Truck Traffic counters or Caltrans PeMS counters (**Figure 2-6**).

- For Surface Streets: the fractions of Non-Truck, Truck 1 and Truck 2 were derived based on traffic axle counts at four auto-counters located on surface streets from the 2009 West Oakland Truck Survey (Bay Area Air Quality Management District 2009; **Figure 2-6**, **Table 2-10**). The fractions were assigned to surface street links based on their spatial proximity to the counters. If a surface street link was a major or prohibited truck route, then the nearest counter of the same route type was used; this prevented assigning higher truck fractions to surface streets that were truck-prohibited routes. For roadway links within Port area, fleet mix fractions were derived from the counter at the Port access point (3rd Street/Adeline Street) only.

Table 2-10. Description of location of automatic traffic counters from the 2009 West Oakland Truck Survey (Bay Area Air Quality Management District 2009).

Automatic counter location	Total traffic level	Route description
3rd Street/Adeline Street	High	Major truck route (3rd Street)
West Grand Avenue/Mandela Parkway	High	Major truck route (West Grand Avenue)
18th Street/Market Street	Moderate	Truck-prohibited route (18th Street)
30th Street/Martin Luther King Drive	Low	Truck-prohibited route (30th Street)

[33] Available from http://www.dot.ca.gov/hq/tsip/gis/datalibrary/Metadata/TruckAADT.html (downloaded February 2019).
[34] http://pems.dot.ca.gov/.
[35] All truck flow (volume) data in the PeMS data used in this analysis was marked as "imputed." This means that the data are estimated from other available parameters from the traffic counter and/or other surrounding traffic counters in the PeMS network (see http://pems.dot.ca.gov/?dnode=Help&content=help_calc#truck).

Generally, the fleet mix by roadway link resulted in a higher proportion of Trucks on major Truck routes and some major arterials in West Oakland, and a lower proportion of Trucks on truck-prohibited routes and local roads (**Figure 2-7**). Notably, using this procedure resulted in a high Truck fraction in near the Port entrance at 3rd Street/Adeline Street and in the surrounding neighborhood, especially on weekdays.

In step (2), the fleet fraction of Truck 2 was split into POAK and Non-POAK-Truck 2 categories. At the time of this analysis, no traffic counts of Port Trucks from traffic measurements or travel models were readily available. Instead, the POAK fraction of Truck 2 was derived from origin-destination (O-D) analyses using the StreetLight InSight platform.[36] The platform simulates trips from Truck 2 vehicles (commercial vehicles) between origin and destination zones based on data from GPS navigation systems installed on the vehicles. A zone can be any size, so long as the geographic extents intersect a roadway. When a zone is drawn as a narrow polygon perpendicular to a roadway, it is referred to as a “gate.” An O-D analysis generates a traffic “index” which quantifies the number of trips between an origin and a destination zone, as well as all trips in each zone independent of trip start or end locations.

In this analysis, it was assumed that all trips originating or ending at the Port were from Port Trucks, which are subject to CARB’s Drayage Truck Regulation[37] (i.e., they are POAK vehicles). The entire Port area was designated as a zone, in addition to 49 gates, which were located on highways and surface streets to account for different road types and traffic conditions (including 21 on freeways, 4 on on-/off-ramps, and 24 on surface streets; **Figure 2-6**). The O-D analyses were conducted for each Port and gate pair. The traffic index between the Port and gate was considered as surrogate of POAK volume, while the traffic index of all trips at gate was considered as surrogate of total Truck 2 volume. Therefore, the fraction of POAK within the Truck 2 category was equal to the POAK traffic index divided by the Truck 2 traffic index. This fraction was assigned to each roadway link based on the spatial proximity of the link to a gate, and then multiplied by the Truck 2 fraction (step (1)) to estimate the fraction of POAK in the entire vehicle fleet. The fraction of Non-POAK-Truck 2 was calculated as the remaining fraction of Truck 2 vehicles. From this, it was estimated that > 75% of the Truck 2 fleet on roadways near or in the Port was composed of POAK vehicles (**Figure 2-8**).

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[36] https://www.streetlightdata.com/.

[37] CARB adopted the Drayage Truck Regulation in 2011 (approved in 2007, changes approved and adopted in 2010; California Air Resources Board 2011b), which requires all Port Trucks to meet or exceed emissions standards for 2007 model year engines. The implementation of the rule has effectively reduced emissions from Port Trucks (e.g., Harley *et al.* 2014).

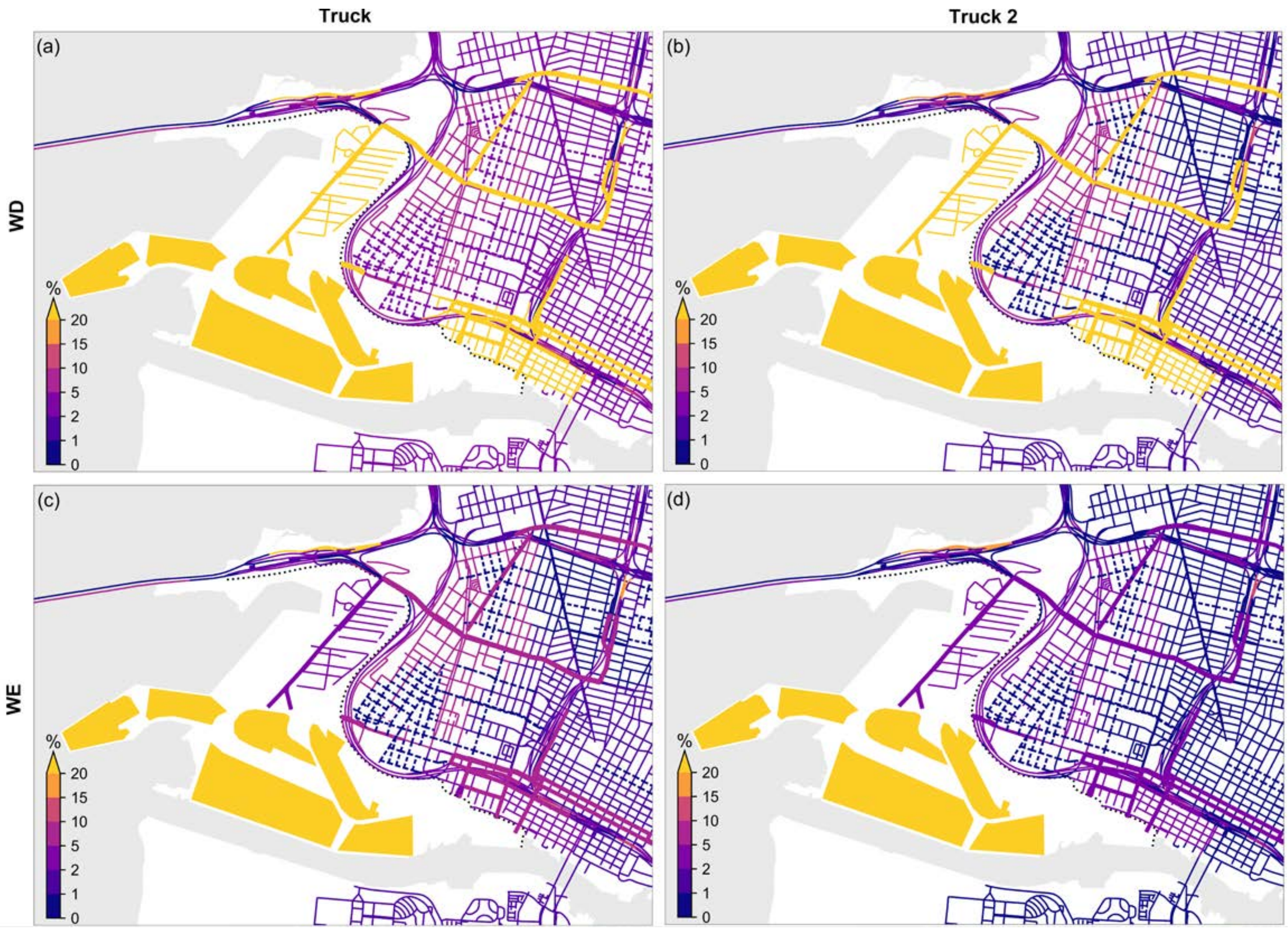

Figure 2-7. Total daily average fleet mix by roadway link in West Oakland for total (a, c) Trucks and (b, d) Truck 2 vehicles by day type (WD, WE). Fleet mix (%) is displayed by roadway (solid line), major truck route (thick solid line), and truck-prohibited route (dashed line). Total fleet volume varies by roadway link. Only roadway segments modeled as volume sources in AERMOD are plotted (*c.f.* **Figure 2-1**); emissions from on-road mobile sources operating within the Port are plotted as polygons.

Figure 2-8. As in **Figure 2-7**, but for total daily average POAK percentage of Truck 2 fleet on weekdays.

(c) Fleet Average Vehicle Weight

For each link, average vehicle weight of the vehicle fleet is required to estimate emission factors for road dust. The fleet average vehicle weight is calculated as follows, where subscripts denote vehicle aggregation levels (vehicle type, VT, or vehicle category, VC, where $x \epsilon \{VT, VC\}$):

$$F_{VT} = \frac{VMT_{VT}}{VMT_{VC}}$$

$$F_{VC} = \frac{VMT_{VC}}{VMT_{fleet}}$$

$$W_{VC} = \sum_{VT} W_{VT} \cdot F_{VT}$$

$$W_{fleet} = \sum_{VC} W_{VC} \cdot F_{VC}$$

where

F_x = VMT-based weighting factor for the vehicle type or category (unitless)
VMT_x = VMT of all vehicles at vehicle aggregation level x (mi)
W_x = weight of vehicle at vehicle aggregation level x (tons)

Therefore, the fleet average vehicle weight is simply the weighted-sum of all vehicle weights. Vehicle weights were taken from the Caltrans-EMFAC2017 (CT-EMFAC2017) tool[38] (California Department of Transportation 2019; using the `Vehicle` table in the underlying CT-EMFAC2017 database).

2.3.3 Emission Factors

Emission factors by emission process were developed for $PM_{2.5}$ and TACs by vehicle category.

(a) Operational Emission Factors

Emission factors from on-road mobile sources are typically estimated using the EMFAC2017, using default fleet mix within vehicle categories. As EMFAC2017 does not generate emission factors for TACs, the District leveraged the CT-EMFAC2017, which generates emission factors for $PM_{2.5}$ and mobile source air toxics (MSATs).[39] CT-EMFAC2017 is based on emission factors and activity data from EMFAC2017, while emission factors for MSATs are based on EMFAC2017 data and chemical speciation profiles from CARB and EPA.

CT-EMFAC2017 can generate emission factors for Non-Truck, Truck 1, and Truck 2 categories. Annual average emission factors were obtained for 2017 Alameda County. The emission factors for POAK and Non-POAK-Truck 2 categories were then derived in the following manner:

- For POAK: $PM_{2.5}$ emission factors were obtained directly from CARB's EMFAC2017 web database.[40] A chemical speciation profile for HHDV vehicles from CARB[41] was applied to total organic gases (TOG) emission factors from the EMFAC2017 web database to derive emission factors for each TAC pollutant.

- For Non-POAK-Truck 2: The emission factor of all Truck 2 vehicles can be expressed as the weighted sum of the emission factors from POAK and Non-POAK-Truck 2:

$$EF_{T2} = (F_{POAK} \cdot EF_{POAK}) + (F_{NPT2} \cdot EF_{NPT2})$$

where EF_x are emission factors for a given pollutant, and F_x are the fleet mix fractions within the Truck 2 category. Then, $PM_{2.5}$ and TAC emission factors can be back-calculated for POAK emission factors (from above), Truck 2 emission factors (from CT-EMFAC2017), and VMT-based vehicle category weighting factors (from the CT-EMFAC2017 database) as follows:

$$F_{POAK} = 1 - F_{NPT2}$$

[38] http://www.dot.ca.gov/env/air/ctemfac-license.html

[39] MSATs in CT-EMFAC2017 include the nine priority pollutants identified by the FHWA within the National Environmental Policy Act (NEPA): 1,3-butadiene, acetaldehyde, acrolein, benzene, DPM, ethylbenzene, formaldehyde, naphthalene, and polycyclic organic matter (POM) (Biondi, 2016). In this analysis, the emissions of these TACs were estimated except for POM (which is a group of compounds and therefore does not have a single associated toxicity value).

[40] https://www.arb.ca.gov/emfac/2017/.

[41] https://www.arb.ca.gov/ei/speciate/speciate.htm.

$$F_{NPT2} = \frac{VMT_{NPT2}}{VMT_{T2}}$$

$$EF_{NPT2} = \frac{1}{F_{NPT2}} [EF_{T2} - (EF_{POAK} \cdot F_{POAK})]$$

This back-calculation approach can be applied to derive emission factors from all emission processes, including emission factors for running loss; while the associated activity is VHT, the VHT-based weighting factor will be equivalent the VMT-based weighting factor (since the travel data used from Citilabs does not distinguish speed by vehicle category).

(b) Road Dust Emission Factors

In this analysis, road dust emission factors were estimated for each roadway link following California Air Resources Board (2016), reproduced below:

$$EF_{fleet} = k \cdot sL^{0.91} \cdot W_{fleet}{}^{1.02} \cdot \left(1 - \frac{P}{4N}\right)$$

where

EF_{RD} = road dust emission factor (g/mi)
k = particle size multiplier (0.00033 lb/VMT for $PM_{2.5}$)
sL = road surface silt loading factor, based on CARB road type (**Table 2-11**) (g/m^2)
W_{fleet} = fleet average vehicle weight (ton) (**Section 2.3.2(c)**)
P = number of "wet" (precipitation ≥ 0.01 in) days in averaging period (days) ($P = 41$ days for Alameda County)
N = total number of days in averaging period (days) ($N = 365$ days for annual analysis)

Table 2-11. Road surface silt loading factor (sL) by road type used in CARB method to estimate emission factors from road dust emissions. Values taken from California Air Resources Board (2016).

CARB Road Type	sL (g/m^2)
Freeway	0.015
Major/Collector	0.032
Local	0.320

2.3.4 Emissions

For operational emissions from on-road mobile sources, annual average daily emissions were estimated by roadway link by vehicle category (Non-Truck, Truck 1, Non-POAK-Truck 2, POAK), and day type (WD, WE), for each emissions process:

- For running exhaust, tire wear, and brake wear:

$$E_{VC} = \sum_{h=1}^{24} VMT(h)_{VC} \cdot EF(s(h))_{VC}$$

  where emissions (E, in g) are summed over all hours (h) of the day (and VMT is a function of hour of day, and for running exhaust, the emission factor is a function of the speed by hour of day).

- For running loss:

$$E_{VC} = \sum_{h=1}^{24} VHT(h)_{VC} \cdot EF_{VC}$$

For road dust emissions, the total fleet annual average daily $PM_{2.5}$ emissions were estimated by roadway link by day type (WD, WE):

$$E_{fleet} = \sum_{h=1}^{24} VMT(h)_{fleet} \cdot EF_{fleet}$$

For each link, the emissions from all processes were summed. The result is an annual average daily emissions inventory by pollutant, by day type, and by vehicle category. The emissions were then converted to emission rates (g/s) with corresponding diurnal activity profiles (see **Section 3.4.3**). The total emissions by vehicle category are reported in **Table 2-2**.

2.4 Truck-Related Businesses

Numerous "truck-related businesses" are located in West Oakland. These businesses offer Port services, such as truck scales and delivery, or operate a fleet of trucks to support their own business activities. Emissions from idling trucks within the business premises were estimated and included in the emissions inventory; operational and road dust emissions from these trucks are already accounted for as part of on-road mobile source emissions inventory (**Section 2.3**). If the business had TRUs in their fleet, emissions estimates from the refrigeration units on the trucks were not included.

2.4.1 Surveyed Businesses

The District worked with Environmental Defense Fund (EDF) and the Oakland Planning Department to develop a comprehensive list of businesses that may operate a fleet of trucks in West Oakland. The District expanded the initial business list from the 2009 West Oakland Truck Survey (Bay Area Air Quality Management District 2009) to include businesses that were selfregistered on the West Oakland Works website[42] and from other field studies performed by EDF. To determine the current level of truck activity at each business, the District sent surveys to the businesses to determine the average number of truck visits per day and the number of loading docks. The District received responses from 52 of 91 businesses surveyed.[43] Responses from the 2009 West Oakland Truck Survey were used for businesses where the District did not receive a response. When no information was available, a default of either 5 or 10 trucks per day was used, based on the survey response received from similar business types. Businesses were then removed from the emissions inventory if:

- Emissions from trucks associated with a business were already accounted for under another source category (i.e., trucks operating at terminals or railyards);
- There were ≤ 3 trucks per day at the business; or
- The business did not have an active truck fleet (e.g., truck brokers, marketing companies).

See **Attachment 3** for a list of truck-related businesses and truck fleet sizes.[44]

Because businesses were not asked to provide truck fleet mix information in the surveys, the District estimated a default truck fleet based on the results from the 2009 West Oakland Truck Survey (**Table 2-12**), which includes heavy heavy-duty trucks (HHDT), medium heavy-duty trucks (MHDT), light heavy-duty trucks (LHDT), and Port Trucks (T7 Port of Oakland drayage trucks; T7 POAK). This default was applied to all businesses except for those where the fleet was clearly not representative of the business operation type; for example, all vehicles were assumed to be buses at the Greyhound Bus Terminal, and all vehicles were assumed to be MHDVs at shredding facilities. Fleet mix type by business are also reported in **Attachment 3**.

Table 2-12. Default fleet mix used for truck-related businesses, as derived from the 2009 West Oakland Truck Survey (Bay Area Air Quality Management District 2009).

Truck category	Percentage of fleet (%)
HHDT	26.5
MHDT	13.5
LHDT	10.0
T7 POAK	50.0

CARB's commercial motor vehicle idling regulation states that all heavy-duty vehicles in California with GVRW ≥ 10,000 lb are prohibited from idling longer than five minutes (California Air Resources Board 2004). However, the regulation allows for longer idling times due to traffic congestion, inspection or service, operating a take-off device, adverse weather conditions, mechanical failure, passenger loading, queuing, or if the engine meets the optional clean idle certification standard. To be conservative, the District assumed that there was 15 min of idling per truck trip.

[42] http://www.westoaklandworks.com/our-directory/.
[43] District staff visited seven of these businesses in person.
[44] For most truck-related businesses, truck fleet size was used as a surrogate for truck trips.

Emission factors for diesel-fueled truck categories[45] were obtained from EMFAC2017 using a 2017 base year for Alameda County. The emissions were then estimated from each business using the following equation:

$$E_i = N \cdot I \cdot EF_i$$

where

E_i	=	emissions of pollutant i (g)
EF_i	=	emission factor of pollutant i (g/h)
N	=	number of vehicles
I	=	idling time (h) ($I = 0.25$ h)

To calculate the annual emissions, the District assumed that truck-related businesses operated 6 days per week (312 days per year).

2.4.2 Schnitzer Steel

A separate emission inventory for trucking operations was developed for Schnitzer Steel based on its permitted operations. Products are transported by trucks to bulk carriers which dock at the Schnitzer Steel deep-water terminal.

The District currently limits the number of trucks that can operate at Schnitzer Steel.[46] There are currently no restrictions on the type of trucks that can operate at Schnitzer Steel; therefore, for this assessment, the District assumed that all trucks were diesel fuel MHDTs and HHDTs (modeled as either Non-POAK-Truck 2 or heavy-heavy duty diesel single unit truck, T7 Single[47]). Due data availability, the vehicle category associated with the emission factors used varied depending on the emission process (**Table 2-13**).

Unlike for the other truck-related businesses in the West Oakland emissions inventory, because of the size and characteristics of the property, emissions from trucks operating at Schnitzer Steel included driving-related emissions. Emissions due to running exhaust, idle exhaust, and tire wear, brake wear and road dust (for PM) were calculated for Schnitzer Steel using the following assumptions: (1) each truck idled for 15 min on the property (to be conservative), (2) each truck drove 800 m on the property (two-times the approximate length of the property, from the entrance to near the ship berth), (3) trucks drove at 10 mph on the property (consistent with the average truck speed of trucks driving within terminals at the Port; Ramboll 2018), (4) trucks drove on unpaved roads, which were modeled as Local Roads for the purposes of calculating re-entrained road dust (**Table 2-11**). Emissions were calculated as in **Section 2.3.4**, and are summarized in **Table 2-13**.

[45] From EMFAC2017, emission factors for LHDT are based on that of LHDT1 (which are highest among all LHDTs), and emission factors for HHDTs are based on the composite of emission factors for all T7 vehicles except T7 POAK (Port Trucks).
[46] Schnitzer Steel's current permit is for 63,875 truck trips per year.
[47] A T7 Single vehicle usually has the highest emission factors of all T7 vehicles in EMFAC2017; this vehicle type was used to provide a conservative estimate of emissions.

Table 2-13. Emission estimates from trucks operating at Schnitzer Steel in 2017 by emission process. The Fleet indicates the EMFAC2017-based fleet from which the emission factor was derived. A hyphen (–) indicates that emissions from the emission process are not applicable.

		Emissions (tpy)	
Process	**Fleet**	**$PM_{2.5}$**	**DPM**
Running exhaust	Non-POAK-Truck 2	0.0073	0.0076
Idle exhaust	T7 Single	0.0034	0.0036
Tire wear	Non-POAK-Truck 2	0.0002	–
Brake wear	Non-POAK-Truck 2	0.0010	–
Road dust	Non-POAK-Truck 2	0.0267	–
Total		**0.0386**	**0.0112**

2.5 Ocean-Going Vessels

Emissions from OGVs were estimated for active terminals at the Port and the privately-owned terminal operated by Schnitzer Steel. Emissions from OGVs include emissions from transiting, maneuvering, and berthing (hoteling). OGVs use propulsion engines for transiting, auxiliary engines for on-board electrical power, and small boilers to meet steam and hot water demands.

2.5.1 Port of Oakland

OGVs use propulsion engines for transiting, auxiliary engines for on-board electrical power, and small boilers to meet steam and hot water demands. Pollutants are emitted based on the operating mode of each OGV. Common modes include open ocean cruising, cruising at reduced speed (in the reduced speed zone [RSZ]) in the Bay, maneuvering (lower speed operation near berths), and hoteling (at berth). RSZ mode occurs after the bar pilot takes command of the vessel at the sea buoy until the vessel slows to a maneuvering speed directly in front of the Port. Emissions associated with cruising from the open ocean and most of the RSZ emissions were excluded in this analysis, since these emissions are outside the Source Domain. Therefore, for this analysis, the District included emission from (a) low speed vessel maneuvering south of the Bay Bridge within the West Oakland Source Domain, and (b) berthing at the Port. The details of how emissions were estimated for both of these operating modes are described below.

(a) Maneuvering

Emissions due to OGV maneuvering were calculated based on Ramboll (2018) to estimate emissions due navigating within the Source Domain.

In 2017, OGVs calling at the Port were exclusively container ships, including some with the capability to handle roll-on/roll-off cargo. All ship calls in 2017 were exclusive to the Port and did not include visits to other ports. An estimated 1,596 vessel voyages[48] to the Port were reported in the 2017 Port inventory. Many vessels follow regular route and schedules; 66% of the total calls were from vessels visiting 4 to 10 times in 2017, while 15% of total calls were from vessels visiting 11 or more times. Most of the vessels are relatively new; 85% were built since 2000, and the call-weighted median age of vessels was 9 years old.

Vessel call data were provided by the Marine Exchange of San Francisco Bay Region (SFMX). This dataset included the vessel identification number, Port berth, and date and time of the beginning and end of each movement, from which the time at berth (time between 'first line on' and 'last line off') and at anchor was inferred. The vessel identification numbers were cross-referenced with data obtained from the 2018 IHS Fairplay database,[49] which contains vessel characteristics such as vessel build date (which was used to estimate the emissions control regulations for the engine, which in turn determines the emission factor), cruise speed, engine type, and installed power. These parameters affect estimates of engine load for each vessel call. Actual vessel speed profiles (travel time by speed bin) were obtained from the Automatic Identification System (AIS),[50] provided by SFMX.

Emissions were determined for each transport mode based on the engine rated power (the maximum power that the engine can produce), typical load factor (the fraction of the actual to the rated power that the engine operates for a given mode), and time elapsed at that load. Emissions per vessel were calculated from propulsion engines, auxiliary engines, and boilers using the emissions factors and methods from CARB (California Air Resources Board 2011c, as amended by California Air Resources Board (2014b) and CARB's Marine Emissions Model v2.3L [California Air Resources Board 2014a]) as follows:

$$E_i = EF_i \cdot e \cdot LF \cdot T_O$$

where

E_i = emissions of pollutant i (g)
EF_i = emission factor of pollutant i (by engine type, operating mode, and fuel type) [g/(kW h)]
e = rated power (maximum power the engine can produce) (kW)
LF = load factor (unitless)
T_O = operating time in mode (h)

Data from the 2018 IHS Fairplay database indicate that the most common propulsion engines used on vessels calling at the Port in 2017 were slow speed engines (2-stroke engines, typically lower than 200 rpm) followed by steam engines powered by boilers for the remaining ships. Emission rates assuming 0.1% fuel sulfur content were used based on CARB fuel regulation except for steamships for which 2.7% sulfur content was used. Emissions factors for DPM (based on emission factors for PM_{10}) and $PM_{2.5}$ used for each OGV engine type are presented in **Table 2-14**.

[48] Vessel voyages account for inbound/outbound trips, whereas calls to the Port represent the number of berthing events (there can be multiple calls per voyage, e.g., when a vessel moves between berths at the Port).
[49] Ramboll (2018) extracted data from IHS Fairplay (Bespoke Maritime Data Services, Ship Data) on February 15, 2018.
[50] AIS data were available from June through December 2017. These data were used to calculate speed distributions. It is assumed that data during this period are representative of OGV transiting behavior over the whole year.

Table 2-14. OGV DPM and $PM_{2.5}$ emission factors by engine and fuel type. From Ramboll (2018), based on California Air Resources Board (2014a).

Engine Type	Fuel Type	Emission Factor [g/(kW h)]	
		DPM	**$PM_{2.5}$**
Slow speed	Marine distillate (0.1% sulfur)	0.250	0.230
Steam	Marine distillate (2.7% sulfur)	0.800	0.780
Auxiliary	Marine distillate (0.1% sulfur)	0.250	0.230
Auxiliary boiler	Marine distillate (0.1% sulfur)	0.133	0.130

Load factor for the propulsion power were determined using Stokes Law:

$$LF = (s/s_{\max})^3$$

where

LF = load factor (unitless)
s = vessel speed
$s_{\max}$ = vessel maximum speed

The speed and maximum speed of the vessel must be expressed in the same units. A load factor of 100% corresponds to the vessel operating at its maximum speed. When the vessel is cruising, the vessel cruise speed is assumed to be equal to its design speed, which is 93.7% of its maximum speed. Using the equation above, this results in a load factor of 0.823. The load factor varies depending on the vessel's speed during other modes. Adjustment factors were also applied to obtain emission factors applicable to operation at low loads where the engine does not operate as efficiently.[51]

Emissions from maneuvering were estimated for the area inside the Source Domain only. Vessels were assumed to be in maneuvering mode while moving between the Bay Bridge and the Port berths. This mode consists of short low speed transits, turns at the berth or in the turning basins, and a start and stop of the propulsion engine at the berth with tug assist. Maneuvering time is shorter for the Outer Harbor terminal calls (Berths 24 through 37) than the Inner Harbor terminal calls (Berths 55 through 68) because of the shorter distance from the Bay Bridge and proximity of the Outer Harbor turning basin to the Outer Harbor berths. Larger ships also require more time to turn. The time from the beginning to the end of the maneuvering mode was obtained from SFMX; 0.25 h were added to account for propulsion engine start up and shut down. The 0.75 h per shift (when a vessel moves between berths or from berth to anchorage) was also included in the emission estimates. Emissions associated with occasional vessel shifts between berths or between anchorage and berth were included in the maneuvering total for purposes of spatial allocation.

Vessel auxiliary power is used during both maneuvering and berthing operations. Vessel auxiliary power was derived from auxiliary generator capacity taken from the 2018 IHS Fairplay database or estimated from a comparable ship (by size and owner) if data were not available. The auxiliary

[51] This is consistent with the approach used in the 2014 Port of Los Angeles Inventory (Ramboll 2018).

engine load factor for maneuvering was assumed to be 50% (California Air Resources Board 2011c).

Emissions from OGV maneuvering (within the Source Domain) to each terminal are summarized in **Table 2-15**. Propulsion steam and auxiliary boiler PM emissions are not included in the DPM total because they are not generated by diesel engines.

Table 2-15. $PM_{2.5}$ and DPM emissions from OGV maneuvering and berthing by terminal. The District only included emissions within the Source Domain (the emissions presented in this table are lower than those reported in the 2017 Port Inventory).

Terminal	Maneuvering (tpy)		Berthing (tpy)	
	$PM_{2.5}$	**DPM**	**$PM_{2.5}$**	**DPM**
TraPac	0.657	0.640	1.305	0.719
Nutter	0.376	0.366	0.746	0.411
OICT	2.649	2.578	5.260	2.897
Matson	0.262	0.255	0.520	0.286
Total	**3.945**	**0.110**	**7.830**	**4.313**

(b) Berthing

During berthing, main engines are turned off while the auxiliary engines are running. Emission estimates due to berthing were provided directly by CARB (personal communication, 12 July, 2019).[52] These emissions estimates include both emissions from the auxiliary engine and boiler operations (**Table 2-15**).

2.5.2 Schnitzer Steel

Schnitzer Steel receives only bulk carriers calling for scrap steel. Emissions from vessel voyages associated with calls at Schnitzer Steel are not included in the Port's maritime inventory because the Schnitzer facility is not owned or controlled by the Port of Oakland. Similar to the emissions inventory developed for the Port (Ramboll 2018), emissions from OGVs operating from Schnitzer Steel were estimated based on the rated power and load factor of each vessel, duration of each trip, and the pollutant-specific emission factors during transiting, maneuvering, and hoteling. Emissions from container ship assist tugs (harbor craft) used to assist cargo vessels movements upon arrival and departure from the terminal were included in the OGV emissions. The District current limits the number of ship calls to Schnitzer Steel on an annual basis.[53] No temporal variations were estimated for OGV trips.

Due to confidentiality agreement, the District cannot release specific parameter information used to derive the OGV emissions for Schnitzer Steel. Emission factors for the main and auxiliary engines were taken from California Air Resources Board (2011c). Emission factors for auxiliary

[52] These emissions are consistent with the current draft OGV at-berth inventory (California Air Resources Board 2019; the final version will be publicly posted 60 days before the CARB Board hearing for the At-Berth Regulation Amendment).
[53] Schnitzer Steel's current permit is for 26 ship calls per year.

boiler operations were taken from the Port of Los Angeles Inventory of Air Emissions for 2017 (Starcrest Consulting Group, LCC 2018). Emission factors for harbor craft emission factors were taken from California Air Resources Board (2012b). Based on CARB fuel regulations, emission factors were based on fuel with 0.1% fuel sulfur content. Estimates of emissions were limited to the Source Domain; transport outside of the domain were not estimated or modeled. The total emissions are summarized in **Table 2-16**.

Table 2-16. $PM_{2.5}$ and DPM emissions from OGVs and assist tugs operating at Schnitzer Steel.

Activity	$PM_{2.5}$ (tpy)	DPM (tpy)
Transiting	0.060	0.060
Maneuvering	0.087	0.087
Berthing	0.155	0.155
Total	**0.302**	**0.302**

2.6 Commercial Harbor Crafts

CHCs are regularly used at the Port to support: (1) operation and maintenance dredging in the channels and at berths, (2) disposal of dredged material, (3) assist container ships (assist tugs), and (4) tug trips and fuel pumping from fuel barges towed from Richmond to refuel ships' bunkers at the Port. Most CHCs at the Port are tugs; otherwise, there are a few small work boats that assist dredging operations, and dredgers.

2.6.1 Operation and Maintenance Dredging and Disposal

Operation and maintenance (O&M) dredging is conducted annually at the Port to maintain the depth of channels and berths and to ensure safe navigation. Materials that are deposited into the Bay by stream and urban runoff are removed, and shallow areas are eliminated by redistributing the bottom sediments from shoaling. Dredging is conducted using diesel-powered derrick barge (clamshell) dredgers, accompanied by tender tugs and work boats. Dredged material is transferred to scows (barges), which are then towed to a disposal site by a diesel-powered tug. After the barge is emptied, the tug returns with the empty barge to pick up a new load.

Recent channel dredging was conducted from August 2017 into February 2018, while berth dredging was conducted in August, October, and the first two weeks of November 2017. During this period, 89,000 cubic yards of material from the Port's berth and 559,000 cubic yards of material from the channel were removed and disposed of at the San Francisco Deep Ocean Disposal Site, located 49 nmi west of the Golden Gate Bridge. These activities were treated as two separate activities in the 2017 Port Inventory: (1) O&M dredging, which includes operation of the clamshell dredge and associated support vessels, and (2) disposal, when dredge materials are transported from the dredging area to disposal sites. Only disposal was inside the Source Domain was included in this analysis (which includes only ~2.3 nmi of transit distance, or ~9.4% of total transiting emissions).

Emissions from dredging equipment was estimated as follows:

$$E_i = EF_i \cdot e \cdot LF \cdot T_O$$

where

E_i	=	emissions of pollutant i (g)
EF_i	=	emission factor of equipment of pollutant i [g/(bhp h)]
e	=	engine brake horsepower rating (bhp)
LF	=	time-weighted engine load factor (fraction of full load) based on different operating modes during a round trip (unitless)
T_O	=	operating hours of equipment (h)

The dredging contractor provided a list of dredging equipment, engine characteristics, and hours of operation. In 2017, dredging operations were performed using a clamshell dredge on a dredge barge (using a main and auxiliary diesel engine), and dredge tenders and work boats (each with two main propulsion diesel engines, and up to two auxiliary engines). Specific information on engine model, power, load factor, emissions factors, and hours of operation are provided in the 2017 Port Inventory. Vessel emission factors, deterioration factors, fuel correction factors, and load factors from CARB's Commercial Harbor Craft Emission Inventory tool (California Air Resources Board 2011a) were used to estimate emissions for all engines used on the dredging and support vessels. Emission factors for the dredgers were derived from CARB's OFFROAD model,[54] which are based on the model year and age of equipment (in 2017). Emission factors for diesel engines on tugs and tenders were estimated based on load factors, zero-hour emission factors, and deterioration factors available in California Air Resources Board (2011a). The resulting emissions are presented in **Table 2-17**.

Table 2-17. Emissions of $PM_{2.5}$ and DPM from O&M dredging and disposal of dredge material. The District only included emissions within the Source Domain (the emissions presented in this table are lower than those reported in the 2017 Port Inventory).

Activity	$PM_{2.5}$ (tpy)	DPM (tpy)
O&M Dredging	1.078	1.111
Dredge disposal	0.043	0.044
Total	**1.121**	**1.155**

2.6.2 Assist Tugs

Tugs are used to assist cargo vessel movements upon arrival, berthing, and departure from the Port, and tow or push a wide variety of barges and other equipment. Assist tugs ensure safe navigation within the Bay, especially when vessels are reversing direction near berths in the Inner and Outer Harbor. Tugs are matched to vessels to ensure they are equipped to handle the vessel based on their size and power level, among other criteria. On average, two tugs are used for each cargo vessel that are inbound or outbound between berths at the Port and the Federal Channel near

[54] See https://ww3.arb.ca.gov/msei/ordiesel.htm for more information.

the Bay Bridge, though up to five tugs are required to assist larger vessels. Emissions from assist tugs were estimated for when they were (1) assisting vessel operation, and (2) transiting to and from berthing bases to conduct the assists.

Tugs assigned to ships calling at the Port are operated by five companies: AMNAV, Foss Maritime, Starlight Marine (part of Harley Marine Services), Crowley, and BayDelta. Vessel call data specific to the Port was provided by SFMX. The activity of each company in 2017, based on the number of calls to the Port, are reported in **Table 2-18**. Although these tugs are used elsewhere in the Bay, emissions were only estimated for activity during transiting and assisting ship calls at the Port.

Table 2-18. Activity (percentage of total calls) of assist tugs calling to the Port by operator. The base indicates where the company bases their operations (at/near). Based on calls to the Port in 2017.

<table>
<tr><th>Operator</th><th>% calls</th><th>Base</th></tr>
<tr><td>AMNAV</td><td rowspan="2">78</td><td>Berth 9, Port of Oakland</td></tr>
<tr><td>Starlight Marine</td><td>Alameda side of Inner Harbor Turning Basin</td></tr>
<tr><td>Foss Maritime</td><td>7</td><td>Richmond</td></tr>
<tr><td>Crowley</td><td>8</td><td>Bay Bridge, San Francisco</td></tr>
<tr><td>BayDelta</td><td>8</td><td>Bay Bridge, San Francisco</td></tr>
</table>

Assist tugs emissions were estimated based on the methods presented in California Air Resources Board (2011a). The equation used to estimate emissions from each assist tug class was as follows:

$$E_i = AEF_i \cdot e \cdot LF \cdot T_O$$

where

E_i = emissions of pollutant i (g)
AEF_i = adjusted emission factor of pollutant i for main or auxiliary engine (adjusted for model year, deterioration rate, and fuel, averaged by tug class) [g/(bhp h)]
e = engine brake horsepower rating, as a weighted average between main propulsion and/or auxiliary engine brake horsepower rating of engines in the tug class (bhp)
LF = time-weighted engine load factor (fraction of full load) for the maneuvering phase for the main engine and/or auxiliary engine (unitless)
T_O = operating hours by tug class (based on number of vessel calls, average maneuvering time per call, average number of tugs assigned to each assist by inbound/outbound direction) (h)

The characteristics of tugs by company that were in operation in 2017 were obtained, including: engine model year, main engine power and tier regulation, and auxiliary power. The total assists by company were evenly distributed among individual tugs. Maneuvering time was estimated for each call based on the Port berth location and the vessel length. Time transiting to and from assists for each tug was estimated using the distances from each operator's base (**Table 2-18**) to various assist destinations, assuming the transit trips were made at an average speed of ~ 9.2 mph (8 kt). For each trip, emissions were calculated for inbound vessels assuming 2.20 tugs, and for outbound trips using 2.08 tugs. Time for each assist including maneuvering ships inbound and outbound from the Port and transiting to and from maneuvering assists.

Zero-hour emission factors, engine emissions deterioration factors, and fuel correction factors for both main propulsion and auxiliary engines were based on California Air Resources Board (2011a). An additional adjustment factor to account for engine deterioration between 2015-2017 was also included (Chris Lindhjem, Ramboll, personal communications, 9 August, 2019). The engine load factor for main engines and auxiliary engines was 0.31 and 0.43, respectively. The total emissions from assist tugs are presented in **Table 2-19**.

Table 2-19. $PM_{2.5}$ and DPM emissions from assist tugs.

Operator	$PM_{2.5}$ (tpy)	DPM (tpy)
AMNAV BayDelta Crowley Foss Maritime	2.96	3.05
Starlight Marine	0.86	0.88
Total	**3.82**	**3.94**

2.6.3 Bunkering Barges

Bunkering is when ships are supplied with fuel. At the Port, tugs tow fuel barges from Richmond to refuel ships at berth. The bunkering barge was towed from and returned to the Richmond long wharf, approximately 10 nmi from the Port; only the portion of the bunkering trip from the Port to Richmond within the Source Domain (a distance of ~1.8 nmi) was used to estimate the emissions. Foss Maritime provided the date and fuel costs for bunkering events in 2017, which was used to develop the emissions inventory for this activity.

Bunkering emissions were estimated using the same approach as that described for dredging (**Section 2.6.1**) since each operation involves a barge and an accompanying tug. The tug load and time-in-mode for movement of the bunkering barge were used to estimate the emissions during the transit trip. Emissions from the tug used to tow the fuel barge between Richmond and the Port were estimated following the method used to estimate emissions from assist tugs (**Section 2.6.2**). Emissions from the barge-mounted diesel-powered pumps were estimated using the emission rate for pumps in CARB's OFFROAD model.

A total of 314 bunkering events occurred in 2017 across 219 unique dates. This means that, for the 95 events that occurred on the same day as another event, there was likely no return trip to Richmond between events. Therefore, only 219 round trips to Richmond from the Port were accounted for in the emissions analysis.

Assuming the one-way trip from Richmond to the Port takes 2.5 h, the total operating hours for towing barges for bunkering was 1,095 h. Time to refuel ships took up to 8 h. Taking the travel time and time required to refuel, the average bunkering event was assumed to take 4 h for pumping (1,256 h of pumping for all 314 bunkering events). Pumping was performed by two 500 hp model year 2003 diesel barge pumps using non-road Tier 2 engines. The propulsion and auxiliary engine model year and power for the two tugs used to tow the bunkering barges are presented in the 2017 Port Inventory.

Total emissions for the bunkering operation to tow boats and barge pumps are shown in **Table 2-20**.

Table 2-20. $PM_{2.5}$ and DPM emissions from operating bunkering barges and pumps by terminal operator.

Terminal	Bunkering Barges (tpy)		Bunkering Pumps (tpy)	
	$PM_{2.5}$	**DPM**	**$PM_{2.5}$**	**DPM**
TraPac	0.032	0.033	0.013	0.014
Nutter	0.018	0.019	0.007	0.008
OICT	0.130	0.134	0.051	0.055
Matson	0.013	0.013	0.005	0.005
Total	**0.199**	**0.193**	**0.075**	**0.082**

2.7 Cargo Handling Equipment

CHE is primarily used to transfer freight between modes of transportation, such as between marine vessels and trucks or between trains and trucks. At the Port, CHE are used almost exclusively to move shipping containers. As such, the types of CHE at the Port are limited to yard tractors, rubber-tired gantry (RTG) cranes, top or side handlers (picks), and forklifts. Other types general purpose off-road equipment, such as sweepers, bulldozers, backhoes, excavators, and other off-road equipment, were not included as part of the CHE category since they are used at the Port for facility maintenance and construction. A more detailed explanation of emissions estimates can be found in the 2017 Port Inventory report.

Annual 2017 emissions for each piece of CHE equipment were estimated at each Port terminal based on the equipment type, engine characteristics (model year, rated power, after-treatment retrofit control device), and equipment operation (hours of operation, fuel consumption rate). Equipment population and operation estimates were derived from surveys of on-dock terminal, off-dock terminal, and railyard activity conducted by the Port in late 2017 and early 2018.

The types of equipment were used to categorize CHE consistent with CARB guidance (California Air Resources Board 2011d) include cranes (including rubber-tired gantry cranes), forklifts, container handling equipment (top or side handlers), and yard trucks (or yard tractors). Annual emissions from CHE were calculated using the following equation:

$$E_i = [EF_i + (dr \cdot T_C)] \cdot e \cdot FCF \cdot LF \cdot CF \cdot T_O \cdot N$$

where

E_i = emissions of pollutant i (g)
EF_i = zero-hour emission factor of equipment [g/(bhp h)]

dr = deterioration rate or increase in zero-hour emissions as the equipment is used [g/(bhp h)/h]
T_C = cumulative hours of equipment use (h)
e = engine brake horsepower rating (bhp)
FCF = fuel correction factor (percent reduction) used to adjust the base emission factor to account for use of California diesel fuel (unitless)
LF = weighted load factor (average load expressed as a percent of rated power) (unitless)
CF = control factor (percent reduction) associated with use of emission control technologies (unitless)
T_O = annual operating hours of the equipment (h)
N = number of pieces of the equipment

The Port sent confidential surveys regarding equipment make and model to all tenants on-dock and off-dock of the BNSF railyard. When information was missing from the survey, default values were assumed based on similar make and model of equipment, along with a default number of hours of operation.

For diesel-powdered CHE, zero-hour emission factors, deterioration rates, fuel correction factors, and emission control factors were obtained from CARB's 2011 Cargo Handling Equipment Inventory (CHEI) model (California Air Resources Board 2012a). Because the current version of the CHEI model does not support emission estimates for non-diesel equipment, emission factors for gasoline and propane powered equipment were obtained from CARB's 2011 CHE Calculator (California Air Resources Board 2011d), following the methodology described in the 2005 original rulemaking for CHE operating at ports and intermodal railyards (California Air Resources Board 2005a).

Of the 386 total pieces of CHE, 345 were diesel-powered, 39 were gasoline-powered, and 2 were liquid petroleum gas-powered (**Table 2-21**). A summary of the average horsepower, annual operating hours by equipment and power range can be found in the 2017 Port Inventory.

Table 2-21. CHE equipment types used at the Port, based on survey results.

Equipment	Equipment Population	% Total
Container handling equipment (top picks and side picks)	123	32
Forklift	14	4
RTG Crane	24	6
Yard Tractor	105	27
Yard Tractor (on-road)	120	31
Total	**386**	**100**

Emissions were split between on-dock and off-dock operations, based on the mix of equipment types used at the marine terminals as compared to the BNSF railyard. Approximately 83% of DPM and $PM_{2.5}$ emissions were associated with the marine terminals, while the remaining 17% were from the BNSF railyard[55] (Till Stoeckenius, Ramboll, personal communication, 22 January, 2019). CHE emissions were further assigned to each terminal based on the proportion of ship calls made to each terminal in 2017 (**Table 2-18**). Emissions from CHE by terminal and yard and the hours of operations are summarized in **Table 2-22** and **Table 2-23**, respectively. All PM_{10} from diesel engines were assumed to be DPM, and $PM_{2.5}$ emissions were calculated as a fraction of PM_{10} based on the fuel type-specific factors provided in California Air Resources Board (2013).

Table 2-22. $PM_{2.5}$ and DPM emissions from CHE by location (terminal or railyard).

Location	Emissions (tpy)	
	$PM_{2.5}$	**DPM**
TraPac Terminal	0.220	0.218
Nutter Terminal	0.126	0.124
OICT Terminal	0.886	0.878
Matson Terminal	0.088	0.087
BNSF Railyard	0.270	0.273
Total	**1.590**	**1.580**

Table 2-23. Terminal operating hours used to develop temporal activity profiles for CHE. Information as of January 25, 2019.

Location	Day of week			
	Monday - Thursday	**Friday**	**Saturday**	**Sunday**
TraPac Terminal	07:00 – 12:00 13:00 – 16:30 18:00 – 02:00	07:00 – 12:00 13:00 – 16:30	None	None
Nutter Terminal	07:00 – 16:15	07:00 – 16:15	None	None
OICT Terminal	00:00 – 03:00 07:00 – 00:00	07:00 – 18:00	None	None
Matson Terminal	08:00 – 11:45 13:00 – 16:45	08:00 – 11:45 13:00 – 16:45	None	None
BNSF Railyard	06:00 – 18:00	06:00 – 18:00	07:00 – 16:00	None

55 CHE emissions at BNSF include emissions during transload to the railyard (i.e., it includes emissions that are not necessarily physically located within the railyard, but are due to the operations of the railyard).

2.8 Port Trucks at Terminals

Port Trucks, or "drayage trucks," transport containers between marine terminals, freeway interchanges, and nearby railyards. Port Trucks travel along truck routes between marine terminals, three nearby freeway interchanges, and two railyards (UP and BNSF). Trucks can only arrive or depart from the Port area via three freeway access points: Maritime Street/West Grand Street, 7th Street, and Adeline Street (via the Adeline Street and Market Street on/off-ramps to I-880).

To calculate total emissions from Port Trucks operating at terminals, vehicle operating modes were separated into four categories: (1) idling inside marine terminals, (2) idling at gate queues, (3) driving within marine terminals, and (4) driving on surface streets between terminals and freeways interchanges or railyards. For each of these modes, the average time and travel speed determine the emissions for each trip. Emissions per trip were calculated by multiplying the appropriate emission factor (idling or by speed bin) by the activity level indicator (idling time or travel distance). For running exhaust, emissions are calculated as:

$$E_i = N \cdot L \cdot EF_i$$

where

E_i = emissions of pollutant i (g)
EF = emission factor of pollutant i (g/mi)
N = number of vehicles (unitless)
L = travel distance (mi)

For idling exhaust, emissions were calculated in the same manner as presented in **Section 2.4**.

Details regarding the method used to estimate each of the emissions parameters are provided in the 2017 Port Inventory. The 2017 truck trip counts at the marine terminals were derived from gate counts (as provided by the Port or the terminal operators) and container lift counts (i.e., the number of containers moved on or off a ship). In the railyards, the reported number of lifts was doubled to estimate the sum of inbound and outbound truck trips. However, trucks may move a container in and out on a single terminal entry or reposition an empty chassis so that the gate counts do not exactly match the number of container lifts. The counts do not include trips to truck parking areas in the Port (such as the former Ports America Outer Harbor terminal and Howard Terminal) since the trucks were already counted when they entered at one of the three access points.

VMT within marine and rail terminals is limited to driving between the terminal gates and container storage areas. Previous surveys of terminal operators conducted by the Port was used to estimate 2017 activity including truck speed, travel distance, and idling time (**Table 2-24**).

Table 2-24. Average activity level for Port Trucks at terminals. Values are estimated from surveys conducted in 2005 and 2012 and terminal trip activity in 2017.

Mode	Average value
Idling at gate (h)	0.14
Idling in terminal (h)	0.34
Distance traveled (mi)	2.54
Speed (mph)	13.5

Emission factors for truck running exhaust, extended idling, tire wear, and brake ware were taken from EMFAC2017. Emission factors from on-road trucks depend on the age distribution of the trucks and site conditions such as temperature, humidity, fuel sulfur, and average speeds. Port Truck hours of operation were assumed to be the same as those for CHE (**Table 2-23**).

In 2017, all Port Trucks used diesel fuel; PM_{10} running exhaust emissions are therefore DPM emissions, but total PM_{10} and total $PM_{2.5}$ also include (non-diesel) PM from brake wear, tire wear, re-entrained road dust. DPM emissions by terminal were back-calculated from total DPM emissions associated with Port Truck trips and the fraction of activity based on ship calls by terminal. Total $PM_{2.5}$ emissions in the 2017 Port Inventory do not include road dust emissions; to estimate these emissions, the District first separated idling exhaust emissions from "driving emissions" (running exhaust, tire wear, brake wear) based on the fraction of emissions by activity by terminal (provided by Till Stoeckenius, Ramboll, personal communication, 12 June, 2019). Using emission inventories developed for Port Trucks on roadways within the Port area (**Section 2.3**), an average ratio of 4.76 (across all roadways links) of road dust emissions to "driving emissions" was obtained. This ratio was then applied to the "driving emissions" within the Port terminals to obtain $PM_{2.5}$ road dust emissions.

The spatial allocation of Port Truck emissions was based on the percentage of emissions between marine terminals and the railyards (**Table 2-25**). Port Truck emissions were further assigned to each terminal based on the proportion of ship calls made to each terminal in 2017 (**Table 2-18**). Consistent with the 2017 Port Inventory, it was assumed that two-thirds of Port Truck travelling to railyards went to the UP railyard, while the remaining one-third went to the BNSF railyard. The emissions by terminal are reported in **Table 2-26**.

Table 2-25. Emissions allocated by Port Truck terminal type trip destination. Information provided by Ramboll (Till Stoeckenius, Ramboll, personal communication, 25 February, 2019).

Terminal type	Emissions (%)	
	$PM_{2.5}$	DPM
Marine	87	88
Railyard	13	12

Table 2-26. $PM_{2.5}$ and DPM emissions from Port Trucks operating at Port terminals. $PM_{2.5}$ emissions include all operational and road dust emissions. Total values are consistent with Ramboll (2018), with the exception of added $PM_{2.5}$ road dust emissions.

Terminal type	Location	Emissions (tpy)	
		$PM_{2.5}$	**DPM**
Marine	TraPac	0.398	0.038
	Nutter	0.227	0.022
	OICT	1.602	0.154
	Matson	0.158	0.015
Railyard	BNSF	0.115	0.011
	UP	0.230	0.021
	Total	**2.730**	**0.261**

2.9 Locomotives (Rail Lines)

The geographical locations of rail lines in the Bay Area was available in a shapefile from the Topographically Integrated Geographic Encoding and Referencing (TIGER) Line spatial database.[56] When the shapefile was transposed onto recent satellite imagery (as viewed in Google Earth), the locations of the lines did not align with visible rail lines; in some cases, they were misaligned up to ~90 m. The rail lines in the shapefile were then manually re-aligned to match the satellite imagery.

In the shapefile, each rail line is made up of many smaller segments that span short distances (0.81–3.8 mi) along each track. In the Bay Area, passenger and freight services may run along a single track (i.e., the track is shared by both services), or along parallel tracks. To determine the cumulative impacts from all rail services on West Oakland, emissions from parallel tracks were consolidated onto a single track (see **Figure 3-15**). In addition, emissions from locomotives that perform switching operations (referred to as “switchers”, which move individual or a small number of rail cars to assemble trains) were evenly distributed along the length of the subdivision line.

In total, emissions were estimated on six rail segments within West Oakland Source Domain. Emissions along each segment represent the combined emissions from all services, though in the following sections (**Section 2.9.1** and **Section 2.9.2**), emission estimates are presented by service.

Because of the limited data available, the District was not able to include emissions from rail sidings. Emissions from railyard activity were evaluated separately (see **Section 2.10**).

2.9.1 Freight Haul Lines

Only rail lines within the Source Domain were included in this analysis (**Table 2-27**). There are two freight rail carriers in the Bay Area: BNSF, and UP. Both freight lines transport goods to and

[56] https://www.census.gov/geographies/mapping-files/time-series/geo/tiger-line-file.html.

from the Bay Area to San Joaquin Valley (east), Sacramento (north), and down the Peninsula (south).

Table 2-27. Freight subdivision lines in Alameda County.

Subdivision	Start Location	End Location
Martinez	10th Street, Oakland	Alameda County Line
Niles	10th Street, Oakland	Newark

BNSF and UP provided the District with the average diesel fuel consumption and miles traveled in 2017 along each county subdivision line in the Bay Area, and EPA fuel-based emission factors (g/gal) for converting fuel consumption to emissions. The railroad companies provided combined fuel consumptions along rail lines that are shared by both carriers. Emissions from switchers were included in the fuel-based emissions estimates and distributed uniformly across specific subdivision lines. The total emissions from freight haul lines was 0.454 tpy of DPM and 0.426 tpy of $PM_{2.5}$ (assuming a size fraction of 0.94).

2.9.2 Passenger Rail Lines

There are several intercity passenger rail lines within the Source Domain, which are serviced by Amtrak along the Capital Corridor, California Zephyr, Coastal Starlight, and San Joaquin passenger lines. Emissions by link were estimated based on latest available schedule for 2017 or 2018 (where available). For each link, emissions were estimated as the sum of emissions associated with exhaust from the locomotive, and idling emissions while loading passengers at stations.

To estimate the emissions, the number of locomotives per day that run along each link, as well as the activity along each line, are required. The activity along each Amtrak route is a function of the estimated average speed of the train and the frequency of the stops. To determine the number of stops, the District used the latest posted timetable and schedule by Amtrak.[57] The timetables provide the number of train stops at each station, and the times and frequency of the train stops. These were used to determine the following:

- The daily number of trains was calculated as the number of weekday and weekend trains weighted by 5/7 and 2/7, respectively.
- The idling times varied from 2 – 10 min at certain stations to accommodate timed connections to other public transportation; the average idling time at a station (to pick up and drop off passengers) was approximately 90 s at most stations. Trains can also spend up to 20 min idling to power on (power down) the engine at the beginning (end) of a run.

Based on the timetable, the number of daily trips along each route is presented in **Table 2-28**. The level of service and number of trains was assumed to remain constant.

[57] In most cases, the most recent timetable was posted in 2017 or 2018. Timetables were obtained from http://www.amtrak.com/train-schedules-timetables (accessed January 2019).

Table 2-28. Amtrak activity by route.

Routes	Destinations	Weekday trains per day	Weekend trains per day
Capital Corridor	Fairfield – Oakland	30	22
	Oakland – Coliseum	18	15
	Coliseum – San Jose	14	14
California Zephyr	Emeryville – Fairfield	2	2
Coastal Starlight	Gilroy – Fairfield	2	2
San Joaquin	Antioch – Oakland	5	0

Locomotives operate under a series of load modes (notches) that, combined with idling, determine the operating mode and the corresponding emission factors. The throttle notch is based on the load expected at each station, as well as the average speed. Emission factors and speeds that were used for each passenger line are presented in **Table 2-29**. The average speed was estimated using the distance traveled by the train on a route (or a portion thereof) divided by the elapsed travel time (based on the scheduled departure and arrival times) of the train between stations. An average throttle notch of three was used for the Capital Corridor because of the frequent stops, while for all remaining routes (which have fewer stops), a throttle notch of four was used.

Table 2-29. DPM emission factor (EF) and average speeds by Amtrak service/route.

Train service	Mode/ Throttle notch	EF (g/h)	Average speed (mph)
All passenger service	Idling	47.9	0.0
Capitol Corridor	3	210.9	35.0
California Zephyr	4	226.4	36.8
Coastal Starlight	4	226.4	40.0
San Joaquin	4	226.4	44.4

DPM emission factors were derived from the Port of Oakland 2005 Seaport Air Emissions Inventory (Environ International Corporation 2008), adjusted for fuel sulfur content of 15 ppm by weight in compliance with CARB's Marine and Locomotive Diesel Fuel regulation (adopted November 2004; California Environmental Protection Agency 2014). All passenger rail services were assumed to have a fleet mix based on GP4x and Dash 9 locomotives with respective certification levels being pre-controlled and achieving Tier 1 emissions.

Emissions were estimated for locomotives based on idling at stations or turnarounds and running exhaust between stations. Daily running exhaust emissions of DPM on each link were estimated as:

$$E_{DPM} = \frac{1}{s}\left(EF_{DPM} \cdot N \cdot L\right)$$

where

E_{DPM} = emissions of DPM per rail link per day (g)
s = average speed (mph) (**Table 2-29**)
EF_{DPM} = emission factor by rail link (g/h) (**Table 2-29**)
N = number of locomotives that travel on the rail link per day (unitless)
L = length of rail link (mi)

Running exhaust emissions were assumed to occur along each link except within 1,000 ft (0.189 mi) of a station. To be conservative, idling emission factors were used to estimate emissions within 500 ft before and after a station (equivalent to 1,000 ft). Idling emissions were used exclusively if the link was less than 0.189 mi and a station was situated on the link. Idling emissions were estimated by multiplying the emission factor by the number of stops on each link and the length of time of each stop, which varied by rail service and link:

$$E_{DPM} = EF_{DPM} \sum_i N_i \cdot T_i$$

where

E_{DPM} = emissions of DPM per rail link per day (g)
EF_{DPM} = emission factor for DPM by rail link (g/h) (**Table 2-29**)
N = number of locomotives that travel on the rail link i per day
T = idling time for each stop or turnaround on rail link i per day (h)

Even though activity levels varied per hour for each train route, the diurnal profile (fraction of total daily emissions that are produced per hour) for emissions from passenger rail were assumed to be evenly distributed over a 24 h period. The total emissions from passenger rail lines was 0.634 tpy of DPM and 0.596 tpy of $PM_{2.5}$ (assuming a size fraction of 0.94).

2.10 Railyards

There are three railyards in the West Oakland Source Domain. The Port has two railyards on its property: Oakland International Gateway railyard, which is leased by the BNSF railway, and Outer Harbor Intermodal Terminal, which is operated by the OGRE. BNSF is a Class I interstate railroad, while OGRE is a small regional Class III railroad serving portions of the former Oakland Army Base. The Union Pacific (UP) railyard is also located within the Port area, but it is privately owned and operated. It serves as an intermodal yard for freight movements through the Port as well as a yard for handling domestic non-Port freight.

2.10.1 BNSF

The BNSF railyard is a near-dock transfer point that handles Port cargo containers. Locomotives are used for line-haul operations (movement of long-haul trains into and out of California) and switching operations (switchers). Line-haul locomotives move into and out of the railyard and idle after arrival and prior to departure. Switching engines operate in the railyard, with idling periods interspersed throughout the day. Locomotives and trains enter the Port area from the north via the UP main line and leave in the same direction via tracks going north through Richmond, and then onto BNSF lines leading out of the Bay Area.

To characterize emissions from switchers, BNSF provided the Port with a sample of engines used in 2017. Switchers assigned to BNSF rotate in and out of service, but a GP25 or GP60 model were typically used (**Table 2-30**).

Table 2-30. Locomotive engine characteristics at the BNSF railyard.

Model	Certification Tier	hp	Number of Engines	Engine Surrogate
GP25	Precontrolled	2500	1	Average of GP-3x (2000 hp) and GP-4x (3000 hp)
GP60	Precontrolled	3600 – 3800	2	GP60 (3600 hp)

Locomotives and switchers operate using a series of load/power modes called "notches." The operating profile for a locomotive is defined by the notch settings and idling periods. Following CARB's guidance on rail yard emission modeling (California Air Resources Board 2006), emissions were estimated using emission rates per engine model and per mode, with average activity (time in mode) profiles for each visit multiplied by the number of engines visiting the railyard. The relative time per mode for switcher engine activity was taken from the 2006 Port of Oakland inventory (Environ International Corporation 2008; **Table 2-31**). Switching activity consists of one engine operating for 7.5 h per day (365 days per year); however, for consistency with the locomotive line-haul operations (see **Section 2.9.1**), the District assumed activity would occur over the entire day (24 h).

Table 2-31. Percentage of time in mode of locomotives at the BNSF railyard.

Mode/ Throttle notch	Time (%)
Dynamic Braking	1.4
Idle	59.8
1	6.6
2	15.0
3	9.5
4	4.4
5	1.9
6	0.3
7	0.0
8	1.0

Activities of line-haul engines include arriving with a train, separating from the train, potentially moving to the ready area where the engines are assigned to a train, moving to an assigned train, and leaving the yard. Twelve locomotive models and engine tiers were used at the BNSF yard for these operations. A sample of the line-haul engine activity was used to develop the average time in mode for line-haul locomotive arriving and departing from the yard. Because almost all line-haul locomotives have automatic idling-reduction devices (beginning with model year 2001), and idling is restricted to 15 min per event (per CARB agreement; California Air Resources Board 2005b), the idle time was adjusted to 1 h, assuming four in-yard movements per arrival and departure. The average time in mode for line-haul locomotives is summarized in **Table 2-32**.

Table 2-32. Average time in mode of locomotives at the BNSF railyard. Idling time is based on assuming 0.5 h per arrival and departure.

Mode/ Throttle notch	Time (h)
Dynamic Braking	0.2963
Idle	1.0
1	0.1726
2	0.0758
3	0.0340
4	0.0049
5	0.0059
6	0.0004
7	0.0036
8	0.0017

Emission factors and fuel consumption by notch are consistent with previous Port inventories with adjustments to account for the idling-reduction devices and in-use fuel characteristics of no more than 15 ppm fuel sulfur content. Using California diesel fuel also reduces PM emissions by 7%; a factor of 0.93 was applied in the emissions estimates (Ramboll 2018). The combined emissions from line-haul and switcher activities at the BNSF railyard was 0.182 tpy of DPM and 0.168 tpy of $PM_{2.5}$ (as exhaust only).

2.10.2 OGRE

OGRE is a Class III, Surface Transportation Board-certified short line rail company created in 2014 that is currently operating at the former Oakland Army Base. In 2017, OGRE exclusively served non-marine facilities located on Army Base. Switching engine fleet characteristics and annual activity were provided by OGRE. Emission factors for locomotives at OGRE were estimated using locomotive engine surrogates of similar power (**Table 2-33**).

Table 2-33. Locomotive engine characteristics at the OGRE railyard.

Model	Certification Tier	hp	Number of Engines	Engine Surrogate
EMD GP9/16	Precontrolled	1500/1600	2	EMD 12-645E (1500 hp)
EMD MP15	Precontrolled	1500/1600	2	EMD 12-645E (1500 hp)

OGRE estimated the total switching engine activity to occur over 780 h (annually). The time in mode for the switchers at BNSF was used for the switchers at OGRE (**Table 2-31**); the total hours were distributed by notch, then the total emissions were obtained by summing the emissions by notch. The combined emissions at the OGRE railyard from line-haul and switcher activities was 0.077 tpy of DPM and 0.071 tpy of $PM_{2.5}$ (exhaust only).

2.10.3 UP

The UP Oakland Railyard is bounded by highway I-880, the Port, and residential, industrial, and commercial properties. The UP railyard is a cargo handling facility where intermodal containers arrive by truck to be loaded onto trains for transport, or arrive by train and unloaded onto chassis for transport by truck. Both cargo containers and chassis are temporarily stored at the yard. The railyard also has facilities for crane and yard hostler maintenance, locomotive service and repair, and on-site wastewater treatment.

Rail cars on arriving and departing line haul locomotives are moved using switchers. Switchers are used to move sections of inbound locomotives to appropriate areas within the railyard (e.g., intermodal rail cars go to the intermodal ramp for unloading and loading), and to move sections of outbound locomotives to tracks from which they will depart. Switchers are remote controlled in the UP railyard; while some are operated exclusively in the railyard, others are operated in the railyard at other outside facilities.

Emissions from the UP railyard were provided to the District by UP, and estimated using annual fuel consumption of eight switcher locomotives operating on the Niles Subdivision operating 8–12 h per day for every day of the year (365 days), as well as other equipment operating in the UP railyard (CHE, TRUs, and service/repair operations). The total emissions thus reflect the total activity at the UP railyard in 2017, estimated as 1.1098 tpy of DPM, and 1.0210 tpy of $PM_{2.5}$.

2.11 Commuter Ferries and Excursion Vessels

PM emissions from ferry and excursion vessel operations within the Source Domain were estimated based on information gathered from CARB, the San Francisco Bay Area Water Emergency Transportation Authority (WETA), ferry and excursion vessel schedules, and field studies.

WETA operates the San Francisco Ferry fleet, composed of 14 high speed passenger-only ferry vessels.[58] There are two commuter ferry terminals inside the West Oakland Source Domain: the Oakland Jack London Square ferry terminal (in Oakland), and the Alameda Main Street ferry terminal (in Alameda). A private excursion cruise operator, Commodore Cruises and Events, is also located within the domain.

(a) Navigating

PM_{10} emissions were estimated using the methods for CHC engines (California Air Resources Board 2012b):

[58] Not all vessels operate at the same time. The WETA San Francisco Bay Fleet information can be found at https://sanfranciscobayferry.com/sites/default/files/SFBFfleet.pdf (accessed December 2018).

$$E_{PM_{10}} = EF_0 \cdot F \cdot \left[1 + D \cdot \frac{A}{UL}\right] \cdot LF \cdot HP \cdot T_O$$

where

$E_{PM_{10}}$	=	emissions of PM_{10} (g)
EF_0	=	zero-hour PM emission factor as a function of model year, horsepower, and engine use (propulsion or auxiliary) [g/(hp h)]
F	=	fuel correction factor (to account for emission reductions from burning cleaner fuel) (unitless)
D	=	engine deterioration factor (percentage increase of emissions when the engine is at the end of its useful life) as a function of horsepower (unitless)
A	=	current age of engine (y)
UL	=	engine useful life as a function of vessel type and engine use (y)
LF	=	engine load factor as a function of vessel type and engine use (unitless)
HP	=	engine horsepower rating (hp)
T_O	=	operating hours for activity (h)

Emission factors specific to the main propulsion and auxiliary engine by model year are required, in addition to a deterioration rate and a fuel correction factor. As vessel-specific data was not always available, state-wide and Bay Area average emission factors and parameters were used based on data from CARB and WETA (**Table 2-34**). Specifically:

- For commuter ferries, state-average emission factors, load factor, deterioration factor, number of engines per vessel, engine useful life, and fuel correction factors were taken from California Air Resources Board (2012b).
- Ferry-specific engine counts, engine age, engine horsepower, and load factor on commuter ferries used at the two ferry terminals were provided by WETA.[59]
- For excursion vessels, Bay Area-specific data for excursion vessels for main and auxiliary engines were obtained from CARB based on their 2017 Statewide CHC survey (personal communication, August, 2018).

To obtain in-transit operating activity, information from ferry schedules were reviewed for each ferry route. Based on departure and arrival times, the duration of travel time was estimated for the Oakland–Alameda route and for runs directly from ferry terminals to the extents of the Source Domain. Operating activity for excursion vessels was taken from the CARB 2017 Statewide CHC survey. In-transit emissions estimates for each route are presented in **Table 2-35**, where DPM emissions were assumed to equal PM_{10} emissions, and $PM_{2.5}$ emissions were obtained by multiplying the DPM emissions by a size fraction factor of 0.97 (consistent with similar vessels in the 2017 Port Inventory).

[59] Obtained from K. Stahnke, San Francisco Water Emergency Transportation Authority, personal communication, September, 2018.

Table 2-34. Commuter ferry and excursion vessel operating parameters. Values obtained from CARB (2012b and personal communication, August, 2018), except number of vessels (n), vessel age (A), horsepower (HP), and load factor (LF) obtained from WETA. EF, F, and D are specific to PM_{10} (DPM). Values reported for excursion vessels are averages over the operating fleet.

Vessel type	Engine	n	EF [g/(hp h)]	F	D	A (y)	UL (y)	LF	HP (hp)
Ferry	Main	2	0.10	0.80	0.67	3	20	0.38	1950
	Auxiliary	1	0.09	0.80	0.44	3	20	0.38	162
Excursion	Main	2.01	0.15	0.50	0.75	0.67	20	0.42	1473
	Auxiliary	1.23	0.22	0.71	0.75	0.44	20	0.43	116

Table 2-35. $PM_{2.5}$ and DPM emissions from commuter ferry and excursion vessel in-transit activity.

Vessel type	Route	$PM_{2.5}$ (tpy)	DPM (tpy)
Ferry	Oakland – Alameda	0.074	0.076
	Oakland – San Francisco	0.278	0.287
	Oakland – South San Francisco	0.088	0.091
	Alameda – San Francisco	0.294	0.303
	Alameda – South San Francisco	0.062	0.064
Excursion	Commodore Events and Cruises (to San Francisco)	0.039	0.040
Total	–	**0.835**	**0.861**

(b) Berthing

As aforementioned, there are two commuter ferry terminals inside the West Oakland Source Domain (one in Oakland, and the other in Alameda), and a berth associated with a privately-operated excursion vessel company (Commodore Cruises and Events).

To estimate the $PM_{2.5}$ emissions from berthing, the number of trip visits at each terminal was determined based on ferry schedules. For excursion vessels, since there was no daily schedule and operating hours vary by event, berthing activity was based on operator data taken from the CARB 2017 Statewide CHC survey. Commuter ferry berthing time was based on a sample of observations taken by District staff in 2018 at the two ferry terminals, where the average berthing time to load and unload commuters at a terminal was approximately 10 min. Both the main and auxiliary engines were observed to run the entire time during this berthing process. Emissions were calculated as described above and are summarized in **Table 2-36**.

Table 2-36. $PM_{2.5}$ and DPM emissions from commuter ferry and excursion vessel berthing.

Vessel type	**Berth**	**$PM_{2.5}$ (tpy)**	**DPM (tpy)**
Ferry	Oakland (Jack London Square terminal)	0.006	0.006
	Alameda (Main Street terminal)	0.006	0.006
Excursion	Commodore Cruise and Events terminal	0.058	0.060
Total	**–**	**0.070**	**0.072**

3. Air Dispersion Modeling

The dispersion model applied in the technical assessment for West Oakland was the American Meteorological Society/EPA Regulatory Model Improvement Committee Regulatory Model (AERMOD). AERMOD was used to perform dispersion modeling using unit emission rates to represent the emissions from emissions sources in the community-scale bottom-up emissions inventory (**Section 2**): permitted stationary sources, on-road mobile sources, truck-related businesses, OGVs, CHCs, CHE, Port Trucks at Port terminals, locomotives, railyard activity, and commuter ferries and excursion vessels. Meteorological data (**Section 3.2**) are used to simulate dispersion using AERMOD (**Section 3.3**), where the emissions from sources with specific temporal and spatial allocations (**Section 3.4**) are dispersed, and concentrations are sampled downwind at receptors (**Section 3.5**). Source contributions at each receptor can then be summed to evaluate total $PM_{2.5}$ concentrations and cancer risk (**Section 4**).

3.1 Modeling Approach

The AERMOD modeling system is comprised of three modules: (1) AERMET, a preprocessor for making compatible meteorological data sets, (2) AERMAP, a processor for digital terrain data, and (3) AERMOD, an air dispersion model. Data generated from AERMET and AERMAP are used by AERMOD to estimate downwind concentrations. AERMOD (Cimorelli *et al.* 2004) is a steady-state Gaussian-based plume dispersion model based on planetary boundary layer turbulence structure and scaling concepts. AERMOD can model dispersion from both surface and elevated sources, in simple and complex terrain, and in rural and urban areas.

In AERMOD, emissions are dispersed from a *source*, and concentrations are sampled at a *receptor*. A source is defined by entering its location, physical characteristics (e.g., width, height), and emissions characteristics (i.e., emission rate, and changes of that rate over time). In AERMOD, a source can be defined by using different source types: point, area, and volume sources. Different sources types are better suited for representing different types of emission sources; for example, point sources are typically used to model dispersion from single facility stacks. A receptor is a location where air pollutant concentrations are estimated by the model. Receptors could correspond to the locations of monitoring sites or specific locations of interest (e.g., sensitive receptors). Many receptors must be placed within a modeling domain to adequately sample the spatial extent and gradients of pollutants near emission sources.

Because of its ability to handle multiple source types, the AERMOD modeling system was used to model dispersion from all emissions sources in community-scale bottom-up emissions inventory for West Oakland. The AERMOD FORTRAN source code (version 18081, dated March 22, 2018) was downloaded from the U.S. EPA Support Center for Regulatory Air Models (SCRAM) web site.[60] The source code was compiled on the District's Linux clusters using the Portland Group, Inc. FORTRAN 90/95 compiler (pgf95 v8.0-6 64 bit). AERMET (version 18081) and AERMAP (version 18081) were installed on the District's Microsoft Windows computers via AERMOD View (provided by Lakes Environmental).

[60] http://www.epa.gov/scram001/dispersion_prefrec.htm.

Modeling a large number of sources requires a large amount of computing time, especially when there are many receptors (see **Section 3.5**). To reduce the wall time required to complete the analysis, model runs by individual source were distributed across a large number of computer processors.[61] And, as the dispersion from each source was modeled separately, individual source contributions could be tracked and assessed.

Dispersion modeling requires many input parameters to characterize emission sources, including an emission rate, which may vary over the modeling period (e.g., by hour of day, by day of week, etc.). For a single source, emission rates also vary by pollutant; ordinarily, in a multi-pollutant analysis, the number of model runs required is equal to the number of pollutants. However, the number of model runs can be reduced by using a *unit emission rate*[62] (1 g/s for point and volume sources, 1 g/(s m^2) for area sources) for each source. Temporal changes in the unit emission rate are scaled using the emissions or activity profile (e.g., hours of operation) of the source. AERMOD output are then *dispersion factors* with units of concentration per unit emissions ([$\mu g/m^3$]/[g/s] for point and volume sources, or [$\mu g/m^3$]/[g/(s m^2)] for area sources) at each receptor. Following this approach, average concentrations can be calculated by multiplying the dispersion factor by an average emission rate in a post-processing step (see **Section 4.1.2**). Using this method holds so long as (a) the emission rates for different pollutants are related to the same changes in source activity, and (b) the dispersion factor and emission rate are averaged over the same time scales.[63] This method does not account for any chemical transformations.

3.2 Meteorological Data

3.2.1 Surface meteorology

The District operates a meteorological monitoring network of stations within the nine Bay Area counties that provide measurements of ambient meteorological parameters to support many air quality-related programs. Several of these stations are near West Oakland. The Oakland Sewage Treatment Plant (OST) station is operating in the current network (**Figure 3-1**). The National Oceanic and Atmospheric Administration (NOAA) operates a network of buoy and land-based weather stations in the Bay as part of the National Ocean Service's Center for Operational Oceanographic Products and Services (CO-OPS) network that monitors atmospheric and ocean/bay surface conditions. Three land-based stations (Oakland Berth 34 [OKXC1], Oakland Middle Harbor Met [OMHC1], and Oakland Berth 67 [LNDC1]) are also located near West Oakland (**Figure 3-1**). All these stations measure wind speed, wind direction and temperature, which are required parameters for the AERMOD model. The OST data are reported as hourly averaged, while the CO-OPS data are two-minute averages reported every six minutes.

[61] Two computer platforms were used: (1) a 14 node Linux cluster, each with eight Intel® Xeon® E5335 2 GHz processors; and (2) a 12 node Linux cluster, each with 20 Xeon E5-2640 Broadwell 2.4 GHz processors. Processors were used as they became available to complete modeling runs using a job queuing system.

[62] Using unit emissions is sometimes referred to as the χ/Q ("chi over q") method. The origin of this reference stems from the conventional use of χ to represent average concentration, and Q to represent an emission rate.

[63] For example, in this analysis, for on-road mobile sources, dispersion factors and emission rates were developed separately by day type (weekend and weekday), and then summed to obtain an annual average concentration. All other sources were modeled as annual averages.

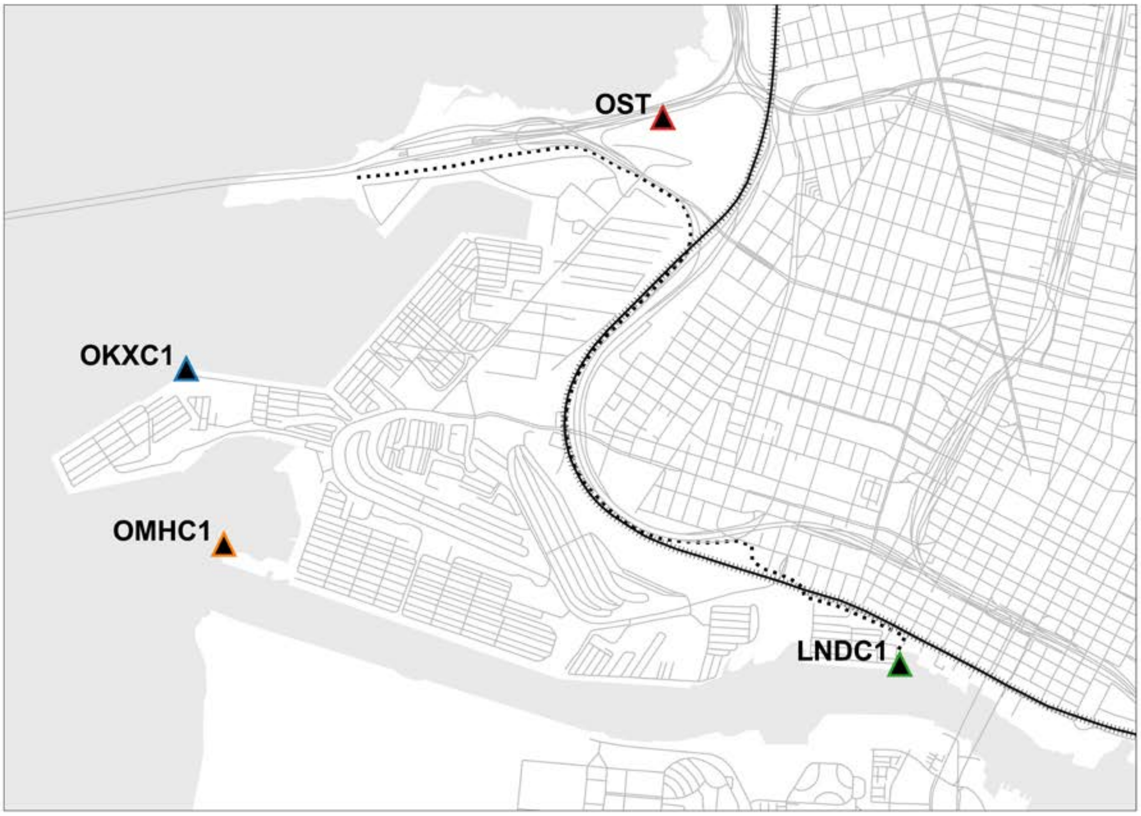

Figure 3-1. Surface meteorological monitoring stations considered for this analysis: OST (Oakland Sewage Treatment Plant), Oakland Berth 34 (OKXC1), Oakland Middle Harbor Met (OMHC1), and Oakland Berth 67 (LNDC1).

Of the four meteorological stations, only OST was sited to meet EPA modeling guidelines. The CO-OPS station sitings were meant to aid in the docking of container ships and in navigating the Oakland inner harbor. The wind vanes on all three CO-OPS stations are well below the recommended 10 m installation height (7.6 m at OKXC1 and LNDC1, and 6.7 m at OMHC1). OKXC1 and OMHC1 are also located at the land/water interface, with open water to the west, which is the dominant wind direction in West Oakland. The smooth upwind water surface could lead to lower mechanical mixing (lower dispersion) when modeled in AERMOD. LNDC1 is also sited in a location that is not ideal to support AERMOD modeling, as the surrounding surface roughness can vary depending on the placement of shipping containers and the movement of the shipping cranes, which can in turn affect measurements at the site. OST wind sensors were installed higher (16.3 m) than the minimum recommended height (10 m) to compensate for the heights of nearby structures. For these reasons, OST meteorological data was selected for the West Oakland AERMOD modeling.

OST data for year 2014 were selected for the AERMOD modeling as subsequent years had significant periods of missing data. In 2014, winds were most frequent from the west and west-northwest at speeds of 2.0–6.0 m/s (4.5–13.4 mph) (**Figure 3-2**). The OST data were processed through AERMET to create meteorological inputs used in subsequent dispersion modeling using AERMOD.

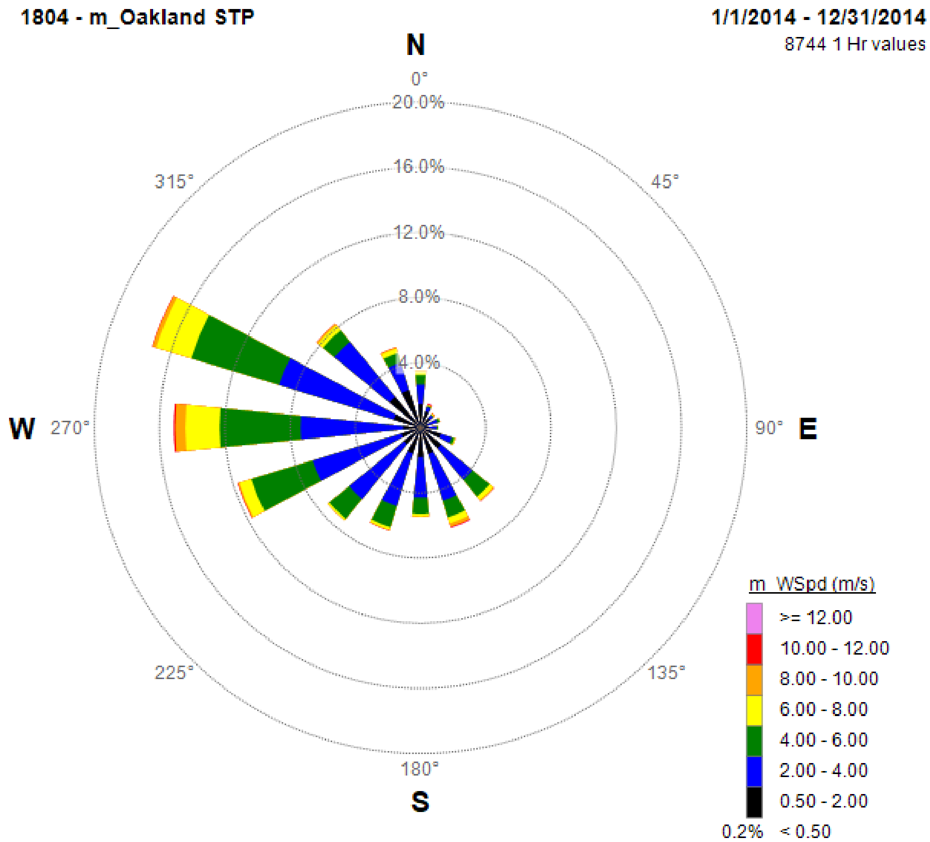

Figure 3-2. Annual windrose at the Oakland Sewage Treatment Plant (OST) in 2014. Compass sectors indicate the direction from which the wind is blowing. The percentage of calm winds (WSpd < 0.5 m/s) are also indicated.

3.2.2 Upper-air meteorology

The twice-daily (4:00 AM LST and 4:00 PM LST) upper air sounding data from the Oakland International Airport (KOAK; +37.744408° N, –122.223510° W) were also processed through AERMET to create input data for AERMOD dispersion modeling. The KOAK sounding is the only National Weather Service (NWS) upper air station in Northern California. Data from these soundings are namely used to calculate the convective mixing height during daylight hours.

3.3 AERMOD Model Configuration

Dispersion factors were modeled using default regulatory model options, including: stack-tip downwash, accounting for elevated terrain, calms processing routine,[64] missing data processing routine,[65] and an urban roughness length of 1.0 m. Additionally, no dry or wet deposition was included. Building downwash effects were not incorporated since individual building heights were not generally available. All sources were classified as urban sources, which is representative of land cover in West Oakland. The urban population (used as a surrogate to define the magnitude of the nighttime urban heat island, which enhances dispersion in the stable boundary layer) used was 650,000.[66] The height of each receptor was set to 1.8 m agl (referred to as "flagpole receptors"), which represents the breathing height of an average adult.

Dispersion factors were output as a daily average over the entire modeling period. Modeling was based on a meteorological dataset from 2014 (see **Section 3.2**). For on-road mobile sources, two modeling periods were used: all weekdays (261 days), and all weekend days (104 days). Otherwise, the period was defined as the entire year (January 1, 2014, through December 31, 2014).

The geographic coordinate system used throughout the modeling was a Universal Transverse Mercator (UTM) projection for zone 10 North with the North American Datum of 1983 (NAD83). Unless otherwise stated, for simplicity, the base elevation of each source was assigned by taking the elevation of the closest receptor as generated using AERMAP (see **Section 3.5**).

All sources in this analysis were located within the Source Domain, which encompassed the entire West Oakland community and Port of Oakland, and includes all emission sources discussed in Section 2 (**Figure 2-2**). A smaller "Receptor Domain" (**Figure 3-3**), embedded within the Source Domain, was used to define the extents of where receptors should be placed in AERMOD (see **Section 3.5**). The location of receptors is more spatially constrained so that they are located in areas where the population could be exposed (i.e., receptors were not placed over the Oakland harbor).

[64] In the calms processing routine, the concentration for a given hour is set to zero if the wind speed of that hour is calm. The (zero) concentration is then excluded when longer term (period) average concentrations are calculated (U.S. Environmental Protection Agency 2018b).

[65] In the missing data processing routine, hours with missing meteorological data are treated the same way as in the calms processing routine (U.S. Environmental Protection Agency 2018b).

[66] This is the total population of Berkeley, Piedmont, Emeryville, Oakland, and Alameda, based on the U.S. Census Bureau July 1 2017 (V2017) dataset (available via https://www.census.gov/quickfacts). The total population from these areas was rounded to the nearest thousand (U.S. Environmental Protection Agency 2015a). A slight over- or under-estimate of the population will not adversely affect modeling results since the urban algorithms in AERMOD depend on the population to the one-fourth power (Cimorelli *et al*. 2004).

Figure 3-3. Extents of the Source Domain (red dotted lines) and Receptor Domain (blue solid lines) used in AERMOD modeling. The inner tiles represent the 1 km × 1 km grid cells of the regional modeling.

3.4 Sources

3.4.1 Overview

Source-specific modeling parameters used for the emission sources in West Oakland (**Section 2**) are described in this section. In AERMOD, the user (modeler) must identify how each emissions source will be modeled (i.e., as a point, area, or volume), and input the location and associated modeling parameters. Location information includes the *x* coordinate (longitude), *y* coordinate (latitude), and *z* coordinate or base elevation (m asl). For point and volume sources, the *x* and *y* coordinates correspond to the center of the source. Multiple *x* and *y* coordinates are required for area sources when represented as polygons. In general, the parameters required by source type are:

- **Point**: emission rate (g/s), stack height (m agl), stack gas exit temperature (K), stack gas exit velocity (m/s), and interior stack diameter (m).
- **Area**: emission rate [g/(s m^2)], release height ($Relhgt$, m agl), and initial vertical dispersion coefficient ($Szinit$, m).
- **Volume**: emission rate (g/s), release height (center of volume) ($Relhgt$, m agl), initial lateral dispersion coefficient ($Syinit$, m), and initial vertical dispersion coefficient ($Szinit$, m).

These modeling parameters are important for determining plume rise and how emissions are transported downwind of the source. As aforementioned, the emission rate for all source types was set to a unit emission rate. An optional modeling parameter to vary the emission rate was applied to sources when the diurnal activity profile was available.

The type of source used to model emission sources in West Oakland depended on the source category (**Table 3-1**). The general process used to determine the location (*x* and *y* coordinates) of sources for each source type in described below, while specific parameters by category are summarized in the sections that follow.

Table 3-1. AERMOD source types used by source category for emissions sources in West Oakland. Point sources include point, capped, and horizontal emission releases.

		AERMOD Source Type			
				Volume	
Section	**Source Category**	**Point**	**Area**	**Single**	**Adjacent**
3.4.2	Permitted stationary sources	×		×	
3.4.3	On-road mobile sources				×
3.4.4	Truck-related businesses		×		
3.4.5	OGVs (maneuvering, berthing)		×		
3.4.6	CHCs		×		
3.4.7	CHE		×		
3.4.8	Port Trucks at terminals (transiting, idling)		×		
3.4.9	Locomotives				×
3.4.10	Railyards		×		
3.4.11	Commuter ferries and excursion vessels – navigating				×
3.4.11	Commuter ferries and excursion vessels – berthing		×		

(a) Point Source and Single Volume Source Locations

The only point and single volume sources in this analysis were permitted stationary sources. The District maintains a database of these sources and their locations, from which the location of each stack was obtained after QA (**Section 2.2**).

(b) Area Source Locations

Area sources were manually traced using Google Earth. The polygons were then saved as a shapefile, and an automated program was used to extract the *x* and *y* coordinate values of the vertices and create AERMOD-ready input files.

(c) Adjacent Volume Source Locations

In this analysis, mobile sources were modeled following much of EPA's current guidance for PM hot-spot analyses for transportation projects (U.S. Environmental Protection Agency 2015b, 2015c).[67] On-road mobile sources were modeled using adjacent volume sources. Both adjacent area and volume sources can be used to represent emissions from on-road mobile sources in AERMOD, though adjacent area sources are usually favored since they "may be easier to characterize correctly compared to [adjacent] volume sources" (U.S. Environmental Protection Agency 2015b, p. 105). This is because adjacent volume sources must be placed so that the volume centroids are equidistant from each other along the length of the emissions source (e.g., roadway), resulting in up to thousands of individual volume sources to characterize a single emissions source. Common errors made when configuring adjacent volume sources include incorrect volume centroid spacing (so that volumes are no longer adjacent), and using an inappropriate source width (e.g., street width) (Desser 2014). Typically, the initial lateral dispersion coefficient, $Syinit$, is calculated as the source width divided by 2.15. For volume sources, the exclusion zone (EZ) is an area around each volume source where AERMOD does not calculate results,[68] and no receptors should be placed. The radius of the EZ (r_{EZ}) from the centroid of the volume is calculated as:

$$r_{EZ} = (2.15 \cdot Syinit) + 1.0 \text{ m}$$

As receptors are to be placed as close at 5.0 m to roadways to adequately sample spatial concentration gradients, the maximum width of a roadway in AERMOD should be 8.0 m (U.S. Environmental Protection Agency 2015c); roadways that exceed this width should be modeled as several series of adjacent volume sources, such as to represent different travel lanes.

Because of the complexity of configuring adjacent volume sources, commercial software can help simplify this task by using a graphical user interface. Though, the process remains arduous if many emissions sources need to be included, such as in this analysis, where all roadways in West Oakland were modeled. For this reason, the District created an internal software package designed to automate the process of configuring adjacent volume sources for all emissions sources that are linear in nature – on-road mobile sources, locomotives on rail lines, and commuter ferries and excursion vessel travel routes.

In this process, the required inputs are a shapefile containing a network of line geometries representing the centerline of the emissions sources (roadway, ferry track, rail line), with a source width assigned to each segment (for roadways, the number of lanes can also be supplied). As a first pass, the number of volumes per line segment is determined by dividing the total length of the segment by its width, and each volume centroid is placed a distance of a width apart.[69] For roadways, if the total width exceeds a maximum width threshold (8.0 m), then the number of lanes is used to create a new series of roadway (lane) 'centerlines' parallel to the input centerline, and the new width is equal to the total width divided by the number of lanes. Multiple iterations are performed to minimize the number of overlapping volume sources at network nodes, as the overlaps can cause spurious small-scale "hot spots" of emissions.

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[67] That being said, as this analysis is not a formal PM hot-spot analysis, some aspects to the modeling approach differed.

[68] Suppose there is a receptor A within the EZ of volume source a; AERMOD will not calculate results (output is 0.0) at A. However, if the model is configured with multiple volume sources – a, b, c – and receptor A is only within the EZ of volume source a, then the results at receptor A only represents the contributions from volume sources b and c, which is an underestimate of the expected results.

[69] Only a whole number (integer) of volumes can be placed along segment. The first volume centroid is located at a position whose distance is half the width of the source from the starting coordinate of the segment.

3.4.2 Permitted Stationary Sources

Depending on the specific source category, emissions from permitted stationary sources were modeled as either point or volume sources in AERMOD. Modeling parameters were based on the most recent data available. All point and volume centroid locations were based on the coordinates available in the 2017 CEIDARS report (see **Figure 2-5**). The District also promulgates the release parameters as part of the CEIDARS report (by individual source at each facility). However, more recent release parameters may be provided by facilities in permit applications (in health risk assessments [HRAs] or in prevention of significant deterioration [PSD] analyses) is conducted as part of a permit application and are therefore not available through CEIDARS. The District therefore collected permit applications (available up to November 2018) and manually updated the 2017 CEIDARS modeling parameters for each permitted source in West Oakland. Increasing the accuracy of the release parameters should result in higher confidence in dispersion model performance and therefore higher confidence in the estimated downwind concentrations.

(a) GDFs

Emissions from GDFs were modeled as volume sources in AERMOD, where the initial release parameters were determined by the number of gasoline dispensers at the facility. When the number of dispensers at the facility was known, $Syinit$ was estimated using the equation:

$$Syinit = -0.00393\ \mathrm{m}\ \cdot n^2 + 0.3292\ \mathrm{m}\ \cdot n + 0.7285\ \mathrm{m}$$

where n is the number of gasoline dispensers (based on Sonoma Technology Inc. 2011). $Relhgt$ was always set to 1.03 m (see **Table 3-2** for a summary of these parameters).

(b) All other permitted stationary sources

Emissions from permitted stationary sources were modeled as point sources when stack release parameters or default parameters were available. Otherwise, the emissions were modeled as volume sources. Default parameters (used when information was not available) for point and volume sources are listed in **Table 3-2**.

Table 3-2. Default modeling parameters for permitted stationary sources. These values were applied when no other modeling information was available. The source type indicates the type of source in AERMOD that was used for dispersion modeling. The following variables are used: $Relhgt$ (release height), $Syinit$ (initial lateral dispersion coefficient), $Szinit$ (initial vertical dispersion coefficient). For gasoline dispensing facilities, n is the number of dispensers at the facility.

Source Description	Source Type	Default	
		Parameter	**Value**
Prime or Standby Generator	Point	Stack height	3.66 m (12 ft)
		Stack diameter	1.83 m (0.6 ft)
		Exit temperature	739.8 °C (872 °F)
		Exit velocity	45.3 m/sec (8,923 ft/min)
Sources that have incomplete modeling information	Point	Stack height	6.1 m (20 ft)
		Stack diameter	3.05 m (1 ft)
		Exit temperature	644 °C (700 °F)
		Exit velocity	17.8 m/s (3,500 ft/min)
No information available	Volume	$Relhgt$	1.8 m
		$Syinit$	10 m
		$Szinit$	1.0 m
Gasoline Dispensing Facility (Gas Station)	Volume	n	4
		$Relhgt$	1.03 m (3.4 ft)
		$Syinit$	1.98 m if n = 4; otherwise use equation in **Section 3.4.2**

3.4.3 On-Road Mobile Sources

The approach for modeling emissions from on-road mobile sources depended on location: those from roadways within terminals at the Port, and those within the rest of the Port area and West Oakland community. This section presents the modeling approach for the latter group; emissions from on-road mobile sources on roadways within terminals are discussed in **Section 3.4.7**.

On-road mobile source emissions were modeled in AERMOD as adjacent volume sources. The location of the volumes (centroids) was developed using a roadway network obtained from Citilabs, and the elevation (expressed as an adjusted release height) was determined from a lidar dataset. Other emissions characteristics were based on current EPA PM hot-spot guidance.

(a) Location (x, y, and z coordinates)

A shapefile containing the geographic location of roadways and roadway attributes in Alameda County was obtained from Citilabs (Streetlytics platform) to develop the locations and extents (widths) of adjacent volume sources. A description of this data set and the filtering and QA process applied by the District is described in **Section 2.3**. While the accuracy of volume source locations is dependent on the accuracy of the roadway network obtained from Citilabs, the District did not directly QA the roadway segment centerline locations.

While roadway (source) width is not a readily available parameter, it is needed to determine $Syinit$ of each volume; a combination of the roadway functional class and the number of lanes was used to approximate the roadway width, where the total width was taken as the number of lanes times the width per lane. The width per lane was based on guidance for roadways in urban areas as classified by FHWA (**Table 2-8**): 3.6 m for freeways, 3.0 m for arterials, and 2.7 m for local roads (American Association of State Highway and Transportation Officials 2018).[70]

Adjacent volume source locations were generated using the algorithm described in **Section 3.4.1**(c) (**Figure 3-4**). Volume source locations were identical for Non-Trucks and Trucks. Once the *x* and *y* coordinates of each volume source were determined, the *z* coordinate (base elevation) was taken from the nearest receptor (**Section 3.5**).

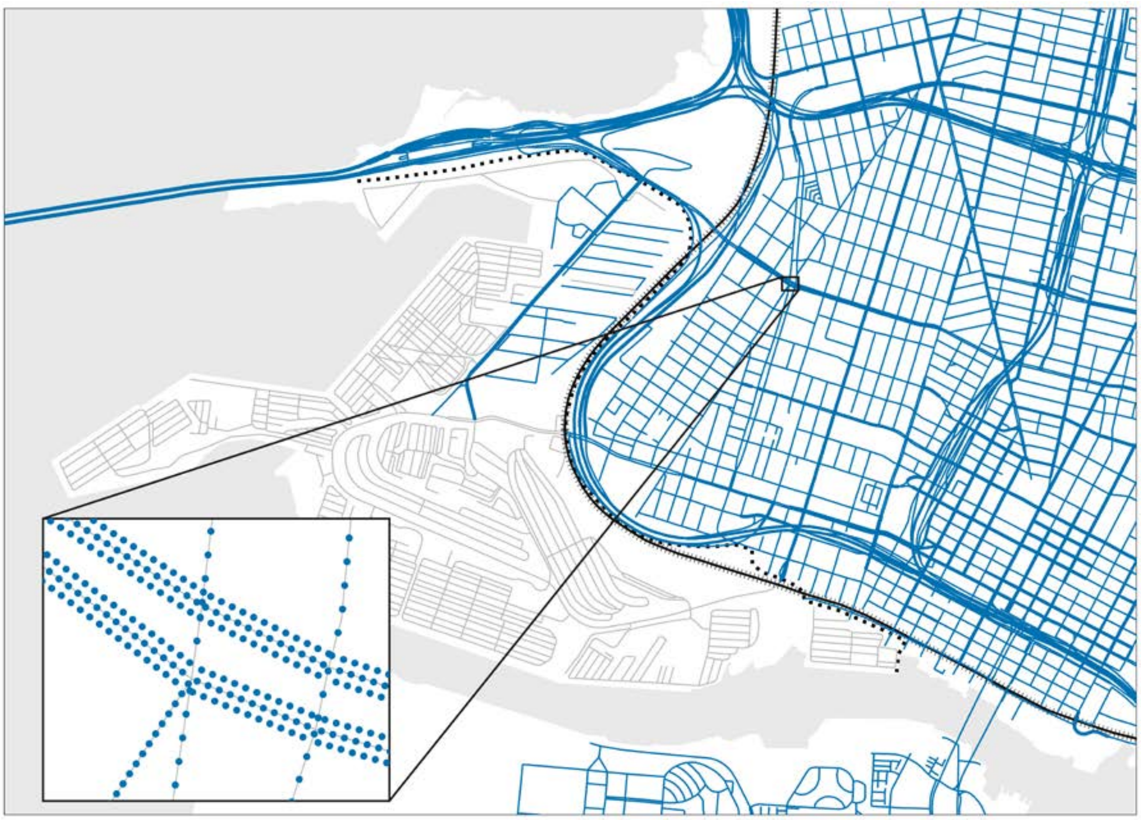

Figure 3-4. Locations of adjacent volume sources used to model emissions from on-road mobile sources. In the inset, the grey lines represent the location of roadways centerlines. The location of the marker represents the centroid of the volume source; the size of the marker does not reflect the dimensions of the volume source.

[70] Based on the Citilabs network, on- and off-ramps were assigned to both arterial and local road categories.

(b) Elevation (Adjusted release height)

In West Oakland, there are many roadways segments that are elevated, i.e., where the road surface is above grade, such as freeway overpasses. In this analysis, the elevated roadway structure heights were added to the emissions release heights (see (c)) to obtain an adjusted release height. The roadway surface heights were developed from two lidar raster datasets obtained from the U.S. Geological Survey (USGS), downloaded via the National Oceanic and Atmospheric Administration (NOAA) Data Access Viewer:[71] *2010 USGS San Francisco Coastal Lidar* (1 m resolution), and *2006 USGS Topographic Lidar: Alameda County* (2 m resolution). Both datasets were available in UTM zone 10 North projection (NAD83). The 2006 dataset was needed to increase the spatial coverage of elevation information so that elevation data would be available for the entire Source Domain. Roadway surface structure heights were developed as follows:

(1) The ground elevation (Z_{Ground}, m asl) and Unclassified (Class 1) elevation ($Z_{Unclassified}$, m asl) data channels were obtained. Unclassified includes the elevation of vegetation, buildings, and other structures (such as roadways). For each channel:
   a. The 2006 dataset was resampled to the resolution of the 2010 dataset.
   b. The 2010 dataset was filled with the 2006 dataset where there was missing data within the Source Domain.
   c. Remaining missing pixel values were filled using an inverse distance weighted (IDW) interpolation.

(2) The resulting absolute structure height, Z_s, was calculated as:

$$Z_s = Z_{Unclassified} - Z_{Ground}$$

To reduce some noise in the data, all values ≤ 1.8 m were coerced to 0.0 m.

(3) The average absolute structure height, $\overline{Z_s}$, was added to the release height of each volume source. Given the area of the volume defined as a circle from the volume centroid (*x*, *y*) with a radius of $Syinit$ (which may vary by roadway link):
   a. For non-overlapping volumes, $\overline{Z_s}$ was taken as the average of all pixel values within the circular area.
   b. For overlapping volumes, which can occur at roadway intersections or for roadways overpasses, the release height was calculated by linear interpolation of $\overline{Z_s}$ values from adjacent volumes along the same roadway link.

Given the input datasets and algorithm, this process may not always determine the correct roadway heights due to channel noise, confounding data (e.g., vegetation overhanging roadways, which results in a higher interpreted structure height), or because of nearly-parallel overlapping roadways resulting in a significant number of overlapping volumes (e.g., an overpass over a street). Some freeway segments[72] (n = 12) with incorrect $\overline{Z_s}$ assignments were manually identified and corrected using an IDW interpolation between the known $\overline{Z_s}$ values start and end of the segment. The resulting values of $\overline{Z_s}$ at each volume centroid are shown in **Figure 3-5**; these results could be further improved with additional QA and filtering techniques in the future (see **Section 6.2.2**).

[71] https://coast.noaa.gov/dataviewer/.
[72] Freeway segments were prioritized since they will have the highest AADT and therefore highest emissions.

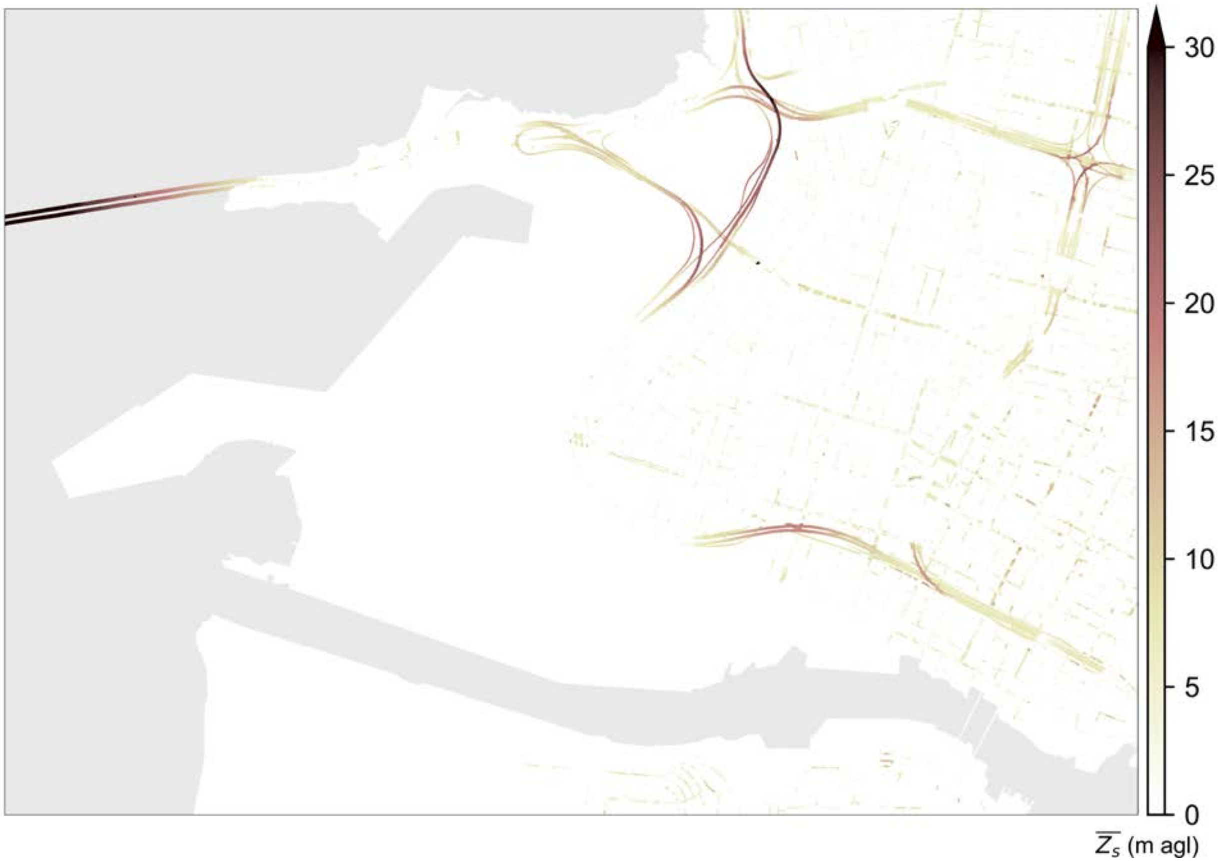

Figure 3-5. Average absolute structure heights of roadways at volume source centroids derived from lidar datasets. A $\overline{Z_s}$ value of 0 m agl indicates (white, not visible) that the volume source is at ground level and the roadway is at grade.

(c) Emissions characteristics

Though the location of volume sources by vehicle categories (Non-Trucks and Trucks), were identical,[73] they were modeled separately to track individual contributions to concentrations at receptors. While dispersion release parameters differ between Non-Trucks and Trucks, diurnal emission (activity) profiles also differ by day of week. This resulted in a four AERMOD dispersion modeling runs for on-road mobile sources for a given roadway segment: (a) WD Non-Trucks, (b) WE Non-Trucks, (c) WD Trucks, and (d) WE Trucks. For roadways located in the Port but that were not within active terminals, only Truck-configured runs were performed but used to characterize the emissions from all vehicle types.[74]

[73] As suggested by EPA, "overlapping versions" of each roadway segment can be used to represent the total emissions, treated each version with appropriate parameters to represent different vehicle categories (U.S. Environmental Protection Agency 2015c).
[74] This was done for convenience, but also because it is assumed that there is a low percentage of Non-Trucks on roads within the Port.

For all adjacent volume sources, the initial horizontal and vertical dispersion coefficients were based on the AERMOD User's Guide for surface-based sources (U.S. Environmental Protection Agency 2018b):

$$Syinit = W / 2.15$$

$$\begin{aligned} Szinit &= PH / 2.15 \\ &= (H \cdot \gamma) / 2.15 \end{aligned}$$

where W is the source width, PH is the initial vertical dimension of the source plume (plume height), H is the average source (vehicle) height, γ is a parameter to account for the effects of vehicle-induced turbulence, which equals 1 when vehicles are not moving, or 1.7 when vehicles are in motion (U.S. Environmental Protection Agency 2015c). H depends on the vehicle category, and was taken as 1.53 m for Non-Trucks, 4.0 m for Trucks. Therefore, $Szinit$ was set to 1.2098 m for Non-Trucks and 3.1628 m for Trucks.

Finally, the release height was estimated as the midpoint of the initial vertical dimension, i.e., $Relhgt = 0.5 \cdot PH$. Therefore, $Relhgt$ was initially set to 1.3 m for Non-Trucks, and 3.4 m for Trucks. For volumes that were not at-grade, $Relhgt$ was then adjusted by $\overline{Z_s}$ to obtain an adjusted release height.

To facilitate a unit emissions modeling approach, diurnal emission profiles for each roadway segment by vehicle category and day type were developed based on activity data (as described in **Section 2.3**). The diurnal activity profiles are comprised of ratios derived from hourly traffic volume normalized by the average daily traffic volume. These values are then used to scale the unit emission rate during the AERMOD run so that the hourly unit emission rate reflect the actual emission rates. For roadway segments located in the West Oakland community, diurnal profiles were link-specific for Non-Trucks, and road type-specific for Trucks (**Figure 3-6**). For roadway segments in the Port, diurnal profiles for Non-Trucks and Trucks were identical (since only one set of runs was performed, as noted above; **Figure 3-7**).

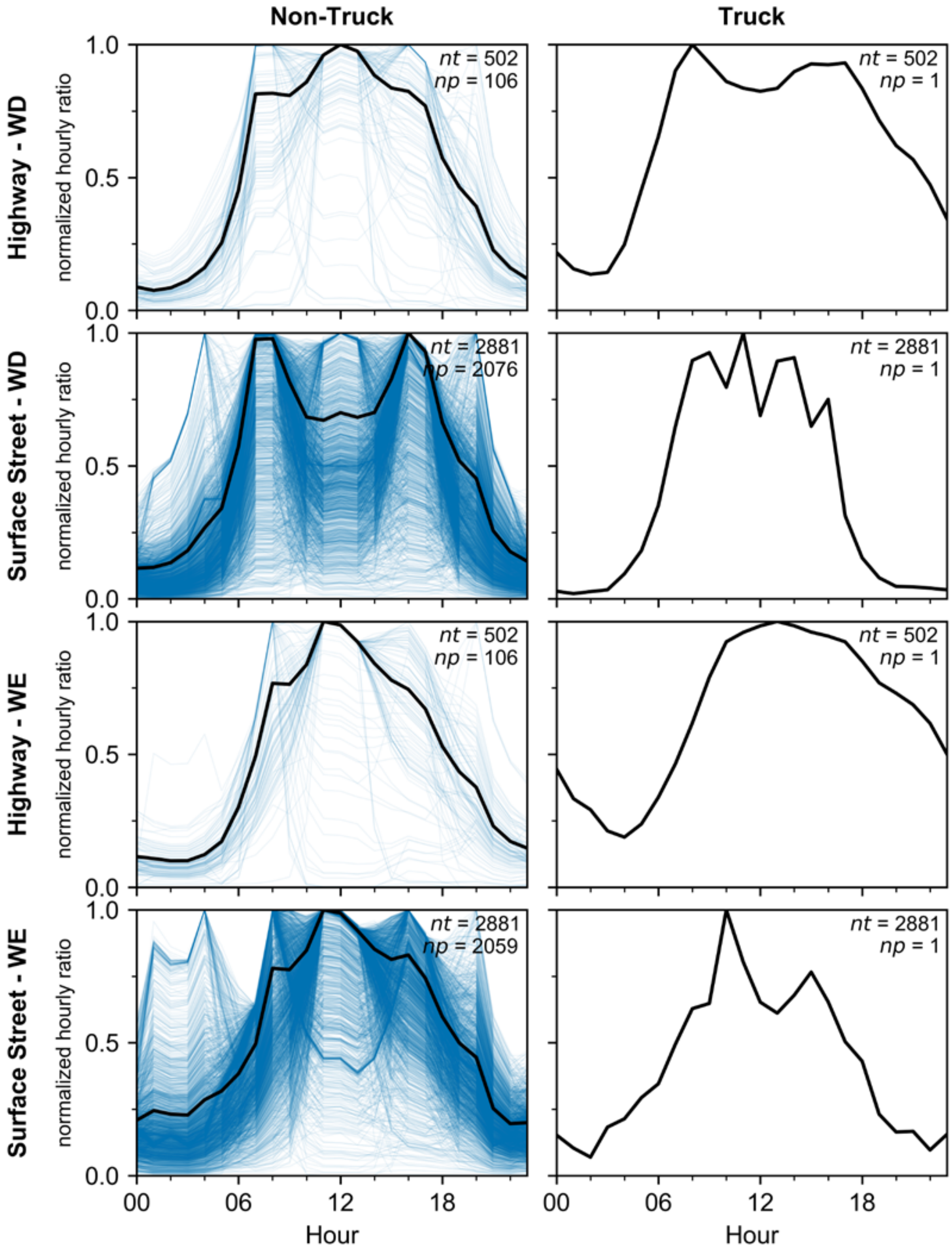

Figure 3-6. Diurnal emission profiles used for individual roadway segments in the West Oakland community normalized by maximum hourly volume. Profiles differ by road type (Highway, Surface Street) and day type (WD, WE) (rows), and vehicle category (Non-Truck, Truck) (columns). The number of unique profiles (np) and total number of roadway segments (nt) is annotated for each case. Individual profiles by roadway segment are plotted (thin blue lines), as well as the average profile (thick black lines); in cases where $np > 1$, the average profile is for illustrative purposes only. For unit emissions modeling, profiles normalized to the average daily traffic volume were used.

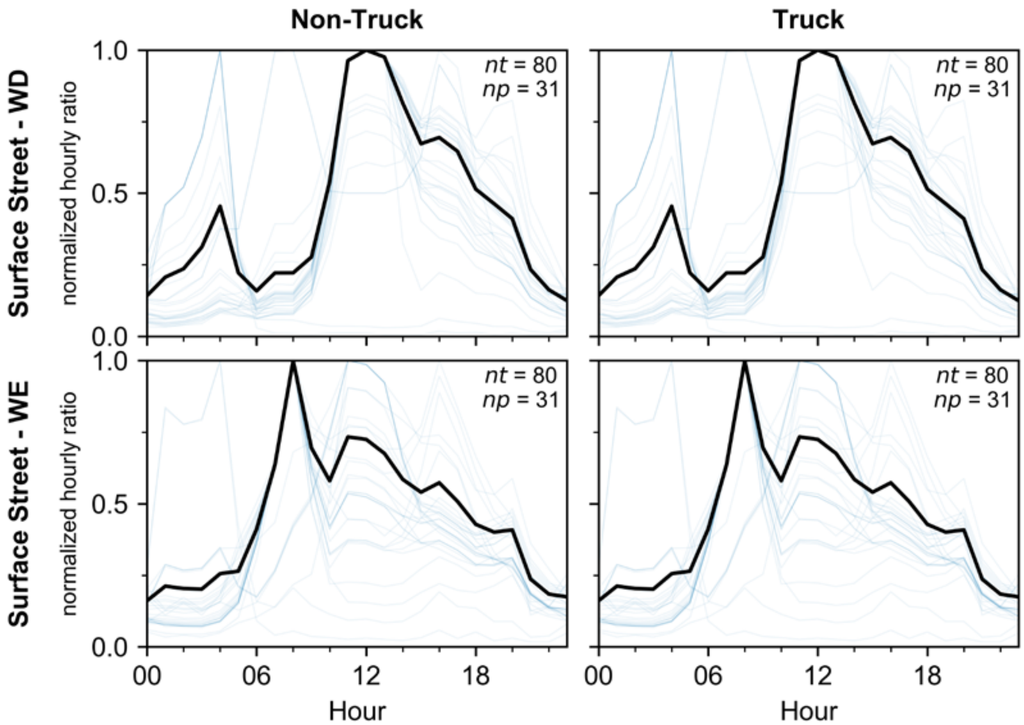

Figure 3-7. As in **Figure 3-6**, but for roadway segments in the Port area.

3.4.4 Truck-Related Businesses

Groups of idling vehicles in the same location can be modeled as an area source (U.S. Environmental Protection Agency 2015c). Emissions from truck activity at businesses with truck fleets (**Attachment 3**) were modeled as area sources (**Figure 3-8**). The areas were manually developed using satellite imagery, and then verified using Google Street View. The activity within these areas was associated with idling only; therefore, dispersion parameters were calculated as in **Section 3.4.3**, but with γ = 1 (no vehicle-induced turbulence, which aligns with modeling guidance provided in U.S. Environmental Protection Agency (2015c)). The height of all trucks was assumed to be 4.0 m, which results in $Szinit$ = 1.86 m, and $Relhgt$ = 2.0 m. Emissions from truck-related businesses were assumed to be evenly distributed from 8:00 AM to 5:00 PM on Monday through Saturday (no activity on Sunday).

Emissions from truck activity at Schnitzer Steel was also modeled as an area source (**Figure 3-8**); this includes emissions from all emission processes (running exhaust, idling exhaust, tire wear, brake wear, and road dust). The area was determined from satellite imagery so that it would not encompass the buildings or stockpiles. A release height of 5.5 m and an initial vertical dispersion coefficient of 2.558 m was used, consistent with modeling performed in California Air Resources Board (2008a). Emissions were evenly distributed over the hours of operation: 4:00 AM to 3:30 PM for Monday through Friday, and 5:00 AM to 12:00 PM on Saturday, with no activity on Sunday.

Figure 3-8. Area source polygons used to model emissions from truck-related businesses. The “S” indicates the location of Schnitzer Steel.

3.4.5 Ocean-Going Vessels

Emissions from maneuvering and berthing OGVs were modeled as two-dimensional area sources that were associated with specific terminal operators. Based on information provided by Ramboll (2018), Port-related OGV emissions were spatially allocated based on AIS records of ship positions in 2017 (2017 NOAA Cadastre AIS dataset). AIS relies on satellite positioning to track locations of commercial marine harbor crafts and large ships, which is required since 2016.[75] The AIS ship position records for ships headed to and from all Port berths were plotted, and the polygons were drawn around the bulk of the data points. For maneuvering and berthing, the positions of ships that headed to and from the four Port terminals were plotted to provide a guide to normal operating zones (by terminal). Spatial allocations according to operating mode were made as follows:

- OGV maneuvering emissions were assigned to polygons extending from the Inner and Outer Harbor channels and towards the entrance to these channels and the Bay Bridge (**Figure 3-9**). These polygons were defined to represent the most likely maneuvering areas applicable to each terminal operating during 2017 (TraPac, Nutter, OICT, and Matson).

[75] https://www.navcen.uscg.gov/?pageName=AISRequirementsRev.

- OGV berthing emissions were assigned to polygons at each terminal berth (**Figure 3-10**). Emissions were allocated between terminals based on the vessel call data from the 2017 SFMX Berth Report.

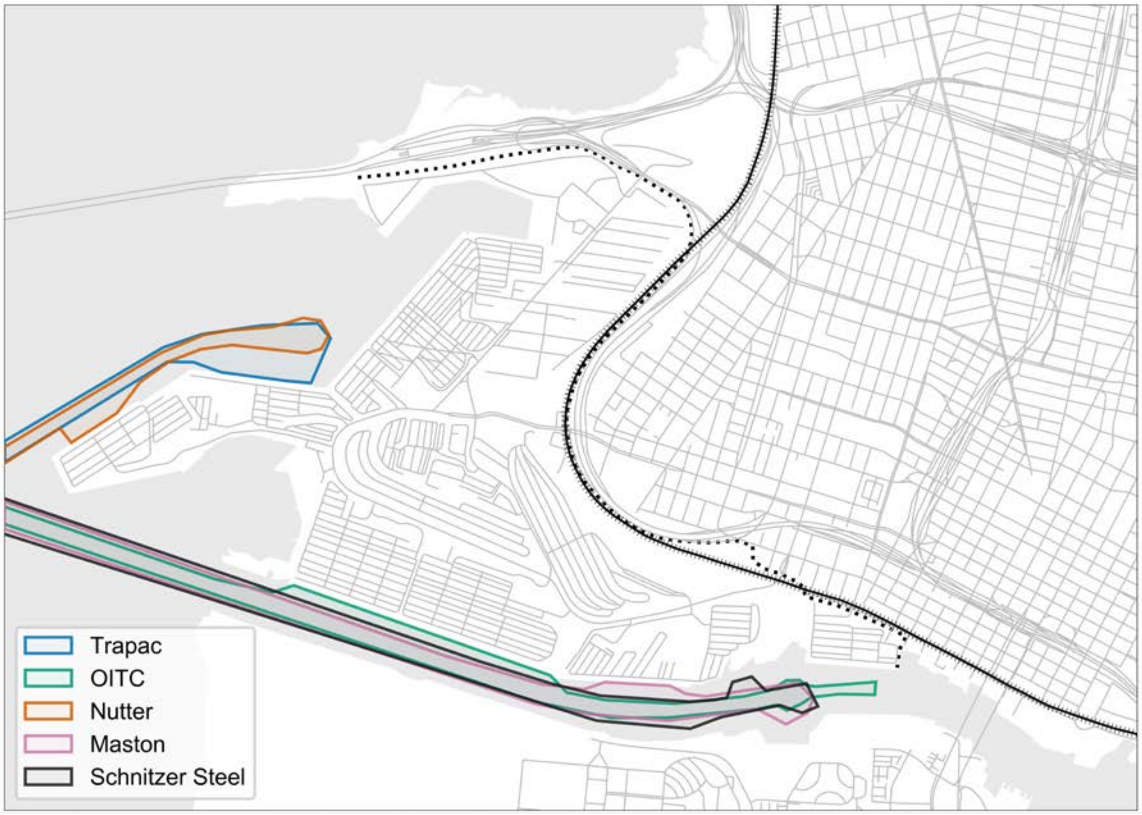

Figure 3-9. Area source polygons used to model emissions from OGV maneuvering.

An initial release height of 50 m was used for both OGV maneuvering and berthing activities. Emissions by activity were then temporally allocated by hour of day (ship call and twenty-foot equivalent unit [TEU] cargo volume throughput data showed little seasonal variation). A diurnal profile was developed for OGV maneuvering activity based on an analysis of hourly vessel movements (**Figure 3-11**). The highest frequency of arrival and departure times occurred near the start of labor shifts;[76] therefore, maneuvering emissions were assigned hour-specific allocation factors based on the arrival/departure frequency pattern. OGV berthing emissions at the Port were assigned a constant diurnal profile.

Emissions from OGV transiting, maneuvering, and berthing for ships to Schnitzer Steel were also modeled as an area source, which was approximated based on the spatial coverage of OGVs transiting to the Port (**Figure 3-9**, **Figure 3-10**). All OGV activities from Schnitzer Steel (transiting, maneuvering, hoteling) were modeled with a release height of 37.5 m, and emissions were assumed to be constant in time.

[76] Based on AIS records, a median of 23 min before ship arrival (denoted by 'first line on' time stamp in the SFMX berth report) and 19 min after departure ('last line off') was used to estimate the relative number of events by time of day for this mode within the Source Domain.

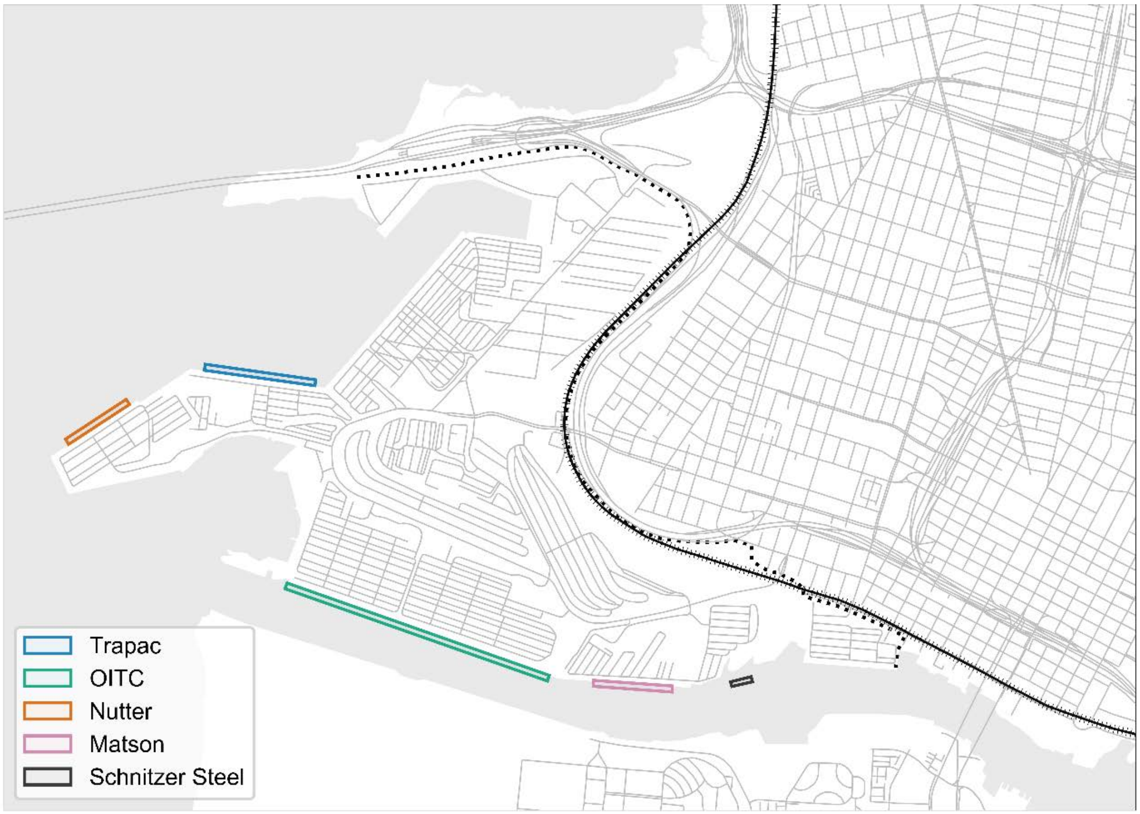

Figure 3-10. Area source polygons used to model emissions from OGVs at berths.

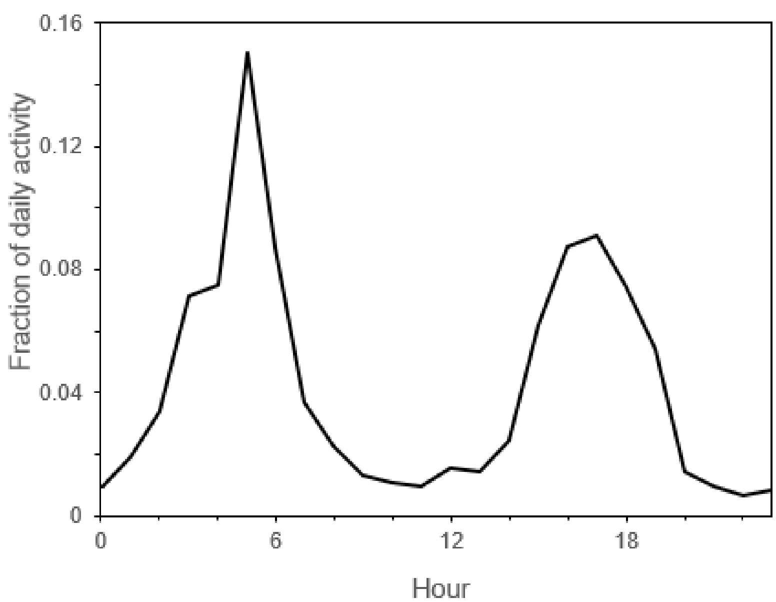

Figure 3-11. Diurnal emissions profile of Port OGV maneuvering. The profile is based on activity data from the 2017 Port Inventory.

3.4.6 Commercial Harbor Crafts

Emissions from all types of CHCs were modeled as area sources, while the spatial and temporal allocations of emissions varied by vessel type.

Dredging operations were assigned to two separate ship channels and berthing areas where these activities occurred (**Figure 3-12**). The area of the activity was created based on OGV AIS ship positioning information, which occurred near the main channel areas and berths that were dredged in 2017; the area was then extended to include unused Berths 23 and 24 in the Outer Harbor, and exclude the Berths 67 and 68 (which are rarely used).[77] Emissions were then allocated temporally based on the dredging schedule in 2017; dredging only occurred on 153 days (from January – February, and from August – December), and during daylight hours (8 AM – 6 PM). A release height of 6 m was used, with $Szinit$ = 4.744 m (consistent with California Air Resources Board (2008a)).

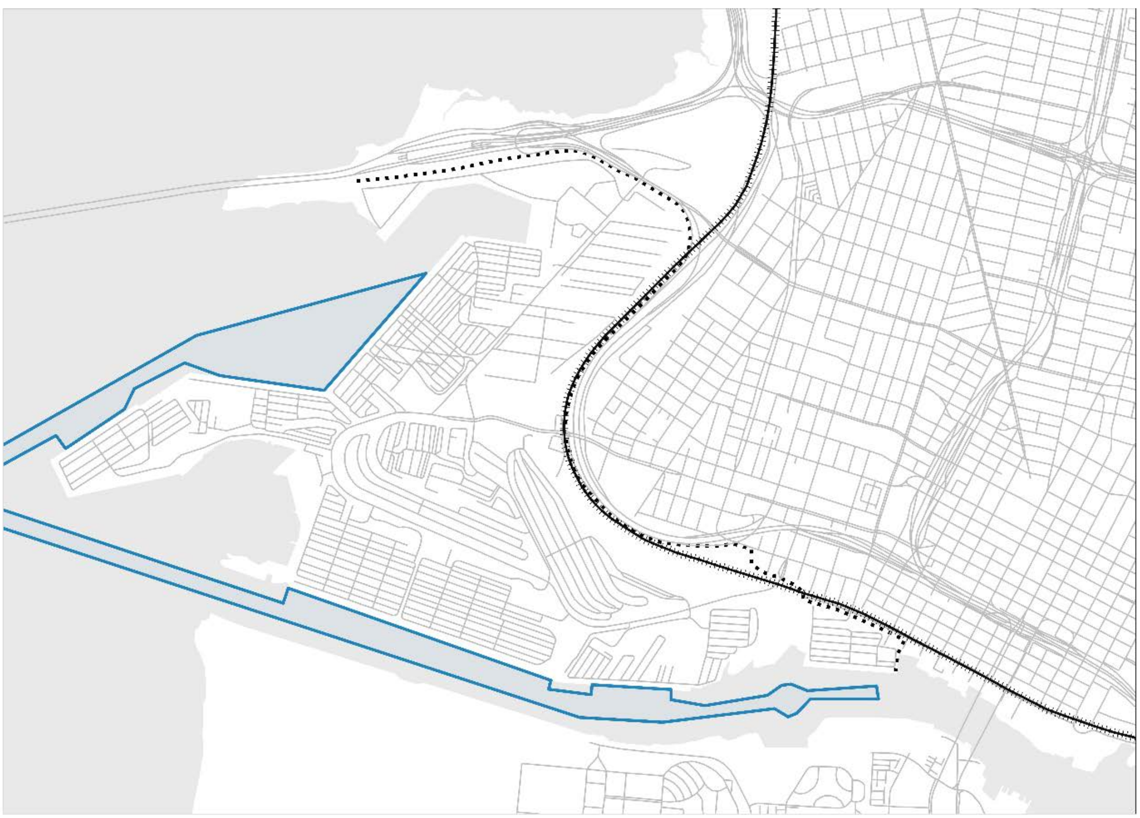

Figure 3-12. Area source polygons used to model emissions from dredgers.

Two areas sources were defined for assist tug operations, with one area representing tugs from the companies AMNAV Maritime Services, BayDelta, Crowley, and Foss Maritime, and the other representing tugs from Starlight Marine Services (**Figure 3-13**). Areas were derived based on AIS vessel position records during maneuvering and transit between the companies' base locations

[77] Based on communication with the company who performed the dredging.

(**Table 2-18**) to the Port. Emissions from assist tugs were temporally allocated in the same manner as OGV maneuvering (**Section 3.4.5**). A release height of 6 m was used, with $Szinit$ = 4.744 m (consistent with California Air Resources Board (2008a)).

Bunkering barges and bunkering pumps by terminal operator were assumed to operate in the same areas previously defined for OGV maneuvering and berthing, respectively (see **Figure 3-9** and **Figure 3-10**). Based on monthly bunkering events in 2017 (provided by Ramboll), emissions from bunkering varied by 6.4% to 9.6% on a monthly basis; for simplicity, emissions from bunkering activities were then assumed to be constant over the entire year. Emissions from bunkering barges were temporally allocated in the same manner as those from OGV maneuvering (**Figure 3-11**), whereas emissions from bunkering pumps were assumed constant.

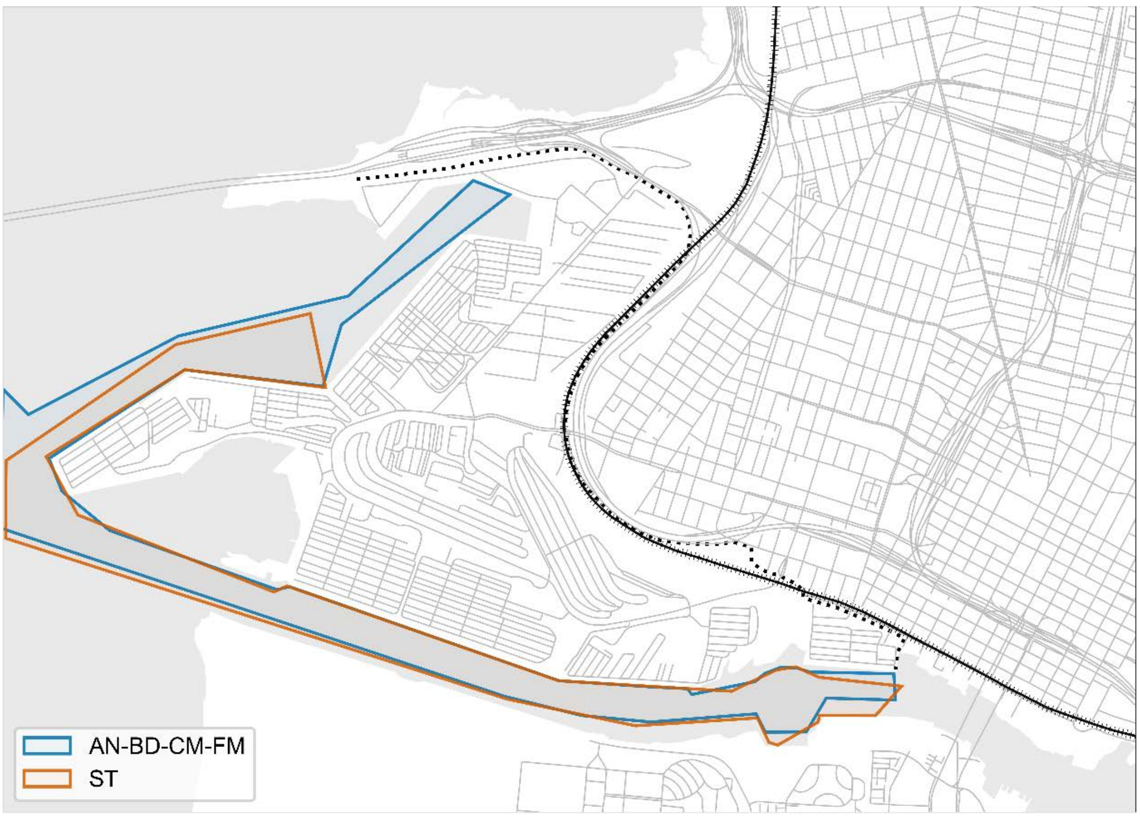

Figure 3-13. Area source polygons used to model emissions from assist tugs. Activity from AMNAV Maritime Services, BayDelta, Crowley, and Foss Maritime (AN-BD-CM-FM), and Starlight Marine Services (ST) were modeled separately.

3.4.7 Cargo handling equipment

Emissions from CHE were assigned to areas encompassing four terminals at the Port operating in 2017 (**Figure 3-14**). Emissions from CHE in the BNSF railyard were also accounted for. Based on California Air Resources Board (2008a), a release height of 5.5 m and an initial vertical dispersion coefficient of 2.558 m was used. The operating hours (**Table 2-23**) were used to develop temporal profiles for AERMOD dispersion modeling.

Figure 3-14. Area source polygons used to model emissions from CHE.

3.4.8 Port Trucks at Terminals

Emissions from Port Trucks operating within port terminals were assigned to source areas defined for BNSF Railyard (see **Figure 3-16**) and the same source areas defined for CHE (**Figure 3-14**). The same dispersion modeling parameters as CHE were used for Port Trucks ($Relhgt$ = 5.500 m, $Szinit$ = 2.558 m), as well as the same operating hours to temporally distribute the emissions (**Table 2-23**).

3.4.9 Locomotives (Rail Lines)

Emissions from locomotives on consolidated rail lines[78] in West Oakland were modeled as adjacent volume sources. A shapefile containing the geographic location of six rail lines in the West Oakland was used, which includes rail line segments with activity from BNSF and Amtrak. Volume source locations were developed using the algorithm described in **Section 3.4.1**(c), with a width of 6.25 m (width of locomotives plus wake effects). The release height of the locomotives was assumed to be 4.78 m (locomotive stack height). $Syinit$ and $Szinit$ were determined based on the equations used for on-road mobile sources (**Section 3.4.3**): $Syinit$ = 2.9070 m, and $Szinit$ = 3.7795 m. Emissions were assumed to be constant in time.

Figure 3-15. Locations of adjacent volume sources used to model emissions from locomotives. The size of the markers does not reflect the dimensions of the volume sources.

[78] For simplicity, emissions from all rail services (passenger, freight) were consolidated to single rail lines, which were then modeled in AERMOD. See **Section 2.9** for further information.

3.4.10 Railyards

Emissions from three railyards were modeled as area sources (**Figure 3-16**). The BNSF and OGRE railyards are considered part of the Port, while the Union Pacific (UP) railyard is a separate entity. A release height of 4.78 m was used for locomotives operating at each of the railyards. $Szinit$ was set to 3.7795 m, based on the equations for on-road mobile sources (**Section 3.4.3**). Emissions were assumed to be constant in time.

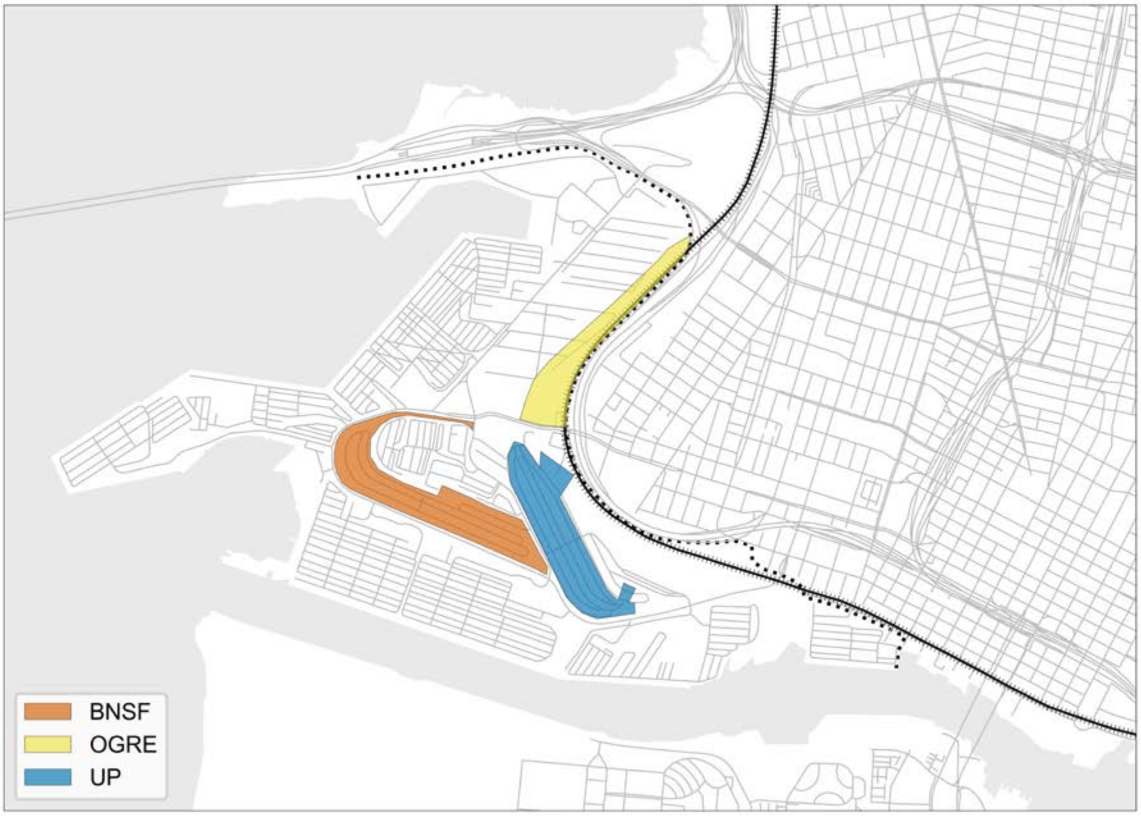

Figure 3-16. Area source polygons used to model emissions from locomotives in railyards.

3.4.11 Commuter Ferries and Excursion Vessels

Emissions from commuter ferries and excursion vessels were modeled using adjacent volume sources; all parameters were the same for both types of vessels. A network of ferry routes was developed using satellite imagery (**Figure 3-17**), and volume source locations were determined using the algorithm described in **Section 3.4.1**(c). Guidance used for on-road mobile source emissions (**Section 3.4.3**) were also used to determine modeling dispersion parameters for commuter ferries and excursion vessels. A width of 10.56 m was used, based on the weighted average beam of the vessels in the commuter ferry fleet.[79] The release height was calculated as 9.0695 m, based on a stack height of 10.67 m (35 ft).[80] The resulting dispersion parameters were:

[79] Obtained from the WETA San Francisco Bay Fleet information at https://sanfranciscobayferry.com/sites/default/files/SFBFfleet.pdf (accessed December 2018).
[80] In 2017, the exhaust stacks on the types of commuter ferries operating from Oakland and Alameda were above passenger decks.

$Syinit$ = 4.9209 m, and $Szinit$ = 8.4367 m. Emissions for commuter ferries were temporally allocated based on their operating schedules by day of week;[81] this reflects only the operating hours of the ferries and not necessarily the level of activity by hour. Because of the variable schedule of excursion vessels, emissions were assumed to be constant in time.

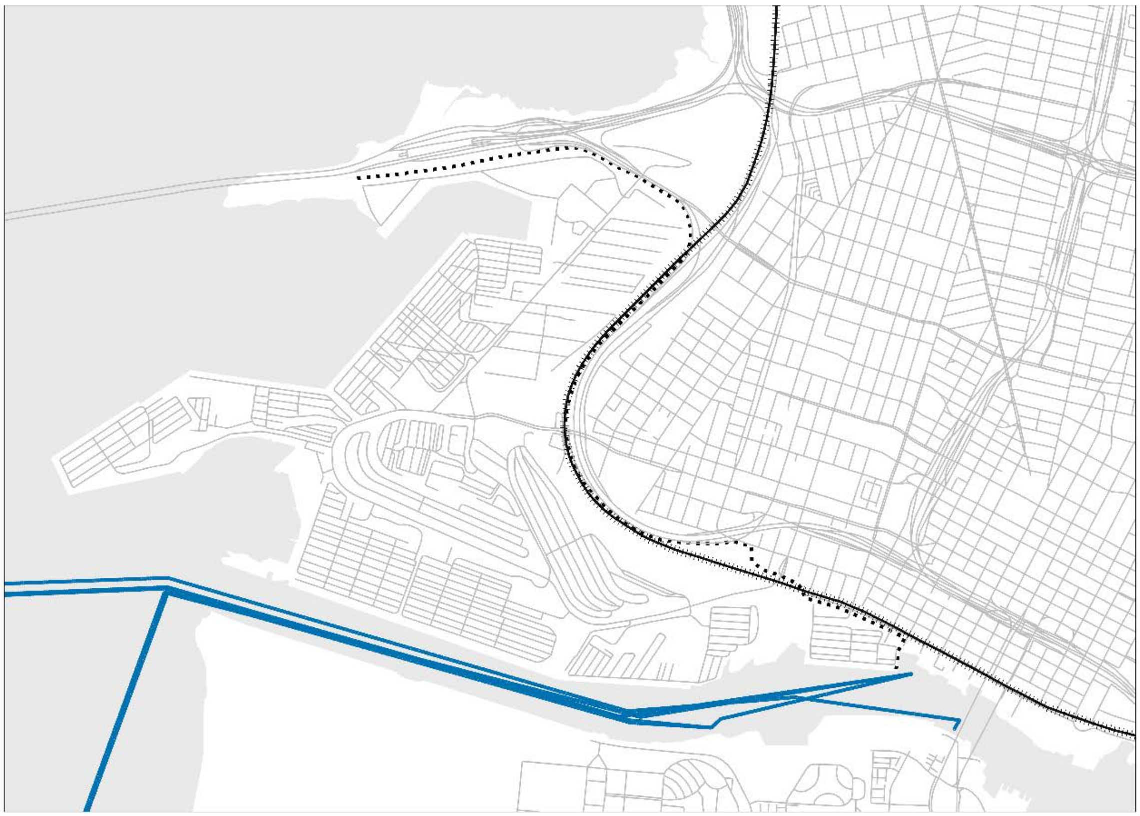

Figure 3-17. Locations of adjacent volume sources used to model emissions from commuter ferries and excursion vessels. The size of the markers does not reflect the dimensions of the volume sources.

Within the Source Domain, there are berths for both commuter ferries and excursion vessels. Emissions from ferry berths were modeled as area sources for AERMOD dispersion modeling (**Figure 3-18**). Because of the orientation of the exhaust stacks on some vessels, the release height was set to the physical height of the stack ($Relhgt$ = 10.67 m). Since berthing vessels are stationary, the initial vertical dispersion coefficient was calculated using γ = 1 (i.e., there is no motion-induced turbulence that will increase initial dispersion), resulting in $Szinit$ = 4.9620 m.

[81] Based on the WETA San Francisco Bay ferry schedule (effective January 7, 2019) https://sanfranciscobayferry.com/sites/sfbf/files/masterschedule010719.pdf (accessed February 2019). The temporal allocation is based on operating hours; it was assumed that the operating hours were similar to those in 2017–2018.

Figure 3-18. Area source polygons used to model emissions from ferries and excursion vessels at berths.

3.5 Receptors

A master receptor grid was generated with receptors spaced every 20 m in the *x* and *y* directions within the Receptor Domain (**Figure 3-3**), resulting in 52,671 discrete cartesian receptors.[82] A spacing of 20 m was deemed sufficient to resolve the spatial concentration gradients around small emissions sources (e.g., roadways) and the spacing of city blocks, which are on the scale of tens of meters; it is also consistent with the "dense" spacing suggested for a PM hot-spot analysis around roadways (U.S. Environmental Protection Agency 2015b).

As mentioned, the height of each receptor was set to 1.8 m agl. AERMAP was run to assign terrain elevations (m asl) and hill height scales to each receptor from Shuttle Radar Topography Mission (SRTM) digital terrain data (with an approximate resolution of 30 m × 30 m within 1° × 1° tiles), which are used to determine the dispersion of plumes in the vicinity of topographic features. The West Oakland area is relatively flat, where elevation is near sea level close to the Bay, and slopes upward gently towards the East (**Figure 3-19**).

[82] While the Source and Receptor Domains must align between models, the projections used are different (UTM in AERMOD, and Lambert conformal conic in CMAQ). Additional receptors were initially modeled (totaling 56,658 receptors), and then filtered so that only those within the Receptor Domain were used in subsequent analyses.

Figure 3-19. Elevation based on SRTM digital terrain data processed through AERMAP. Elevations are assigned to receptor locations only within the West Oakland Receptor Domain (blue polygon).

For emission sources modeled as point or area sources, the entire master receptor grid was used. For emission sources modeled as volume sources, individual receptors were removed from the master grid where they intersected a volume source EZ (**Section 3.4.1**(c)); results were imputed to these locations in a post-processing step (see **Section 4.4.1**).

3.6 Background Concentrations

AERMOD provides estimates of pollutant concentrations associated with local sources in West Oakland. However, total pollutant concentrations in the community are also impacted by regional emissions sources that are located in other parts of Alameda County, the Bay Area, and beyond. To account for the impact of these regional emission sources on air pollutant concentrations in West Oakland, the U.S. EPA's Community Multi-scale Air Quality (CMAQ) model was applied at a 1-km grid resolution over the entire Bay Area (**Figure 3-20**). CMAQ is a complex photochemical grid model that simulates physical and chemical processes in the atmosphere to predict the airborne concentration of gases and particles, as well as the deposition of these pollutants to Earth's surface. CMAQ requires two primary types of input data: (1) meteorological information such as temperature, wind speeds, and precipitation rates; and (2) emissions estimates for all anthropogenic and natural emission sources in the modeling domain.

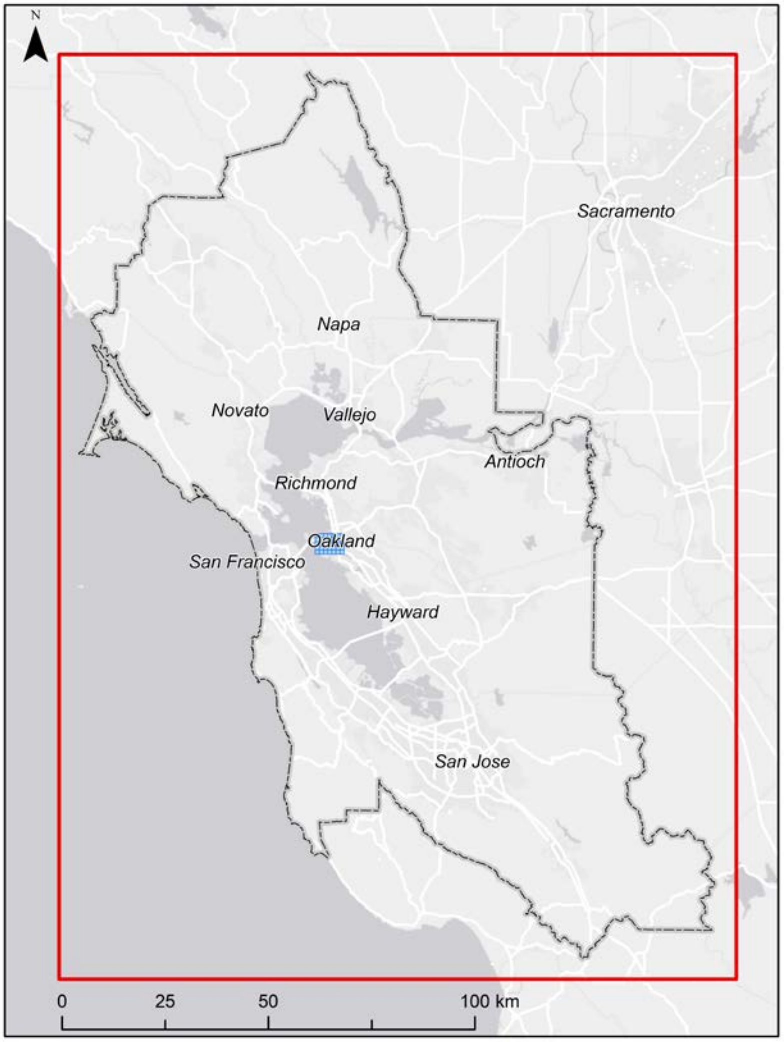

Figure 3-20. Regional-scale modeling domain (red rectangle). The subset of grid cells that comprise the community-scale (AERMOD) modeling are indicated by blue squares. The extents of the BAAQMD are also outlined (grey dashed line).

Meteorological inputs for CMAQ were prepared using the Weather Research and Forecasting (WRF) model version 3.8 (Skamarock *et al.* 2008). The WRF model configuration was tested using available physics options, including planetary boundary layer processes, strategies for assimilating meteorological measurement data into the simulations, horizontal and vertical diffusion parameters, and advection schemes. The final choice of options was the one that proved to best characterize meteorology in the domain based on a statistical evaluation. WRF model performance was evaluated by comparing model outputs to available meteorological data from the EPA's Air Quality System (AQS), the District's meteorological network, and the National Centers for Environmental Information (NCEI, formerly the National Climate Data Center [NCDC]). These comparisons were conducted by using the METSTAT program[83] to statistically evaluate the performance of WRF using established metrics such as bias, gross error, root mean square error

[83] version dated December 9, 2013; retrieved from Ramboll Environ: http://www.camx.com/download/support-software.aspx

(RMSE) and index of agreement (IOA). WRF's performance was determined to be within established criteria for these metrics for every day of 2016.

Emissions inputs for CMAQ were assembled from a variety of data sources, including the District's estimates, emissions data from CARB, outputs from CARB's EMFAC2017 model, and outputs from EPA's Biogenic Emission Inventory System (BEIS) version 3.61. These emissions data were processed through the Sparse Matrix Operator Kernel Emissions (SMOKE) processor (Houyoux and Vukovich 1999) version 4.5[84] to develop CMAQ-ready emissions inputs for each day of 2016. SMOKE uses a variety of processing steps to convert "raw" emissions data to the spatial, temporal, and chemical resolution required by air quality models, such as CMAQ. For example, SMOKE disaggregates TOG and $PM_{2.5}$ emissions into a series of model species that CMAQ uses to represent atmospheric chemistry.

For the Bay Area regional modeling, speciation profiles developed for the SAPRC-07 chemical mechanism were applied to TOG emissions from all sources, and profiles developed for the AERO6 aerosol module (AE6) were applied to $PM_{2.5}$ emissions from all sources. The SAPRC-07 mechanism treats some toxic species explicitly, including acetaldehyde, benzene, and formaldehyde, while others are lumped into model species that act as surrogates for multiple compounds with similar mass and reactivity. Therefore, existing SAPRC-07 speciation profiles were modified to treat additional air toxics (acrolein and 1,3-butadiene) explicitly. In addition, AE6 profiles were modified to track DPM emissions separately from other PM emissions. Lastly, emissions estimates for five trace metals that are not included in the AE6 mechanism (cadmium, hexavalent chromium, lead, mercury, and nickel) were taken from EPA's 2014 National Air Toxics Assessment (NATA) inventory.

Once all inputs were prepared, CMAQ version 5.2 (U.S. Environmental Protection Agency 1999) was run to simulate $PM_{2.5}$ and TAC concentrations for the Bay Area for 2016. CMAQ model performance was evaluated by comparing model outputs to available ambient data from the District's Data Management System and the EPA's AQS. Various statistical metrics were used to evaluate the performance of CMAQ, in keeping with EPA's latest modeling guidance (U.S. Environmental Protection Agency 2018a). The CMAQ model performed reasonably well, meeting the performance goals proposed by Boylan and Russell (2006) and criteria by Emery *et al.* (2017), two well-known references for PM model evaluation. The model also showed reasonable agreement with the limited air toxics observations that were available for comparison.

The modeling framework was run (a) with emissions in the West Oakland Source Domain to obtain the total concentrations over the community and perform the model evaluation, and then (b) without emissions to provide an estimate of background pollutant levels in West Oakland. From (b), CMAQ results for the 1-km grid cells in the West Oakland Receptor Domain were extracted and analyzed to develop average background concentration values for the community. The background values for $PM_{2.5}$, DPM, and cancer risk, which represent expected levels in the absence of any local emissions in West Oakland, are summarized in **Table 3-3**.

[84] For further information and technical documentation, see https://www.cmascenter.org/smoke/documentation/4.5/manual_smokev45.pdf

Table 3-3. Background pollutant concentrations and cancer risk for West Oakland. Values are derived as an annual average across all grid cells in the Receptor Domain.

Parameter	Value	Units
$PM_{2.5}$ concentration	6.9	µg/m^3
DPM concentration	0.46	µg/m^3
Cancer risk	421	Additional cancer cases per million people

Additional information on the CMAQ simulations are available in separate reports on the District's 2016 $PM_{2.5}$ modeling (Tanrikulu *et al.* 2019a) and air toxics modeling (Tanrikulu *et al.* 2019b).

4. Analysis Methods

In this section, the methods applied to determine pollutant concentrations and cancer risk from emission sources that were identified, quantified, and provided as inputs to dispersion models are outlined. The approach used to aggregate and display the results are also described.

4.1 Estimating Pollutant Concentration and Cancer Risk

4.1.1 Totals at Receptors

The total of a quantity at a receptor can be calculated by summing the contributions from all sources; based on the community-scale (AERMOD) dispersion modeling, this represents the local contribution to a total quantity, as in **Figure 1-2**. This can also be expressed mathematically; that is, the *incremental contribution* from a specific emissions source s_j (where j is the index of any individual source modeled in AERMOD) to the total of quantity Y (which may a dispersion factor, F; pollutant concentration, C_p; or cancer risk, $risk$) at a receptor r_i (where i is a location index, and r_i is located at coordinates (x_i, y_i, z_i), and z_i = 1.8 m at all receptors in this analysis) can be denoted as: $Y_{ij} \equiv Y(r_i,\ s_j)$. The total quantity of Y_i is then the sum over all contributions from all sources:

$$Y_i = \sum_j Y_{ij}$$

However, as previously explained, individual receptors were removed from the master "grid" (a set of receptors placed every 20 m) where they intersected a volume source EZ (used for modeling on-road mobile sources, locomotives along rail lines, and commuter ferries and excursion vessels). This means that if using only the direct model outputs, at some receptors, Y_i can only be partially summed over all sources because the incremental contribution from some sources was not sampled at r_i. Therefore, dispersion factors were imputed at locations of receptors from the master grid that were removed for AERMOD modeling in these instances. Because the receptors that were removed from EZs are likely in areas of high concentrations (since they are closest to emission sources), values at receptors were imputed using the local maximum dispersion factors from a set of k_{max} = 8 closest receptors filtered within a distance (radius) of d_{max} = 28.78 m (the maximum diagonal distance between two receptors plus 0.5 m); the final number of receptors is therefore $k \leq k_{max}$. If no receptors were available within d_{max}, the value was imputed using the IDW with a power value of two (i.e., inverse distance squared weighting, IDW2) from the k_{max} (or $k \leq k_{max}$ if only k receptors were defined) nearest receptors. The resulting values at receptors could therefore be derived from a mix of local maxima and IDW2 interpolation.

To assess the air quality at receptors, the total pollutant concentrations of $PM_{2.5}$ and DPM were calculated, as well as cancer risk. While the summation technique is identical, calculating the values of each quantity at each receptor requires additional information with respect to emission rates and toxicity, as detailed in the following sections.

4.1.2 Pollutant Concentration

The concentration of a pollutant at each receptor location was calculated for a modeled source by multiplying annual average emission rate of a pollutant from a source by the dispersion factor from the source. At each receptor r_i from each source s_j, the concentration of pollutant p is then:

$$C_{pij} = ER_{pj} \cdot F_i$$

where

C_p = annual average concentration for pollutant p (µg/m^3)
ER_p = annual average emission rate for pollutant p [g/(s m^2) for area sources, g/s for point and volume sources]
F = dispersion factor, concentration per unit emission rate [(µg/m^3)/(g/(s m^2)) for area sources, (µg/m^3)/(g/s) for point and volume sources]

The concentration contributions can then be summed over all sources at a receptor to obtain the total concentration from local sources.

4.1.3 Cancer Risk

Cancer risk is the incremental probability that an individual will develop cancer over a lifetime as a direct result of exposure to potential carcinogens from anthropogenic sources. The estimated risk is a unitless probability, often expressed as the number of people who might experience cancer per million people who are similarly exposed (a value "in-a-million"). Chemical species included in the dose calculate include acrolein, benzene, DPM, ethylbenzene, hexane, naphthalene, toluene, and xylene, among others (see **Attachment 1**); the type of TAC emitted depends on the emissions source.

The risk assessment method used here follows guidelines from the California EPA (CalEPA) Office of Environmental Health Hazard Assessment (OEHHA) and the risk management guidance for stationary sources adopted by the CARB and the California Air Pollution Control Officers Association (CAPCOA). Cancer risk was calculated over an assumed 70-year lifetime by multiplying the annual average chemical concentrations of TACs by the chemical intakes and chemical-specific cancer potency factors (CPFs)[85] (**Attachment 1**). The chemical concentrations were modeled from the emission sources to the exposure point at the downwind locations (receptors). Contributions from all emissions sources (**Section 2**) were aggregated to determine the cumulative risk. The District assumed that all emissions sources would remain operational for 30 years at the same level of emissions (the District has previously adjusted emissions for certain source categories where operations will be phased out); the District also assumed that emission factors for on-road mobile sources do not change in future years. The resulting analysis therefore represents a 'snapshot' of the level of cancer risk that would result from the base year emissions.

[85] A CPF is a chemical-specific "theoretical upper bound probability of extra cancer cases occurring in an exposed population assuming a lifetime exposure to the chemical" (Office of Environmental Health Hazard Assessment 2015).

The chemical intake or *dose* describes the frequency and duration of the exposure, estimated using the breathing rates, exposure durations, and exposure frequencies. In accordance with OEHHA's revised health risk assessment guidelines (Office of Environmental Health Hazard Assessment 2015), the intake methodology was updated to address children's greater sensitivity and health impacts from early exposure to carcinogenic compounds. The updated calculation procedures include the use of age-specific weighting factors, breathing rates, fraction of time at home, and reduced exposure durations. Each factor is described below:

- Age Sensitivity Factors (ASFs) account for the heighted sensitivity of children to carcinogens during fetal development and early childhood. Consistent with OEHHA, the District uses ASF values as listed in **Table 4-1**. The District has incorporated ASFs in its air permits since 2010.
- Daily Breathing Rate (DBR) is the age-specific daily air intake. OEHHA developed a range of rates for four age groups: last trimester to newborn, newborn to two years of age, two years to 16 years of age, and older than 16 years of age. CAPCOA and CARB recently recommended the use of 95th percentile breathing rates for the most sensitive age group (less than two years of age) and 80th percentile for all other age groups.
- Fraction of Time at Home (FAH) refers to the estimated amount of time residents stay at home. In past HRAs, the District assumed that residents are home 24 hours per day, 7 days per week. In the 2015 Risk Assessment Guidance, OEHHA recommends less than 100% of time to be used as a FAH based on population and activity statistics. Consistent with OEHHA, this analysis incorporates a FAH of 0.73 for individuals ≥ 16 years old and 1.0 for individuals < 16 years old to address exposures at local schools in close proximity to emitting facilities.
- Exposure Duration (ED) is the length of time an individual is continuous exposed to air toxics. Previously, the District used a 70-year lifetime exposure duration for residents over a 70-year lifespan. Based on updated demographic data, the District follows the OEHHA recommendation of a 30-year exposure duration, consistent with US EPA, for residents.

The values of these factors are summarized in Table 4-1.

Table 4-1. Factors used to calculate chemical intake, based on a 30-year average. Age intervals are left-bounded.

Factor	Unit	Age Groups			
		Last Trimester to Newborn	**0 – 2 years old**	**2 – 16 years old**	**16 – 30 years old**
DBR	L/(kg day)	361	1090	572	261
ASF	unitless	10	10	3	1
FAH	unitless	1	1	1	0.73
ED	years	0.25	2	14	14

The equation used to calculate the dose for the inhalation pathway of a pollutant p is as follows:

$$dose_{pij} = \frac{1}{AT}\left[c \cdot ef \cdot \sum_{y}^{30\ years} C_{pijy} \cdot DBR_y \cdot FAH_y \cdot ED_y \cdot ASF_y\right]$$

where

$dose_p$	=	accumulated dose for an individual breathing pollutant p for 30 continuous years [mg/(kg day)]
AT	=	averaging time [25,550 days, equivalent to 70 year lifespan]
c	=	conversion factor [10^{-6} (mg/L)/(µg/m^3)]
ef	=	exposure frequency (350 days per year[86])
C_{py}	=	annual average concentration of pollutant p during year y [µg/m^3]
DBR_y	=	daily breathing rate during year y [L/(kg day)]
FAH_y	=	fraction of time at home during year y [unitless]
ED_y	=	exposure duration of year y [years]
ASF_y	=	age sensitivity factor for year y [unitless]

The cancer risk from a pollutant (p) at a receptor (i) from a specific source (j) is equal to the dose multiplied by the chemical-specific inhalation CPF (**Attachment 1**):

$$risk_{pij} = CPF_p \cdot dose_{pij}$$

In most cases, CPF specific for the inhalation pathways were used. However, some chemicals, in addition to being inhaled, can deposit on the ground in particulate form and contribute to risk through ingestion of soil or through other routes. To account for the additional risks from exposure to non-inhalation pathways, multi-pathway CPFs were used where available from OEHHA. Risks were not estimated for chemicals lacking OEHHA approved toxicity values.

When the pollutant concentration term is dropped from the dose equation, the remaining terms represent a constant cancer risk weighting factor of $WF = 677$ [m^3/µg]/[mg/(kg day)], irrespective of pollutant. Because the pollutant concentration term is calculated by multiplying the annual average emission rate of a pollutant from an emissions source by the dispersion factor of that source (**Section 4.1.2**), the cancer risk equation becomes:

$$risk_{pij} = CPF_p \cdot WF \cdot ER_{pj} \cdot F_i$$

The total per-million cancer risk is then the sum of the pollutant-specific risk values (p). These can be further summed over all emission sources (j).

A similar method was used to calculate cancer risk-weighted emissions (as presented in the Action Plan). In this calculation, the dispersion factor term was dropped from the equation above, and

[86] An ef of 350 days per year was used, which represents the number of days an individual will reside in their home less approximately two weeks of vacation. This value is consistent with current OEHHA and EPA guidance.

annual average emissions (tpy) were multiplied by 677 [mg/(kg day)]/[µg/m^3] and pollutant-specific inhalation slope factors (**Attachment 1**). For sources that emit multiple TACs, the total cancer risk-weighted emissions were calculated by summing the cancer risk-weighted emissions for each pollutant. The resulting units are then inverse of the dispersion factor expressed in tpy rather than g/s, which can be thought of as a risk-weighted sum of emissions. For example, given annual DPM emissions from the OGRE railyard (diesel-fueled switchers) are 0.08 tpy, the cancer-risk weighted emissions are then: 0.077 tpy · 677 [mg/(kg day)]/[µg/m^3] · 1.1 (mg/kg day)$^{-1}$ ≈ 57 tpy / (µg/m^3) ("cancer-risk weighted [CRW] tpy").

4.2 Spatial Distributions and Source Apportionment

4.2.1 Source Apportionment

As modeling was performed for each emissions source separately (**Section 3.1**), the contributions from each source s_j to the quantity Y_i at each receptor r_i can be tracked and then compared to those contributions from other sources; this is generally termed a *source apportionment*. In this analysis, the results are already apportioned to sources by virtue of running each source individually in AERMOD.

Furthermore, rather than examine the contributions at receptors from each individual source (e.g., a single generator, on-road mobile sources on individual roadways), contribution can be examined from *source categories* (e.g., permitted stationary sources, passenger vehicles on freeways). Sources within a source category may be similar in how they are managed or regulated, their emissions processes, their geographic locations, or are of particular research interest. An individual source can only belong to a single source category. Then, the total of a quantity at a receptor can be expressed as the sum of contributions from different source categories s_J, as:

$$Y_{iJ} = \sum_{j \in J} Y_{ij}$$

$$\text{and} \quad Y_i = \sum_J Y_{iJ} = \sum_j Y_{ij}$$

4.2.2 Interpreting Map Products

Annual average $PM_{2.5}$, DPM, and cancer risk in West Oakland are presented in a series of maps and map-based products (tables and charts at different locations within the domain). When drawing conclusions from maps, it is important to consider the assumptions used to derive the underlying data.

Specifically, the maps were derived from air dispersion modeling that were used to calculate concentrations and cancer risk estimates from direct emissions. The maps themselves, therefore, portray concentrations associated with directly emitted $PM_{2.5}$ and DPM, as well as cancer risk associated with directly emitted TACs. The results do not reflect regional or long-range transport of air pollutants, nor the effects of the chemical transformation (formation or loss) of pollutants.

However, some discussion of background concentrations resulting from those processes is provided (**Section 3.6**).

Finally, output from AERMOD at receptors represents a value sampled at a single point in space; that is, the values are not averages over grid cell volumes (as output from models such as CMAQ). Therefore, while results at regularly space receptors can be mapped as "grid cells" (raster), the values do not necessarily represent the average value over the area of the "grid cell." The results at receptors also reflect the choice of flagpole receptor height (1.8 m); while some sources may emit a large quantity of pollutants, these pollutants may not necessarily impact receptors near ground-level if the release heights are much higher.

4.2.3 Spatial Aggregation

Receptors were placed every 20 m within the Receptor Domain to adequately capture concentration gradients around various sources. Results can be plotted as "grid cells" centered at each receptor. However, results summarized at larger spatial scales can be more useful when examining population exposures or proposed mitigation measures.

In this analysis, spatially aggregated results were generated by computing the arithmetic average within specific polygons, i.e., the sum from all source categories over all receptors within the polygon divided by the number of receptors. If a polygon contains a subset of receptors $n = |I|$ ($r_{i \in I}$), then:

$$Y_{IJ} = \frac{1}{n} \sum_{i \in I} Y_{iJ}$$

$$\text{and} \quad Y_I = \sum_J Y_{IJ}$$

Three types of spatial aggregation polygons were used, and further details of how they were defined are discussed below:

(1) **Hexagons** were used to form a complete "hexagon grid" of adjacent regular hexagons with a long diagonal of 100 m (incircle radius of 43.3 m);

(2) **Zone polygons** covering seven areas in the West Oakland community (**Figure 4-1**).[87] Within these zones, results were also presented as pie charts, where source categories were further aggregated for simplicity (Highways, Surface Streets, Port, Rail, Permitted, and Other); and

(3) **Census blocks** within the West Oakland community (**Figure 4-2**) were namely used to obtain a *population-weighted result* (or "*residential impact*"). Population-weighted results can help emphasize how air pollution affects areas where residents live. For this approach, the TIGER polygons from the 2010 Decennial Census were used with

[87] These locations were selected in consultation with project co-leads and generally represent areas where pollutant concentrations are known to be elevated based on previous research and/or sensitive receptors.

corresponding 2010 population (**Figure 4-2**), and results were weighted by the population within the polygon as a proportion of the total population summed across all polygons.[88]

Results based on source category and spatial aggregations were combined into interactive maps, which can be used to represent the spatial variation of pollutant concentrations and cancer risk across West Oakland, and to represent the spatial variation of the incremental contributions from different source categories across West Oakland. Taken together, these results are intended to aid local planning efforts by identifying areas or sources where emission reductions may be needed and by providing information on the sources which are contributing to air quality impacts at specific receptor locations.

[88] Although the absolute population of West Oakland has changed since 2010, the population-weighted results only depend on the relative spatial distribution of population among census blocks. Relative changes in this distribution during inter-decennial years (2011–2019) are difficult to estimate accurately; population data at the block level are not published as part of inter-decennial Census products (e.g., American Community Survey).

Figure 4-1. Zones in the West Oakland community used to assess air quality in this study: 1: Lower Bottoms / West Prescott, 2: 3rd Street, 3: 7th Street, 4: Acorn, 5: Upper Adeline, 6: Clawson, 7: West Grand & San Pablo.

Figure 4-2. Percentage of total population by census block in West Oakland, based on 2010 Decennial Census data. Total population for the census blocks examined in West Oakland in 2010 was 33,561 (based on 1,029 census blocks). Only census blocks within the West Oakland community boundary are outlined (blue lines); census blocks with no population are not colored.

5. Results

Annual average local $PM_{2.5}$, DPM, and cancer risk results derived from dispersion modeling are presented in this section in a series of maps. Additionally, a source apportionment is performed where information is provided on the relative contributions of the source categories described in previous sections: permitted stationary sources, on-road mobile sources (by road type and vehicle category), Port-related sources (e.g., OGVs, CHE), locomotives on rail lines and at railyards, and other sources (e.g., truck-related businesses). All results are presented with respect to the total emissions represented in the community-scale emissions inventory as noted in **Section 2.1.5**, unless otherwise specified.

5.1 $PM_{2.5}$ Concentrations

Based on combined AERMOD results from all sources, the annual average $PM_{2.5}$ concentration associated with local sources in the West Oakland averaged over the community domain[89] was 1.71 µg/m^3, with local concentration contributions exceeding 4.0 µg/m^3 in areas that are proximate to large emission sources and roadways (**Figure 5-1**). This annualized value reflects an average of all receptors in the domain; when the calculation is weighted by population in Census blocks (i.e., residential areas), the annual average local $PM_{2.5}$ concentration increases slightly to 1.73 µg/m^3, largely due to the higher levels of road dust emissions in the residential areas.

The average local $PM_{2.5}$ concentration was 1.71 µg/m^3, whereas the background concentration was 6.9 µg/m^3 (**Section 3.6**), resulting in a total average $PM_{2.5}$ concentration of 8.61 µg/m^3. This value compares well with the annual average $PM_{2.5}$ concentration of 8.7 µg/m^3 measured at the West Oakland monitoring site (in 2016). Based on this modeling analysis, local sources account for ~ 20% of the annual average $PM_{2.5}$ concentration in West Oakland.[90]

5.2 DPM Concentrations

The annual average DPM concentration associated with local sources in the West Oakland community domain was 0.39 µg/m^3, with concentrations exceeding 1.0 µg/m^3, namely in areas that are proximate to the Port and railyards (**Figure 5-2**). When the calculation is limited to receptors in residential areas, the annual average local DPM concentration decreases to 0.25 µg/m^3, as the highest local DPM concentrations are generally near the Port rather than residential areas.

The average local DPM concentration was 0.39 µg/m^3, whereas the background concentration (**Section 3.6**) was estimated as 0.46 µg/m^3, resulting in a total average DPM concentration of 0.85 µg/m^3 in West Oakland. Based on this modeling analysis, local sources account for about ~ 46% of the annual average DPM concentration in West Oakland.

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[89] Results averaged over the "community domain" include all receptors within the Receptor Domain that intersect the Community Boundary (*c.f.* **Figure 1-1**, **Figure 5-1**). The Receptor Domain does not completely cover the Community Boundary; the areas that are excluded are mainly in the Port and over the Bay Bridge.

[90] This local contribution only accounts for directly emitted $PM_{2.5}$ emissions. However, it is likely that the secondary formation of $PM_{2.5}$ from precursor emissions in the West Oakland domain will largely occur beyond the boundaries of the domain.

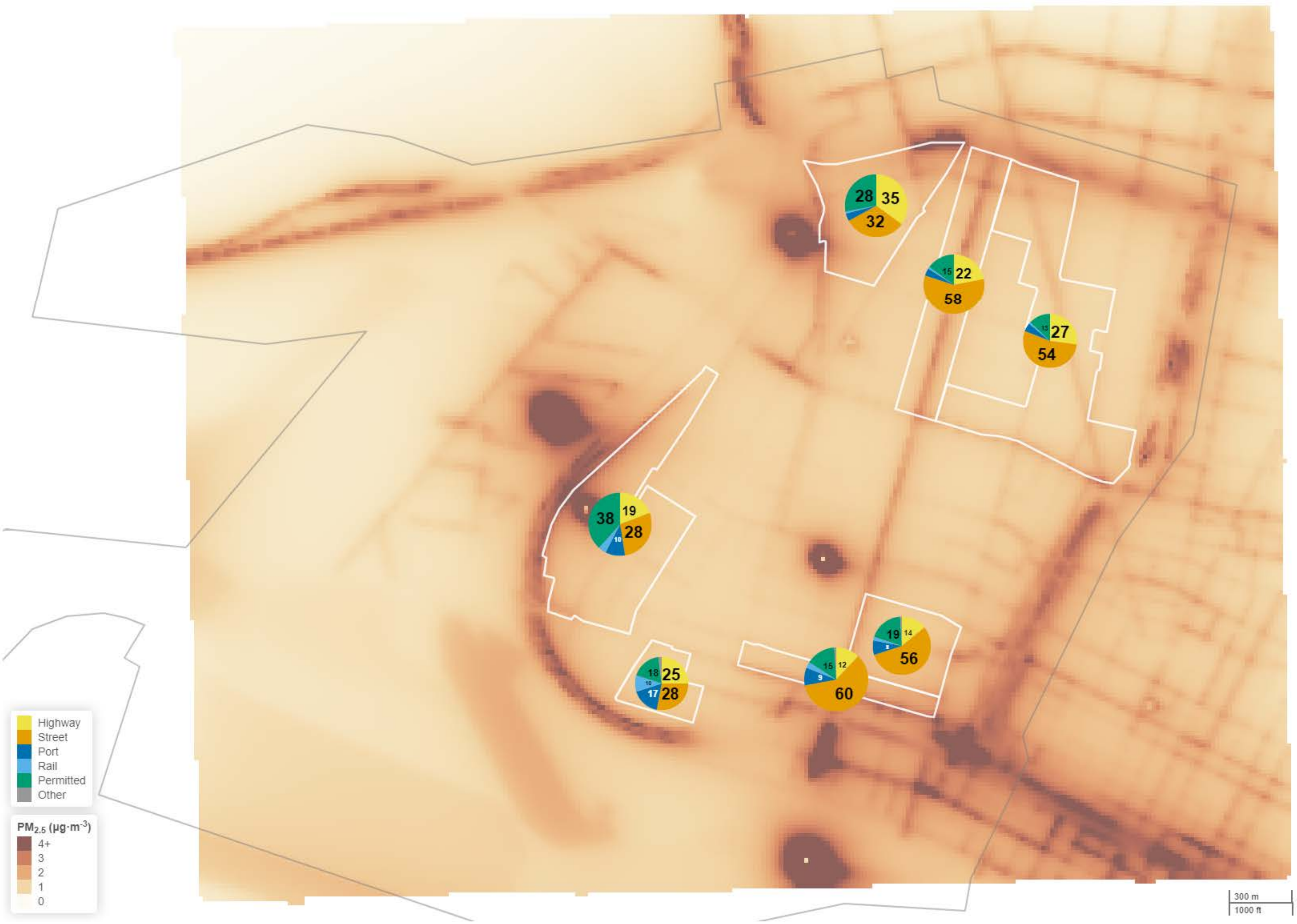

Figure 5-1. Annual average $PM_{2.5}$ concentrations associated with modeled local sources in the West Oakland Receptor Domain (colored extents). Pie charts indicate the percentage of concentrations contributed from specific Source Categories in each zone (white polygons, **Figure 4-1**); the size of the pie chart indicates the total magnitude of the concentration. The grey line indicates West Oakland Community Boundary. Outlines of other geographical features (roadways, etc.) are omitted for clarity.

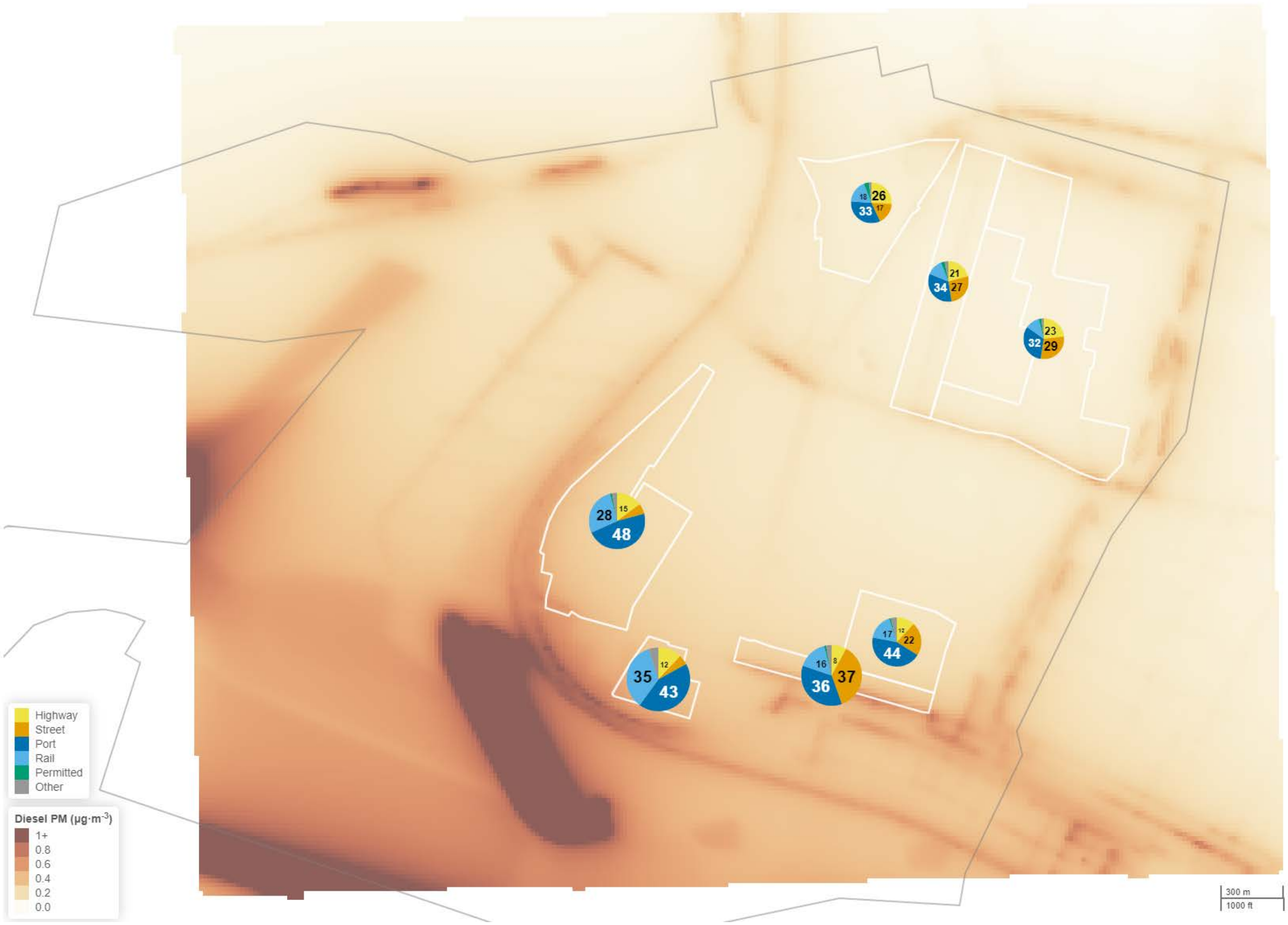

Figure 5-2. Annual average DPM concentrations associated with modeled local sources in the West Oakland Receptor Domain (colored extents). Pie charts indicate the percentage of concentrations contributed from specific Source Categories in each zone (white polygons, **Figure 4-1**); the size of the pie chart indicates the total magnitude of the concentration. The grey line indicates West Oakland Community Boundary. Outlines of other geographical features (roadways, etc.) are omitted for clarity.

5.3 Cancer Risk

Based on combined AERMOD results from all sources, the excess (local) cancer risk associated with local emissions sources in the West Oakland Source Domain was 303 in-a-million people, with risk values exceeding 1,000 in-a-million in areas that are proximate large emission sources, especially those that emit high levels of DPM (**Figure 5-3**). Furthermore, the annual excess cancer risk decreases to 199 in-a-million when weighted by population, as the highest air toxic concentrations are generally near the Port and the Schnitzer Steel facility rather than residential areas.

The total excess cancer risk in West Oakland is than 724 in-a-million, based on a background value of 421 in-a-million (**Section 3.6**) and a local value of 303 in-a-million. Based on this modeling analysis, local sources account for ~ 42% of the excess cancer risk in West Oakland.

5.4 Source Apportionment

To support source apportionment analyses, AERMOD results for all sources were combined in a series of interactive digital maps that allow users to click on a location of interest and view a tabular summary of the contributions of individual local sources to the $PM_{2.5}$ concentration, DPM concentration, and excess cancer risk at that location.[91] The percentage contribution from source categories to the domain-wide averages, and by location or zone were also generated (as depicted by the pie charts in **Figures 5-1**, **5-2**, and **5-3**).

Source contributions to annual average local $PM_{2.5}$ concentration (1.71 $\mu g/m^3$), annual average local DPM concentration (0.39 $\mu g/m^3$), and excess cancer risk (303 in-a-million) are tabulated by emissions source category in **Table 5-1**. For $PM_{2.5}$, the main sources include road dust, passenger vehicles (especially on highways) and MHDT/HHDTs. Some stationary sources (e.g., Pinnacle Ag Services, Schnitzer Steel) also contribute a comparable amount. For DPM and cancer risk, the main source include MHDT/HHDTs, assist tugs, OGVs, and locomotives and railyard activity.

Source contributions to local $PM_{2.5}$ concentrations, DPM concentrations, and excess cancer risk within Zones in the West Oakland domain vary by location, and the interactive maps described above allowed users to investigate those variations. For example, while Zone 2 (3rd Street) and Zone 3 (7th Street) are close to each other (< 1 km), the proportions of difference source categories to the overall excess cancer risk within the zones varies considerably (**Figure 5-3**, **Table 5-1**).[92] Within Zone 2, key sources include those in the Port (especially assist tugs and OGVs) and rail (UP railyard and locomotives on rail lines). In contrast, within Zone 3, key sources include those in the Port (assist tugs and OGVs) and on-road mobile sources on surface streets (especially MHDTs/HHDTs).

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[91] See: http://www.baaqmd.gov/ab617woak.
[92] The results within two zones are presented here. Results at other sensitive receptors in West Oakland are available elsewhere.

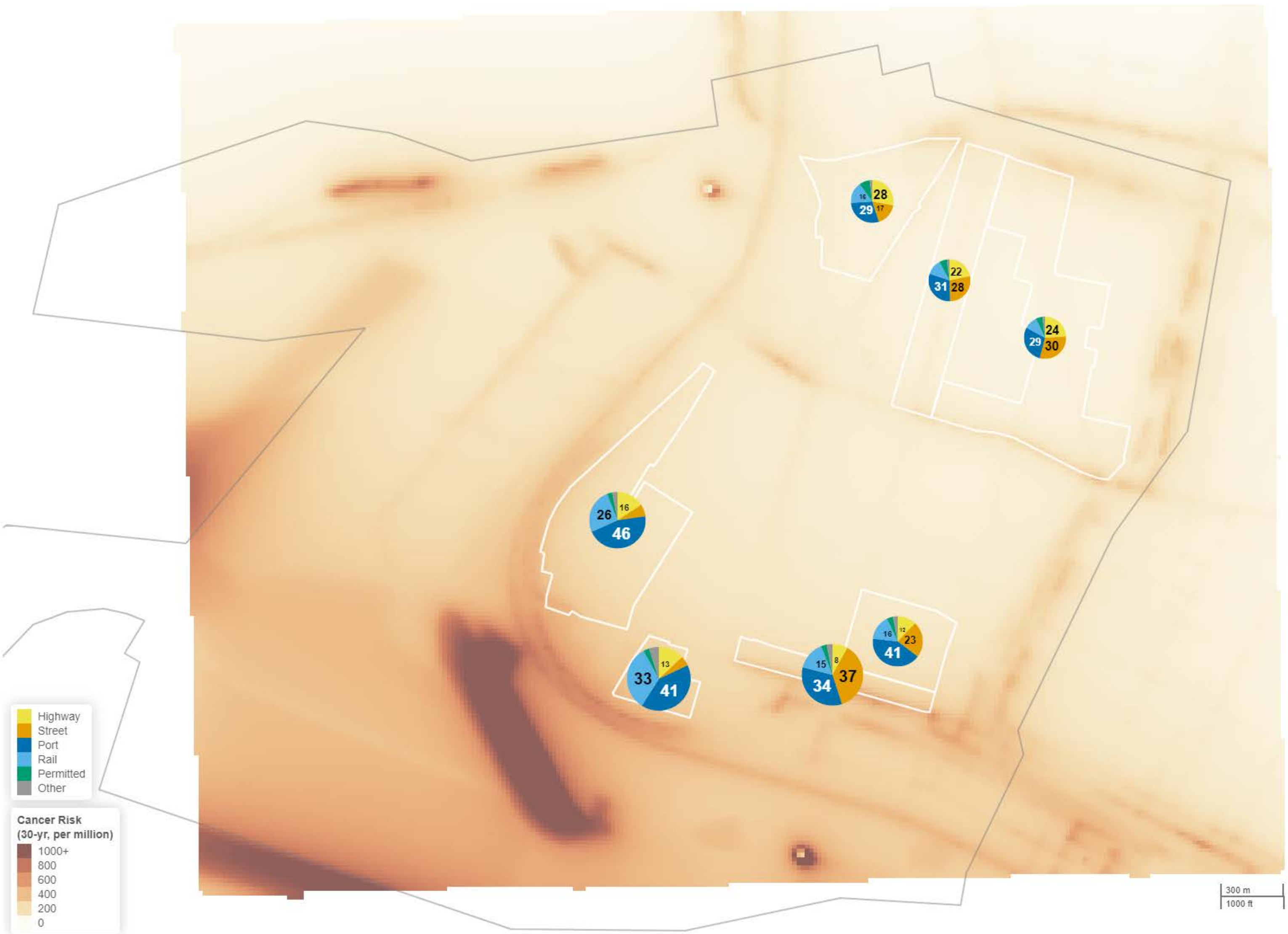

Figure 5-3. Annual average excess cancer risk associated with modeled local sources in the West Oakland Receptor Domain (colored extents). Pie charts indicate the percentage of risk contributed from specific Source Categories in each zone (white polygons, **Figure 4-1**); the size of the pie chart indicates the total magnitude of the risk. The grey line indicates West Oakland Community Boundary. Outlines of other geographical features (roadways, etc.) are omitted for clarity.

Table 5-1. Source contributions to the annual average $PM_{2.5}$ and DPM concentrations and excess cancer risk across the West Oakland community area. Port Truck contributions represent those from Port Trucks on all roads and within Port terminals.

Source Category	**$PM_{2.5}$**		**DPM**		*risk*	
	µg/m³	**% of total**	**µg/m³**	**% of total**	**per million**	**% of total**
Highway						
Non-Trucks	0.242	14	0.004	1	7	2
LHDT	0.009	1	0.002	1	2	1
MHDT/HHDT	0.058	3	0.043	11	33	11
Road dust	0.103	6	–	–	–	–
Surface Streets						
Non-Trucks	0.107	6	0.002	1	4	1
LHDT	0.005	< 1	0.001	< 1	1	< 1
MHDT/HHDT	0.038	2	0.029	8	22	7
Road dust	0.395	23	–	–	–	–
Port						
OGV – maneuvering	0.023	1	0.023	6	17	6
OGV – berthing	0.048	3	0.026	7	20	7
Dredging	0.020	1	0.020	5	15	5
Assist Tugs	0.071	4	0.073	19	55	18
Bunkering (tugs, pumps)	0.005	< 1	0.005	1	4	1
CHE	0.027	2	0.027	7	20	7
Port Trucks	0.023	1	0.012	3	10	3
Road dust	0.043	3	–	–	–	–
Railyard – OGRE	0.004	< 1	0.005	1	4	1
Railyard – BNSF	0.009	1	0.010	3	8	2
Rail						
Locomotives	0.026	2	0.028	7	21	7
Railyard – UP	0.057	3	0.062	16	46	15
Permitted						
CA Waste (10th Street)	0.029	2	–	–	–	–
California Cereal	0.034	2	–	–	< 1	< 1
CASS	0.005	< 1	–	–	< 1	< 1
Dynegy	0.001	< 1	< 0.001	< 1	< 1	< 1
EBMUD	0.056	3	0.002	1	2	1
Pinnacle Ag Services	0.095	6	–	–	–	–
Schnitzer Steel – stationary	0.090	5	–	–	5	2
Sierra Pacific	0.054	3	–	–	–	–
Other	0.022	1	< 0.001	< 1	2	1
Other						
Ferry/Excursion vessels	0.006	< 1	0.006	2	5	2
Schnitzer Steel – OGV	0.002	< 1	0.002	1	2	1
Schnitzer Steel – trucks	0.001	< 1	< 0.001	< 1	< 1	< 1
Truck-related businesses	0.002	< 1	0.002	1	2	1
Total	**1.710**	**100**	**0.385**	**100**	**303**	**100**

Table 5-2. Residential (population-weighted) source contributions to excess cancer risk within Zone 2 (3rd Street) and Zone 3 (7th Street). Values have been rounded and may not necessarily sum to the values indicated in the Total row. Port Truck contributions represent those from Port Trucks on all roads and within Port terminals.

Source Category	Zone 2		Zone 3	
	per million	% of total	per million	% of total
Highway				
Non-Trucks	5	1	4	1
LHDT	2	< 1	1	< 1
MHDT/HHDT	38	11	22	7
Surface Streets				
Non-Trucks	4	1	8	3
LHDT	1	< 1	3	1
MHDT/HHDT	13	4	108	34
Port				
OGV – maneuvering	20	6	16	5
OGV – berthing	23	7	17	5
Dredging	14	4	10	3
Assist Tugs	54	16	42	13
Bunkering (tugs, pumps)	4	1	3	1
CHE	11	3	6	2
Port Trucks	8	2	13	4
Railyard – OGRE	3	1	2	1
Railyard – BNSF	5	2	2	1
Rail				
Locomotives	37	11	21	7
Railyard – UP	79	23	27	8
Permitted				
EBMUD	1	< 1	1	< 1
Schnitzer Steel – stationary	7	2	8	2
Other	1	< 1	2	< 1
Other				
Ferry/Excursion vessels	6	2	6	2
Schnitzer Steel – OGV	3	1	2	1
Schnitzer Steel – trucks	< 1	< 1	< 1	< 1
Truck-related businesses	8	2	1	< 1
Total	**346**	**100**	**323**	**100**

6. Limitations, Uncertainties, and Future Improvements

In this analysis, the District qualitatively evaluated uncertainties associated with the data and methodologies used to create a bottom-up emissions inventory for the West Oakland community, the community-scale modeling approach using the AERMOD dispersion model, and the approach used to quantify air pollutant exposure, cancer risk, and perform the source apportionment. Such assumptions are inherent in efforts to characterize emissions and associated risk in complex settings and can result in or under- or over-predictions in concentration and risk estimates. While a quantitative analysis of the uncertainties may provide more useful information as to the potential variability of impacts, it was beyond the scope of this analysis,[93] especially given that uncertainties for emissions and modeling parameters are generally not available. A qualitative assessment of uncertainties can be useful as a component of a model evaluation, where the quality of the output information (emissions, dispersion factors, concentration and risk calculations) are determined. The following sections summarize common sources of uncertainty associated with the emissions estimation, air dispersion modeling, and risk estimation components of the risk assessment.

6.1 Emissions Inventory

There are several sources of uncertainty associated with the bottom-up estimation of emissions from each of the source categories that may affect the subsequent estimation of exposure concentrations and risk characterization. The District identified several emission sources categories where emissions estimates could be improvement.

6.1.1 Permitted Stationary Sources

The emissions inventory for permitted stationary source in West Oakland was developed using the District's 2017 CEIDARS report. Rather than following a traditional calendar or fiscal year, the District issues permits to facilities on a rolling 12-month period, and renews those permits every one to three years. Because of this, the emissions shown in the 2017 CEIDARS report may represent a facility's emissions from either 2015, 2016, or 2017. Uncertainties associated with the emission estimates also stem from throughput information, which varies from year to year, and the use of default emission factors. The District did attempt to correct emissions for the largest emissions sources (such as Schnitzer Steel) to better reflect the latest source test results and facility modifications completed by the end of 2017. The District will continue to make improvements to the stationary source database by incorporating source test results as they become available, and by updating emissions factors as necessary.

6.1.2 On-Road Mobile Sources

For on-road mobile emissions, uncertainties are primarily associated with link-specific traffic activity, especially fleet mix, and emission factors for Port Trucks, as well as tire wear, brake wear, and road dust.

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[93] The District is performing a quantitative evaluation of AERMOD dispersion modeling results for black carbon in a separate study.

(a) Fleet Mix

Estimates of fleet mix by roadway link, represented as the fraction of trucks of the total fleet, have significant uncertainties. On surface streets, truck fraction information relied on traffic counts from only four counters over a limited period (1 week) in 2008; the fleet mix could therefore be outdated, and the data from these counter locations may not be representative of all surface streets. On highways, while truck fractions were derived from PeMS, which has higher spatial and temporal coverage (e.g., based on a full year of continuous measurements at several counter locations on each highway), the method of detection still has inherent uncertainties: single loop detectors were used to estimate truck volume based on lane-by-lane flow and occupancy at 5 min resolution, instead of actual truck counts measured by the Automatic Vehicle Classifiers (AVCs) using technologies such as weigh-in-motion (WIM). WIM-based truck traffic counts were available at a limited number of locations but only in 2010, and were therefore not used in this analysis.

The fraction of Port Trucks within the Truck 2 category (MHDTs and HHDTs) was derived using O-D analysis on the StreetLight platform. Data on this platform is GPS-based, and the District designed 49 gates to best capture Port Truck activity in the West Oakland community. There is uncertainty in both actual traffic counts (as no evaluation was performed) and the limited spatial coverage of gates selected.

For the West Oakland community, the VMT-based overall Port Truck fraction within the Truck 2 category derived from StreetLight for 2017 is about half of that estimated in the 2009 truck survey. The decrease could be largely explained by the truck prohibition regulation the City of West Oakland has implemented since 2010. However, further verification is needed when the direct measurements in more recent years become available. For example, a study using video footage acquired from Automated License Plate Readers (ALPR) to collect vehicle counts and license plates at key locations in West Oakland could be used to better estimate the size and characteristics of the Port Truck fleet. The license plate data would provide the necessary information to link registration data from the Department of Motor Vehicles (DMV) or International Registration Plan (IRP) to a list of Vehicle Identification Numbers (VINs) from the Port of Oakland and the Drayage Truck Registry database, which could be used to obtain import vehicle characteristics (e.g., model year, weight class, emission control technologies, and whether the vehicle is a Port drayage truck or not). These characteristics could then be used to better estimate emission factors and emissions. If implemented, the proposed study would provide ground-truthing to improve our understanding and help validate the fleet mix data used in this analysis.

(b) Emission Factors

Emission factors for on-road mobile sources were obtained from EMFAC2017 and CT-EMFAC2017, which were used to estimate emissions from roadways in West Oakland, as well from fleet operating at truck-related businesses and Port Trucks operating within Port terminals.

In the future, brake wear, tire wear and re-entrained road dust emissions will dominate total PM emissions, due to increasingly stringent standards for exhaust emissions (Reid *et al.* 2016). However, uncertainties in the emission factors from these processes is much higher because of their complexity and limited research, as they are currently unregulated processes. The methods used to estimate emission factors are either outdated or based on limited measurements or stringent assumptions. For example, brake wear emissions factors in EMFAC2017 are assumed to be independent of vehicle travelling speed, despite the fact that there are often more braking events during low speed driving. CARB is sponsoring four studies that are expected to be completed next year to improve the emissions factors for brake and tire wear. While road dust emissions are estimated using AP-42 methodology, the empirically-derived equation (see **Section 2.3.3**(b)) does not take into account vehicle speed, which can affect the emission factor (U.S. Environmental Protection Agency 2011), and does not restrict the maximum emissions by the number of vehicles. Silt loading values are inherently site-specific as they vary by road type and geographic locations. In this analysis, the county-average default values were used since values specific to West Oakland roadways are not available. Uncertainty in road dust emissions is further complicated by the mismatch between roadway classification systems of the data available, where freeway on- and off-ramps were assigned to multiple functional classes and thus numerous CARB road types, which are used to determine the silt loading factor by roadway segment. This likely resulted in a slight overestimate of road dust emissions from these roadway segments.

Of critical importance to West Oakland is the estimation of emissions from Port Trucks, which in part relies on the emission factors. Some field studies have suggested that there are uncertainties in the emission factors for Port Trucks for specific model years; for running exhaust emission factors for model years 2007 to 2009, a ~ 50% increase in black carbon and ~ 100% increase in $PM_{2.5}$ between calendar years 2013 and 2015 has been observed, while EMFAC2017 estimates only a ~ 26% increase in $PM_{2.5}$ (Preble *et al.* 2016). The inconsistency is likely due to the underestimates of high emitters caused by deterioration of Diesel Particle Filters (DPFs) in EMFAC2017. Further drayage truck studies conducted near the Port of Los Angeles exhibited a similar increase in emission factor in 2015, but showed emission factors in 2017 were closer to 2013 levels (Bishop and Haugen 2018). This suggests that the underestimate of emission factors did not continue in 2017. As noted in Bishop and Haugen (2018), a potential explanation for fewer high-emitting vehicles in 2017 is that there was increased roadside compliance testing and issuance of statewide citations since 2015 by CARB; this may have encouraged corrective maintenance or relocation for some of the high-emitting trucks observed in 2015.

To develop a better understanding of how DPF failure rates can affect emission factors of Port Trucks, the District conducted a sensitivity analysis for 2017 where EMFAC2017-based emission factors of affected model years were adjusted to reflect the same deteriorations observed by Preble *et al.* (2016). The analysis suggested a < 50% underestimate in Port Truck $PM_{2.5}$ running exhaust emissions, which corresponds to a ~ 1% underestimate in the overall 2017 emissions inventory for West Oakland. For future years 2024 and 2029, there should be no impact as the 2007-2009 model year group will be phased out by January 1, 2023 according to CARB's Truck and Bus Rule.

(c) Other Emission Processes

While the inventory developed for this analysis represents the majority of $PM_{2.5}$ and DPM from on-road mobile source activity, emissions generated from other operational processes (e.g., start emissions) may be developed in future emissions inventories and may be included in air dispersion modeling if relevant spatial and temporal data are available.

6.1.3 Truck-Related Businesses

Estimating emissions from truck-related businesses is inherently uncertain since business operations, such as activity patterns and fleet mix, are generally unknown. Truck fleet size estimates were based on responses District surveys (2009 or 2019 when available). When the District did not receive a response, a default truck fleet size and mix were assigned to the business. The District also applied a default truck fleet mix based on the 2009 West Oakland Truck Survey since fleet mix was not reported in the 2019 survey. The number of trucks reflects the trucks owned or operated by the business but excludes other trucks that visit the premises for business purposes.

In previous surveys conducted by the District (Bay Area Air Quality Management District 2009), the District found that all trucks complied with the 5 min idling regulation adopted by CARB (California Air Resources Board 2004). To be conservative, the District intentionally used a higher value of 15 min of idling per truck trip for all businesses. The accuracy of this assumption is unknown; this will certainly cause an over-prediction of air pollutant exposure from this source category, but without a more detailed or recent survey, it is difficult to quantify the uncertainties.

The results of this analysis suggest that truck-related businesses are relatively minor contributors to the overall air pollution and cancer risk in West Oakland. However, the District may consider a more detailed survey in the future to ensure the accuracy of the predictions and include any changes in business operations. The District may also incorporate additional truck-related businesses as information becomes available.

6.1.4 Port-Related Sources

Emissions for Port related activities were taken from the 2017 Port Inventory, prepared by Ramboll (2018). Because the District relied on data provided by the Port, it is difficult to quantify the uncertainties in the emissions estimates. In general, emission inventories have several sources of uncertainties including emission factors, equipment population and age, equipment activity, load factors, and fuel type and quantity. Most uncertainties are associated with the emission factors and engine load factors that were obtained from previous studies, literature reviews, and emission models developed by CARB. To improve the accuracy of the emissions estimates (and reduce uncertainty), the District only used emissions developed using more accurate data on OGV speeds inside the Bay, more realistic OGV emission factors under low load operations, and inclusion of emissions from bunkering that was not quantified in past inventories.

The 2017 Port Inventory, and therefore the emissions inventory presented herein, excludes emissions from smaller emissions sources within the Port, such as TRUs and gasoline powered light-duty vehicles. However, TRUs plug into shore power at the Port (which means they do not run their own engines, thus reducing emissions), and there are few gasoline powered vehicles compared to diesel-powered trucks operated by the Port. Therefore, emissions from these sources are not considered significant, and the overall effect on the Port emissions inventory is minimal.

6.1.5 UP Locomotives and Railyard

Freight activity is not always predictable and annual emissions vary by year depending on regional economics. Although the District used the most accurate emissions available, the District can improve the rail emissions inventory by (1) using Tier-specific emissions factors for locomotives and switchers, (2) including other activities and associated emissions at the railyard, and (3) spatially and temporally allocating activities and emissions along the yard and rail lines.

Using a fuel-based emissions inventory is the preferred method for developing an accurate inventory, as performed for the UP freight locomotives and railyard. The District converted the fuel consumption by rail link provided by UP to emissions using a fuel-based emission factor obtained from EPA, which are based on average operating duty cycles and an estimated average nationwide fleet mix for both switcher and line-haul locomotives. Using locomotive-specific conversion factors would yield better estimate of emissions, as fleet mixes vary from railroad to railroad and can be highly regionalized. And, though the use of Tier-specific emission factors (e.g., as shown in **Table 6-1**) could be used to improve the emissions inventory, it is also recognized that individual engines and thus emission factors are highly variable within Tier categories, depending on the specific locomotive model, operation cycle, and condition of operation (Bergin *et al.* 2012). In this analysis, it is not known whether the use of nationwide fuel-based emission factors may have resulted in under- or overestimates of emissions, given that detailed information on the locomotive characteristics and activity is not available.

Table 6-1. Fuel-based PM_{10} emission factors for locomotive engines by Tier. Values from California Air Resources Board (2017c).

Tier	PM_{10} (g/gal)
Pre-Tier	6.66
Tier 0	6.66
Tier 0+	4.16
Tier 1	6.66
Tier 1+	4.16
Tier 2	3.74
Tier 2+	1.66
Tier 3	1.66
Tier 4	0.31

Another improvement for future modeling efforts is the inclusion of other sources of emissions at the UP railyard. This analysis focused on emissions from line-haul locomotives and switchers, and excluded other sources of emissions at the railyard due to lack of data. In 2008, CARB completed an HRA for the UP railyard in Oakland that evaluated the health impacts associated with TACs emissions (California Air Resources Board 2008b). According to this report, activities in the railyard include receiving inbound trains, switching rail cars, loading and unloading intermodal trains, storing intermodal containers and truck chassis, assembling outbound trains, releasing outbound trains, and repairing freight cars and intermodal containers/chassis. Specific emission sources associated with these activities include locomotives, on-road diesel-fueled trucks, CHE, TRUs and refrigerated rail cars (reefer cars), and fuel storage tanks. DPM emissions from the UP railyard in 2005 inventory from California Air Resources Board (2008b) and the 2017 fuel-based emissions in this Action Plan are presented in **Table 6-2**. Although the District's analysis did include the largest sources of emissions primarily from switcher locomotives moving rail cars, line-hauls, and on-road trucks, the analysis did exclude cargo handling equipment and TRUs/reefer cars which contribute 49% of the emissions in the 2005 inventory. For this analysis, UP confirmed that the District modeled the most significant sources of diesel PM at the railyard and that the excluded sources were minor (James Brannon, UP, personal communication, 4 April, 2019). Additionally, at the time of this analysis, emissions from these other sources were not readily available from UP, and it is unknown whether the current activity levels are consistent with operations in 2005. The decline in switcher and line-haul emissions may be an indication that non-modeled sources would likewise experience a decline due to the introduction of new equipment and fleet turnover, resulting in lower emissions.

Table 6-2. UP railyard DPM emissions (tpy) in 2005, from California Air Resources Board (2008), and 2017, based on the West Oakland Action Plan (this document). The percent change from 2005 to 2017. The 2017 emissions from freight haul lines includes emissions from both UP and BNSF locomotives. "n/a" indicates that the source category was not included in the 2017 emissions inventory for UP operations.

Source Category	2005	% total	2017	% total	% change
Locomotives					
Haul lines (freight)	1.6	14	0.5044	30	-68.5
Switchers (railyard)	1.9	17	1.1098	67	-41.6
Service/testing	0.5	4	n/a	–	–
TRUs, reefers	3.2	28	n/a	–	–
CHE	2.2	19	n/a	–	–
On-road trucks	1.9	17	0.0416	3	-97.8
Total	**11.3**	**100**	**1.6558**	**100**	

The last improvement is the spatial and temporal allocation of emissions at specific railyard source locations. At the time the modeling was completed, information regarding locations of specific sources was not known. Instead, switcher engines and on-road trucks emissions were allocated on to an area that encompassed all of the rail lines, intermodal gates, locomotive service, and main yard. In subsequent discussions with UP, they confirmed that individual source locations identified in the 2008 CARB report were valid for 2017 operations (Gary Rubenstein, personal communication, 5 April, 2019; see **Figure 6-1**). The modeling assumed constant activity throughout the year but adjustments can be made in the modeling to account for temporal variations in activity level by season, time of day, or weekly.

UP is in the process of developing a detailed, comprehensive emissions inventory for the Oakland railyard which is expected to be completed by the end of 2019. UP expects to capture individual locomotive characteristics and movements to develop a bottom-up inventory of sources and emissions in the railyard. The District plans to use this detailed inventory in future UP emissions estimates that will address most of the uncertainties identified in this analysis.

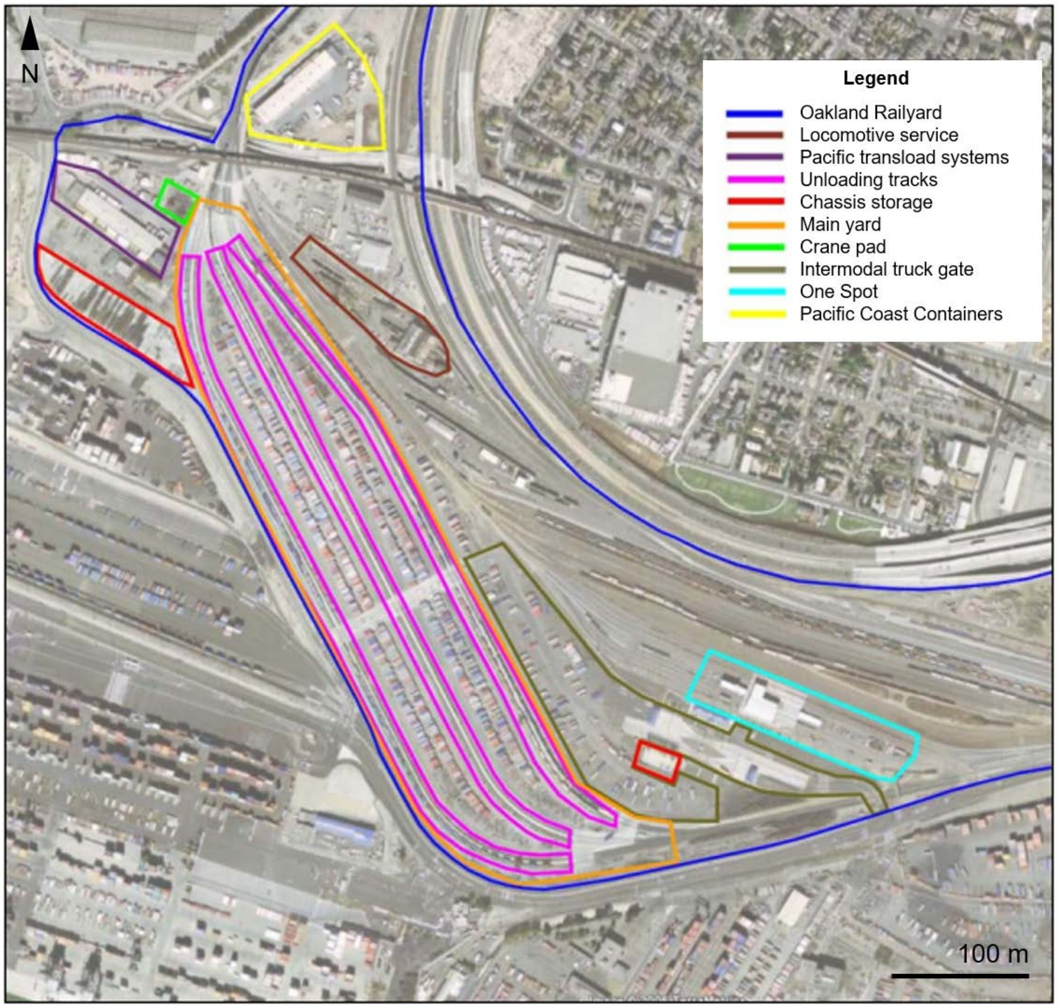

Figure 6-1. Layout of operations at the UP railyard in West Oakland. The components delineated represent different emissions sources (obtained from Gary Rubenstein, personal communication, 5 April, 2019).

6.1.6 Omitted Emissions Sources from Air Dispersion Modeling

Emissions from other sources that were not included in the community-scale air dispersion modeling were estimated using a top-down approach, as reported in **Table 2-3**. Further refinements to the emissions estimates of these source categories, in addition to their temporal and spatial allocation, would further improve the estimates of community exposure in West Oakland and source apportionment of local concentrations and excess cancer risk as presented in **Section 4**.

(a) Commercial Cooking

Commercial cooking emissions for West Oakland were estimated by disaggregating the District's emissions estimates for Alameda County by using spatial surrogate data developed for the regional modeling. The spatial surrogate for commercial cooking was based on the fraction of Alameda

County restaurants that fall within the West Oakland community-scale Source Domain. Approximately 10% of Alameda County restaurants fall within the West Oakland domain, resulting in 20.63 tpy of $PM_{2.5}$ emission in 2017.

To start to refine the District's understanding of commercial cooking emissions at a community-scale in West Oakland, specific restaurant locations were identified from a database purchased from InfoUSA.[94] There are 537 restaurants within the West Oakland Source Domain, where most of the facilities are in Chinatown (south of Downtown), southwest of the West Oakland community (**Figure 6-2**). In fact, only 74 of the restaurants fall within the main residential area of West Oakland, some of which may not use cooking devices that emit $PM_{2.5}$ (e.g., charbroilers, deep fat fryers, or griddles). Additional analyses are underway to evaluate the potential impact of commercial cooking in West Oakland, especially given that the majority of commercial cooking facilities are generally downwind of the West Oakland community.

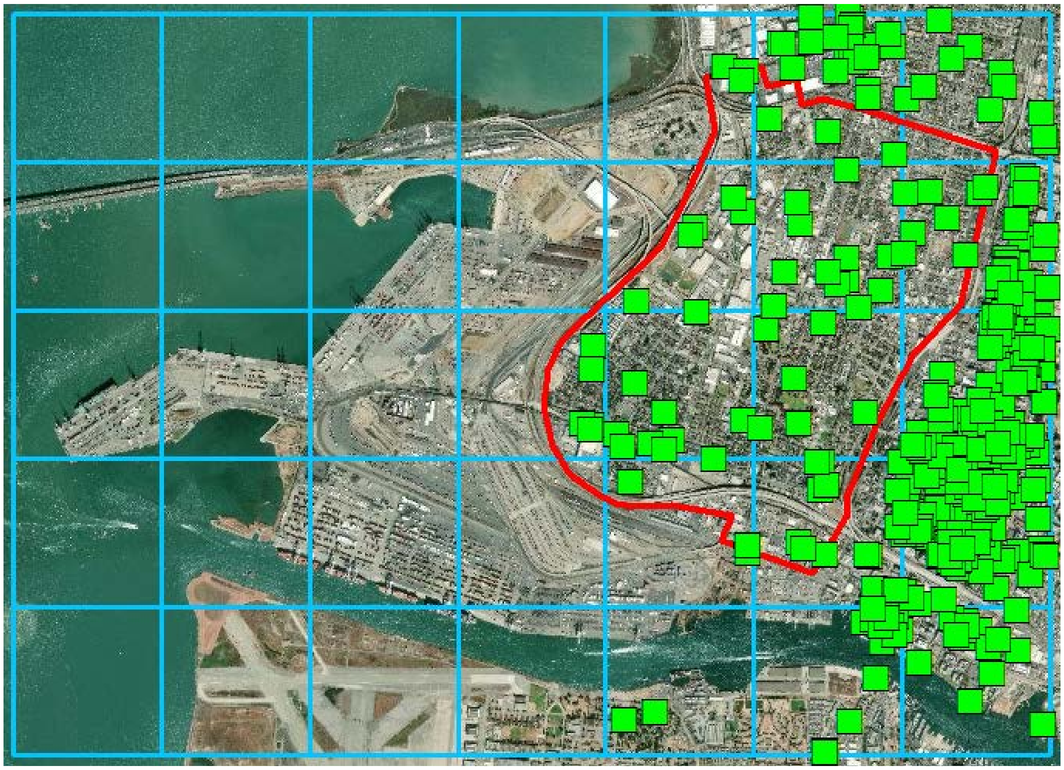

Figure 6-2. Restaurant locations (green squares) within the West Oakland Source Domain (blue grid). The major residential area of the West Oakland community is outlined (red line).

[94] https://www.infousa.com/

(b) Construction

Emissions from construction equipment and construction dust for West Oakland were estimated by disaggregating CARB's emissions estimates for Alameda County using spatial surrogate data developed for the regional modeling. Alameda County emissions data were obtained from CARB's 2016 SIP Emissions Projections Tool,[95] and the spatial surrogate was developed based on land use data from ABAG. Specifically, ABAG's Existing Land Use Data for 2000 and 2005 were compared to identify land use changes and determine where construction activity likely occurred. This approach leads to high uncertainty in emission estimates for 2017, as construction activity is highly transient, changing in scope and location from year to year. Construction emissions were not included in the community-scale modeling for West Oakland due to uncertainties associated with 2017 emission estimates and the spatial distribution of construction activities in the community. ABAG has not updated the Existing Land Use Data since 2005, and the District is currently exploring other sources of information for recent and projected construction activity in West Oakland.

(c) Transport Refrigeration Units (TRUs)

Emissions from TRUs were estimated at the county-level using CARB's OFFROAD model. The District disaggregated Alameda County TRU emissions to West Oakland using an industrial land use spatial surrogate which was derived from ABAG's 2005 Existing Land Use Data. Based on this surrogate, ~ 4% of Alameda County TRU emissions occur in West Oakland.

CARB has also provided the District with estimates for TRU emissions in West Oakland. CARB allocated a portion of Alameda County emissions to West Oakland using a spatial surrogate based on facilities that operate TRUs or are frequented by TRUs.[96] Such facilities include grocery stores, liquor stores, cold storage warehouses, and trans-load facilities. Approximately 80% of West Oakland emissions were classified by CARB as large (> 200,000 ft^2) and medium (50,000 – 200,000 ft^2) sized facilities. The remaining 20% of TRU emissions were allocated to operation on roadways within West Oakland.

The District's TRU emissions estimate for West Oakland are about half of CARB's estimate (**Table 6-3**). The District plans to investigate this further by contacting the 10 large- and medium-sized facilities in West Oakland identified by CARB to obtain more information regarding their TRU activity. TRU emissions may then be refined and/or included in future community-scale modeling.

Table 6-3. 2017 TRU emissions for Alameda County and West Oakland.

Estimated by	Area	$PM_{2.5}$ (tpy)	DPM (tpy)
CARB	Alameda County	6.57	7.30
	West Oakland	0.49	0.53
District	West Oakland	0.24	0.26

[95] https://www.arb.ca.gov/app/emsinv/2016ozsip/2016ozsip/.

[96] As documented in a memo, *Spatial Allocation Methodology of Transportation Refrigeration Unit (TRU) Emissions for AB617 Communities*, provided to the District by CARB on May 30, 2019.

(d) Residential Wood Combustion

The District developed a top-down emission inventory for residential fuel combustion in West Oakland by disaggregating county-level emissions estimates using the proportion of primary heating fuel used by households assigned to wood combustion from the 2010 Census data. This approach results in uncertainties for wood combustion emissions, as some homes may burn wood in fireplaces recreationally, but not report wood as the primary heating fuel.

Past residential wood combustion surveys conducted by the District did not include homes in West Oakland. In addition, community members have reported backyard burning that may not be reflected in the District's residential wood combustion emissions estimates. Due to these uncertainties, and especially given the lack of spatial information, this source category warrants further investigation and was not included in community-scale modeling efforts.

6.2 Air Dispersion Modeling

While AERMOD is a state-of-the-art dispersion model for near-field applications, there are still inherent uncertainties associated with the model calculations.

6.2.1 Model Formulation

Generally, a model is a (often) simplified representation of a real-world system, where complex processes are parameterized and characterized using equations that are solved by a computer. Some uncertainties in the results are inherent to a model itself, and thus may be referred to as "irreducible" errors or uncertainties. The District used the AERMOD dispersion model to estimate the dispersion factors and consequently pollutant concentrations in West Oakland to which the population could be exposed. AERMOD uses simplified atmospheric physics and scaling concepts to simulate air pollutant dispersion. Some uncertainties in the results arise from the model's inability to represent the complex aerodynamic and dispersion processes.

Specifically, AERMOD is a steady-state plume model; this means that only a single set of temporally averaged (usually 1 h) meteorological parameters are used to represent the atmospheric state over the averaging time at any point in space, i.e., meteorological conditions are spatially homogeneous. This can potentially be problematic in coastal areas or in areas of complex terrain, where wind fields can have high spatiotemporal variability. Given the proximity and orientation of the Bay surrounding the West Oakland community, only using a single meteorological dataset introduces uncertainties to the potential dispersion of pollutants. Wind directions from the meteorological dataset from OST, located to the northwest of the modeling domain, used in AERMOD were predominantly from the northwest (**Figure 3-2**). These winds influence the dispersion from emissions sources at any location within the domain, though winds likely have a more southerly component at locations along the channel and Inner Harbor. As a result, dispersion to locations in the northeastern section of the domain may be slightly underestimated. And, while AERMOD uses a dividing-streamline concept to model dispersion of plumes around topographic features (Cimorelli *et al.* 2004, Snyder *et al.* 1985), the inherent uncertainties in this formulation are likely less important for dispersion modeling in West Oakland, as the area is relatively flat (**Figure 3-19**).

AERMOD also does not account for small-scale flow patterns and dispersion around structures or recirculation and channeling in urban canyons, as is typical in urban areas with multi-story buildings. While AERMOD can include some of the influence of building wakes on plume rise and dispersion (using the Plume Rise Model Enhancements [PRIME] model downwash algorithm [Schulman *et al.* 2000]), this calculation feature can only be used for point sources (Cimorelli *et al.* 2004); most of the emissions sources in this analysis were modeled as area and volume sources.

The performance of the AERMOD modeling system has been evaluated against several observational datasets (Perry *et al.* 2005); the accuracy of the output depends on the pollutant, type of source modeled, terrain (flat or complex), whether or not wake effects are accounted for, and the averaging period of results compared to observations (e.g., 3 h, 24 h). AERMOD tends to perform well, especially in reproducing the highest concentrations of pollutant distributions (Perry *et al.* 2005), which are often used to assess compliance with air quality regulations (e.g., National Ambient Air Quality Standards [NAAQS]) or investigate "worst-case scenarios." However, if there are additional "reducible" uncertainties associated with input data (e.g., wind direction), "composite errors in the highest estimated concentrations of 10 to 40 percent are found to be typical," (U.S. Environmental Protection Agency 2017, paragraph 4.1(e)). AERMOD may also underestimate lower concentrations, which can namely impact annual average estimates (Perry *et al.* 2005). While the overall distribution of pollutant concentrations may be well captured by AERMOD, the exact time and location of the concentrations may be less certain (Cimorelli *et al.* 2004, Perry *et al.* 2005), especially given the steady-state formulation.

That being said, AERMOD is currently the preferred model for near-field (≤ 50 km) dispersion of emissions, as listed in EPA's Guideline on Air Quality Models ("Appendix W" to 40 CFR Part 51; U.S. Environmental Protection Agency 2017). AERMOD is routinely used in research and regulator frameworks, performs better than similar models (e.g., Perry *et al.* 2005), and has been applied to estimate pollutant concentrations in similar studies (e.g., California Air Resources Board 2008b). The District has evaluated and used an appropriate meteorological dataset such that "reducible" uncertainties are limited (see **Section 3.2.1**). As future modeling efforts are implemented, the District will ensure that the latest versions of each model in the AERMOD modeling framework are used to reduce some of the inherent uncertainty.

6.2.2 Dispersion Modeling and Emissions Source Parameters

The selection dispersion modeling and emissions source parameters use for AERMOD dispersion modeling also introduce limitations and uncertainties to the results. Some of these are discussed below:

- **Urban surface roughness length**: All sources were modeled as urban sources with a surface roughness length set to 1.0 m. While this is the default value for regulatory applications in AERMOD (U.S. Environmental Protection Agency 2018b), and is considered appropriate for most applications (U.S. Environmental Protection Agency 2015a) as it is representative of centers of large towns and cities or landscapes with regularly-spaced large elements, a more representative value could be derived and used West Oakland. Though, the default value was used in this analysis to be consistent with other permit modeling performed by the District.

- **Building downwash**: The effects of building downwash were not accounted for. The building downwash option in AERMOD, using the PRIME algorithm, accounts for the buildup of air pollution in a building's cavity due to recirculating winds created by nearby buildings; the effects are governed by the building geometry and the wind direction. Typically, building downwash leads to higher concentrations downwind of the (stack) emission source. Parameters required to use this feature include the building height and dimensions; for West Oakland, these parameters could be derived from the lidar dataset used (**Section 3.4.3**(b)) or similar dataset. However, the building downwash algorithms can only be applied to point sources; they do not apply to volume or area sources, which were the primary source types used in this analysis. The District did not apply building downwash to point sources for consistency.

- **AERMOD source type selection**: Source types must be selected by the modeler to represent the physical geometry and emission characteristics of emission sources. In AERMOD, these are generally point, area, or volume sources. While the District selected source types based on general modeling guidance, previous studies, and/or engineering judgements, some AERMOD source types may not adequately capture the emissions characteristics of certain sources, while the District did not have necessary configuration information for others (e.g., see the discussion below for permitted stationary sources).

- **Missing parameters**: When modeling parameters were not known, the District used default model values or values based on general modeling guidance, previous studies, and/or engineering judgements. Modeling parameters were often selected so that the modeling would produce more conservative results.

While there are uncertainties related to dispersion modeling parameters used for all emissions source categories, those that could be improved upon in future modeling analyses are discussed below:

Permitted Stationary Sources: Only a limited number of facilities had complete release parameter information (**Table 2-5**). Missing parameters, such as stack height and diameter, were assigned "default" values (**Table 3-2**), which were based on previous modeling studies conducted by the District. Moreover, in spite of significant effort expended to improve the exact location of stacks and emission sources at permitted facilities, errors and uncertainties persist due to the complex arrangement of the facilities. The District also had to use either a single volume source or point source for each permitted stationary source; however, the District recognizes that some sources, particularly fugitives, tanks, and waste piles, may be more accurately modeled as area sources. In future modeling analyses, the District may seek to remove this restriction and include more site-specific emissions release parameters, where available.

On-road mobile sources: The main uncertainties in the modeling parameters for on-road mobile sources is related the source (roadway) width (W), and the release heights ($Relhgt$) assigned to each volume source. First, the width determines the initial horizontal dispersion coefficient ($Syinit$), the size of the exclusion zone (r_{EZ}), and therefore which receptors from the "master grid" must be excluded (**Section 3.4.1**, **3.5**) and where dispersion factors must be imputed (**Section 4.1.1**). In this analysis, the roadway width was based on road type class (originally based on the Citilabs dataset) and FHWA guidance. The highest degree of uncertainty likely applies to on- and off-ramps, since they were distributed among multiple road type classes. Second, since current EPA guidance (U.S. Environmental Protection Agency 2015b) does not include recommendations on how to model on-road mobile source emissions on elevation roadways in AERMOD, the District adjusted the release heights to account for the elevation of roadways. The structure elevation data was based on a lidar dataset (**Section 3.4.3**(b)). The resulting structure heights appeared to be overestimated (and "noisy," with a higher degree of spatial variability than expected) on surface streets (**Figure 3-5**), where it is assumed that roadways are generally at grade. An improvement or further assumption could be that structure elevation data should only be assigned to freeways and on- and off-ramps, since they are the largest source of on-road mobile source emissions, and are most likely to be above grade. This would require further refinement of the road type classes assigned to each roadway segment. Otherwise, an alternative dataset could be used, such as the Caltrans automated pavement condition survey (APCS).[97] This dataset contains the start and end elevations of roadway segments for freeways in California. As such, the elevation along each segment could be interpolated to volume source locations. However, since the primary purpose of the APCS data is to assess pavement conditions, the data is not necessarily well calibrated. Using the dataset would also require more refined geospatial processing techniques to properly match segments from the APCS shapefile to those in the Citilabs dataset. The APCS dataset also does not include all elevated roads and on- and off-ramps in West Oakland. In summary, both the width and release heights of the volume sources used to model emissions form on-road mobile sources could be improved with further refinement of road type classification, especially for on- and off-ramps.

Since there can be discrepancies between real-world emissions characteristics from a source and how they are represented in AERMOD, exposure concentrations derived in this analysis should be taken to represent approximate exposure concentrations.

6.2.3 Receptors

Receptors were placed at a height of 1.8 m agl; this parameter is used to conservatively model exposures within an individual's "breathing zone." Using the flagpole receptors may not always capture the highest predicted concentration, especially in cases where both the source and the receptors are elevated above the surface terrain. Concentrations estimated at receptors also only represent those that an individual may be exposed to outdoors (indoor air quality and exposure is not assessed).

[97] Currently, the most recent dataset is the 2016 Elevation APCS dataset ("Elevation2016APCS", created July 27, 2016, by the Caltrans Office of Pavement Management and Performance; available at: http://www.dot.ca.gov/hq/tsip/gis/datalibrary/Metadata/Elevation.html).

6.3 Risk Assessment Methodology

A risk assessment is a decision-making tool that can be used to estimate the probability of adverse health effects in humans exposed to pollutants in the environment. Risk assessment methodology uses an estimated level of contamination in the environment (concentration) while assuming a constant rate of intake and length of exposure, combined with chemical effect factors, to produce cancer risks. While mean parameters values derived from scientifically defensible studies are a reasonable estimate of central tendency, the exposure variables used in this assessment are only estimates. Therefore, that is to say, the resulting cancer risk estimated in this analysis is not the expected rate of illness in West Oakland, but is rather an estimate of potential risk that can be used to compared to risk from other sources or in communities if using a similar methodology.

Risk assessments are designed to be overly conservative to ensure that the probability, expressed as the chance of developing cancer for one million people that are exposed at a specific location, are health protective of the most sensitive population. EPA notes that the conservative assumptions used in a risk assessment are intended to assure that the estimated risks do not underestimate the actual risks posed by an emissions source, and that the estimated risks do not necessarily represent actual risks experienced by populations at or near a source (Environmental Protection Agency 1989). The methodology and parameters used in risk assessments have long been established and are accepted practice for comparing exposure and health impacts between sources. The main assumptions within the risk assessment methodology (based on OEHHA's guidance) are:

(1) Ambient pollutant concentrations (estimated from dispersion modeling in this analysis) are constant over the exposure period (30 years), while in reality, average pollutant concentrations vary on many time scales, including daily, seasonally, and inter-annually.
(2) An individual is exposed *in vitro* starting from the last trimester of pregnancy and continues to reside at the same location into adulthood and only nominally absent from the location of exposure.
(3) Some chemical toxicity values are estimated based on *in vivo* studies using animals that are extrapolated to estimate effects on humans. High chemical doses administered to these animals are often much higher than what human are exposed to in the environment.

All of these factors are designed to overestimate exposure, cancer risk, and health effects to humans. Thus, while resulting in conservative cancer risk estimates, each assumption contributes to inherent uncertainties in the results. Further uncertainties lie within the variability of in emissions from different emissions sources (which result in fluctuations of pollutant concentrations over time), changes in daily human activity patterns and therefore location of exposure (i.e., not always at the place of residence), and range of individual responses to chemical exposures (which could depend on genetics, immune system response, metabolism, etc.).

ASF values, as recommended by OEHHA, increase the effective CPF to account for increased sensitivity of younger individuals to cancer-causing pollutants. However, there may be pollutants in the urban environment whose cancer toxicity is amplified due to the presence of other pollutants (synergic effects) or because of pre-existing conditions or sensitivities; these effects are not accounted for. Furthermore, there may be pollutants whose toxicity is not yet recognized or quantified and, as such, is unaccounted for in this analysis.

While the District used CPF values recommended by OEHHA to estimate cancer risk associated with pollutant exposures from the modeled emissions sources, these values are uncertain in both the estimation of response and dose for many pollutants. For example, the level of risk for DPM is uncertain; public health and regulatory organizations, such as the International Agency for Research on Cancer (IARC), World Health Organization (WHO), and EPA, agree that diesel exhaust may cause cancer in humans, though there is uncertainty in the CPF value (see Scientific Review Panel 1998, Office of Environmental Health Hazard Assessment 2011). As such, any adopted changes to CPFs or exposure factors will be incorporated in future risk assessments for West Oakland.

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Attachment 1. Toxic Air Contaminants

Table A-1-1. Inhalation CPF by Chemical Abstract Service (CAS) number. Inhalation CPFs are adjusted to account for multi-pathway slope factor, where applicable (consistent with Regulation 2-5). Chemicals listed are those that were emitted from one or more sources in the West Oakland emissions inventory (Section 2). Only those chemicals with an associated inhalation CPF were modeled and therefore included in the calculation of cancer risk (Section 4).

CAS number	Chemical name	Inhalation CPF $[(mg/(kg\ day))^{-1}]$
71-55-6	1,1,1-Trichloroethane	–
75-35-4	1,1-Dichloroethylene	–
107-06-2	1,2-Dichloroethane	0.072
106-99-0	1,3-Butadiene	0.6
542-75-6	1,3-Dichloropropene	0.055
106-46-7	1,4-Dichlorobenzene	0.04
12391-1	1,4-Dioxane	0.027
1746-01-6	Chlorinated dioxins and furans (2,3,7,8-Tetrachlorodibenzo-p-dioxin and related compounds; California TCDD equivalent)	650000
75-07-0	Acetaldehyde	0.01
67-64-1	Acetone	–
10-702-8	Acrolein	–
7664-41-7	Ammonia	–
7440-38-2	Arsenic	180
71-43-2	Benzene	0.1
7440-41-7	Beryllium	8.4
7440-43-9	Cadmium	15
75-15-0	Carbon Disulfide	–
124-38-9	Carbon Dioxide (CO_2) (non-biogenic)	–
630-08-0	Carbon Monoxide (CO)	–
67-66-3	Chloroform	0.019
7440-50-8	Copper and Copper Compounds	–
18540-29-9	Chromium (hexavalent, 6)	560
9-90-1	DPM (Diesel Exhaust Particulate)	1.1
107-21-1	Ethylene Glycol	–
111-76-2	Ethylene Glycol Monobutyl Ether	–
100-41-4	Ethylbenzene	0.0087
50-00-0	Formaldehyde (gas)	0.021
7647-01-0	Hydrogen Chloride	–
7664-39-3	Hydrogen Fluoride	–
7783-06-4	Hydrogen Sulfide	–

CAS number	Chemical name	Inhalation CPF [(mg/(kg day))$^{-1}$]
64742-48-9	Isoparaffinic solvents C10+	–
67-63-0	Isopropyl Alcohol	–
7439-92-1	Lead and Lead Compounds	0.98
7439965	Manganese & Manganese Compounds	–
7439976	Mercury (Inorganic)	–
74-82-8	Methane (CH_4)	–
67-56-1	Methanol	–
74-83-9	Methyl Bromide	–
78-93-3	Methyl Ethyl Ketone	–
75-09-2	Methylene Chloride (Dichloromethane)	0.0035
91-20-3	Naphthalene	0.12
7440-02-0	Nickel and Nickel Compounds	0.91
10024-97-2	Nitrous Oxide (N_2O)	–
110-54-3	n-Hexane	–
98-56-6	Parachlorobenzotrifluoride (PCBTF)	–
50-32-8	Polycyclic aromatic hydrocarbons (PAH) (as benzo(a)pyrene equivalent)	86
108-95-2	Phenol	–
1336-36-3	Polychlorinated Biphenyls (PCB)	74
7782-49-2	Selenium	–
127-18-4	Tetrachloroethylene (Perchloroethylene)	0.021
108-88-3	Toluene	–
79-01-6	Trichloroethylene	0.007
1330-20-7	Xylenes (technical mixture of m, o, p-isomers)	–

Attachment 2. Permitted Stationary Sources

Table A-2-1. Permitted stationary sources in the West Oakland Source Domain. "M" indicates whether the facility was modeled (×) or not (–); facilities were not modeled if either (a) there were no $PM_{2.5}$ or TAC emissions available in the database for the base year, or (b) all TAC emissions were associated with pollutants that did not have associated cancer risk toxicities. The plant number (Plant No.) indicates a unique facility. Cities are abbreviated as "O" for Oakland, "A" for Alameda, and "E" for Emeryville. The SIC code indicates the Standard Industrial Classification code. The values of *x* and *y* are the coordinates of the source centroid in UTM zone 10 North (NAD83).

M	Plant No.	Facility Name	Address	City	SIC code	*x*	*y*	Source Category
×	24024	2150 Webster Holdings VII	2150 Webster Street	O	9631	564648.165924	4185022.458960	Generator
×	111616	AAA San Pablo Fuel Inc.	3420 San Pablo Ave	O	5411	563549.336623	4186746.924690	Gas station
×	14532	AC Transit General Office	1600 Franklin Street	O	9621	564409.165973	4184484.458940	Generator
–	23085	Acorn Restoration	2914 Poplar Street	O	7641	562956.166026	4186300.458690	Spray booth
×	16713	Alameda County Employees Retirement Assn (ACERA)	475 14th Street	O	4812	564069.166042	4184376.458890	Generator
×	20828	Alameda County General Services Agency	1111 Jackson Street	O	9199	564574.165975	4183921.459000	Generator
×	107875	Alameda County General Services Agency	165 13th Street	O	5411	564684.165951	4183963.459030	Gas station
×	10997	Alameda County GSA	661 Washington St	O	9199	563718.490000	4183843.070000	Generator and boiler
×	10998	Alameda County GSA	400 Broadway Avenue	O	9299	563845.760000	4183606.200000	Standby generator
×	13929	Alameda County GSA	1106 Madison Street	O	9199	564717.040000	4183834.660000	Standby generator
×	17114	Alameda County Public Works Agency	3455 Ettie Street	O	9532	562573.165973	4186712.458690	Generator
×	19321	Alameda Cremations	2900 Main Street, Suite 116	A	7261	562363.166189	4182717.459020	Crematory
×	3676	Alta Bates Summit Medical Center	450 30th Street	O	8062	564611.165840	4186083.458850	Generator and boiler
–	22763	Amber Flooring Inc	3441 Louise Street	O	1752	562851.080000	4186802.130000	Coatings
×	200693	Amtrak	120 Magnolia Street	O		562481.166186	4183885.458960	Generator
×	2112	Aramark Uniform Services	330 Chestnut Street	O	7218	562723.166109	4183993.458910	Boiler
×	18668	AT&T Corp	344 20th Street	O	4899	564670.058785	4184834.236440	Generator
–	200827	Automotive Collision Repair	365 26th Street	O	7532	564651.165873	4185526.458920	Autobody
–	3069	B and T One Hour Cleaners	190 14th Street	O	7216	564726.165955	4184100.459030	Petroleum dry cleaning
×	200393	BA1 1330 Broadway LLC	420 13th Street	O		564191.165976	4184276.458970	Generator

M	Plant No.	Facility Name	Address	City	SIC code	*x*	*y*	Source Category
×	200620	BA1 2201 Broadway LLC	2201 Broadway	O		564482.165923	4185116.458900	Generator and boiler
×	112534	Bart Gas & Food	1395 7th St	O	5411	562206.166118	4184385.458900	Gas Station
×	20703	Bay Area Rapid Transit Dist. (BART)	418 Clay Street	O	4911	563677.166072	4183706.459010	Generator
×	22703	Bay Area Rapid Transit	550 W MacArthur Blvd	O	6512	564569.165800	4186899.458770	Generator
×	9684	Bay Ship and Yacht Co	2900 Main Street, Suite 2100	A	3731	562367.166212	4182722.458960	Coatings/blasting
×	12691	Berkeley Millwork & Furniture Co	2279 Poplar Street	O	2511	562731.018032	4185768.066460	Finishing with heater
–	17822	Berkeley Repertory Theatre	2526 Wood Street	O	5812	562399.166012	4186237.458670	Painting operations
×	21949	Bicycle Coffee LLC	364 2nd Street	O	2043	563894.166042	4183377.459030	Coffee roaster
×	21713	Blue Bottle Coffee Company	300 Webster Street	O	2095	563994.323692	4183422.851580	Coffee roaster
×	111014	BNSF Intermodal	333 Maritime St	O	5411	560377.166300	4184470.458710	Gas station
×	15538	BNSF Railway Co	333 Maritime Street	O	4013	562230.166190	4184011.458950	Generator
–	10987	Bolero Co	2905 Union Street	O	7532	562984.165983	4186288.458700	Autobody
×	22884	Broadway Franklin LLC	1111 Broadway	O	6512	564043.166022	4184189.458930	Generator
×	210258	Burger King	1240 Broadway	O	5812	564138.165974	4184245.458950	Charbroiler
×	24153	Cafe Tartine LLC	325 Martin Luther King Way	O	2095	563327.1661	4183779.459	Coffee roaster
×	10131	California Cereal Products Inc.	1267 14th Street	O	2043	562586.166136	4184922.458790	Grain system
–	20665	California Finest Body & Frame	1415 18th St	O	7532	562386.166089	4185378.458730	Spray booth
×	111397	California Highway Patrol	3601 Telegraph Ave	O	5411	564529.375244	4186675.889090	Gas station
×	14572	California Highway Patrol-Telecommunications	3601 Telegraph Ave	O	9221	564569.885283	4186642.089800	Generator
×	21295	California Hotel	3501 San Pablo Ave	O	6513	563493.165960	4186770.458660	Generator
×	15740	California Waste Solutions - Wood Street	3300 Wood Street	O	5093	562495.166064	4186548.458720	Recycling
×	15739	California Waste Solutions-10St Street	1820 10th Street	O	5093	561475.166213	4185141.458710	Recycling
×	22649	Caltrans	200 Burma Road	O	4111	560738.166175	4186460.458630	Generator
×	100210	Caltrans - East Bay Yard	Burma Road	O	5411	560755.166135	4186467.458670	Gas station
×	200062	Caltrans SFOBB Maintenance Complex	200 BURMA RD	O	5411	560733.166177	4186456.458660	Gas station
×	146	CASS Inc,	2730 Peralta Street	O	5093	562822.166009	4186107.458720	Furnace
×	21941	Cathedral Gardens Oakland	638 21st Street	O	3679	564035.165958	4185114.458850	Generator

M	Plant No.	Facility Name	Address	City	SIC code	*x*	*y*	Source Category
×	1253	Central Concrete Supply A U.S. Concrete Company	2400 Peralta Street	O	3273	562704.166064	4185937.458700	Cement Silo
–	21947	Chevron Environmental Management Company	706 Harrison Street	O	1522	564240.166026	4183668.459020	Soil vapor extraction
×	107693	Chevron SS #9-4800	1700 Castro St	O	5411	563781.373230	4184857.894450	Gas station
×	111947	China Town 76 Unocal #0752	800 Harrison St	O	5411	564281.166049	4183753.458990	Gas Station
×	20248	CIM Group Properties	1901 Harrison Street	O	6512	564679.140000	4184629.770000	Generator and fire pump
×	20345	CIM Properties	1333 Broadway	O	6512	564093.994123	4184334.960920	Generator and boiler
×	23838	City Center 1300 LLC	1300 Clay Street	O	6531	563966.165972	4184412.458950	Generator
×	20438	City of Alameda Northside Pump Station	1253 Marina Village Parkway	A	4911	563904.166063	4182438.459100	Generator
×	14502	City of Oakland, Environmental Services Division	150 Frank Ogawa Plaza	O	9199	564173.165992	4184440.458930	Generator
×	21819	City of Oakland	455 27th St, Fire Station 15	O	9229	564573.165885	4185607.458900	Generator
×	201072	City of Oakland	1111 Broadway	O	9224	564046.420000	4184190.710000	Generator
×	14503	City of Oakland, Environmental Services Division	1 Frank Ogawa Plaza	O	9199	564064.166028	4184463.458910	Generator
×	14291	City of Oakland, Public Works Facilities	455 7th Street	O	9221	563833.166039	4183787.459030	Generator
×	14301	City of Oakland, Environmental Services Division	1605 Martin Luther King Jr Way	O	9224	563758.972178	4184774.902360	Generator
×	14302	City of Oakland, Environmental Services Division	14th & Mandela Way	O	9224	562266.166084	4185050.458770	Generator
×	109646	City of Oakland Fire Station 1	1605 Martin Luther King Way	O	5411	563796.165984	4184760.458890	Gas station
×	107940	City of Oakland-Fire Department Drill Tower	250 Fallon St	O	5411	564794.166029	4182969.459090	Gas Station
×	106473	City of Oakland-Police Admin Building	495 6th Street	O	5411	563821.166076	4183803.458970	Gas Station
–	17439	Clear Channel Outdoor	2865 Hannah Street	O	5199	562755.165971	4186373.458720	Coatings
×	111913	Clear Channel Outdoor	2857 Hannah St	O	5411	562751.166014	4186335.458710	Gas station
×	18641	Color Folio Design	1467 Park Avenue	E	7389	562617.166008	4187249.458660	Coatings
–	20821	ConGlobal Industries	555A Maritime Street	O	5085	560475.166256	4184659.458700	Roller coater
–	18431	Continental Auto Body	1355 Park Ave	E	7532	562817.165947	4187280.458640	Autobody

M	Plant No.	Facility Name	Address	City	SIC code	*x*	*y*	Source Category
–	23039	Cooks Collision	1900 Martin Luther King Way	O	7532	563928.165958	4184901.458940	Autobody
–	23040	Cooks Collision	149 11th St	O	7532	564697.165942	4183778.459030	Spray booth
×	201187	Coolport LLC	575 Maritime Street	O	9224	560017.110000	4184626.200000	Generator
×	17190	County of Alameda	1221 Oak Street	O	9229	564784.165962	4183908.459030	Generator
×	13908	County of Alameda - GSA	1401 Lakeside Drive	O	9199	564725.165954	4183831.458990	Generator and boiler
×	18947	County of Alameda - Public Works Agency	8th Ave & Between Fallon St	O	9229	564622.166034	4183582.459050	Generator
×	17739	Cushman & Wakefield	Jack London Square	O	6531	563565.166106	4183351.458960	Generator
–	20526	Custom Wood Finishing	2311 Adeline Street	O	5712	563032.165995	4185688.458740	Generator
–	22272	Dawit Auto Body	4101 Martin Luther King Way	O	7532	564365.165829	4187302.458680	Autobody
×	20537	Department of Transportation	Toll Operations Building, SF Oakland Bay Bridge	O	4911	560392.166186	4186542.458540	Generator
×	20586	Digital 720 2nd LLC	720 2nd Street	O	4813	563160.166139	4183761.458900	Generator
×	20802	Domain Residences, LLC	1389 Jefferson St	O	6512	563805.166051	4184475.458910	Generator
×	19997	DWFIU 1999 Harrison, LLC	1999 Harrison Street	O	6531	564708.984401	4184731.933590	Generator
×	11887	Dynegy Oakland LLC	50 Martin Luther King Jr Way	O	4931	563278.166088	4183491.458950	Turbines
×	8001	East Bay Municipal Utility District	1200 21st Street	O	4941	562895.166049	4185545.458780	Spray booth
×	13712	East Bay Municipal Utility District	1100 21st Street	O	4941	563100.165995	4185500.458840	Generator
×	13728	East Bay Municipal Utility District	375 11th Street	O	4941	564204.165985	4184024.458980	Microturbine
×	109891	East Bay Municipal Utility District	2144 Poplar St	O	5411	562740.166030	4185560.458750	Gas Station
×	13737	East Bay Municipal Utility District PSK	2101 7th Street	O	4941	560669.166256	4184799.458780	Generator
×	591	East Bay Municipal Utility District	2020 Wake Avenue	O	4952	562060.166061	4186640.458610	Generator
×	14238	East Bay Municipal Utility District	1001 W Red Line Ave	A	4941	561168.166359	4182649.458950	Generator
–	20061	Englund Studio	1850 Campbell Street	O	3369	562304.166125	4185571.458820	Spray booth
×	19971	Essex Portfolio LLC DBA The Grand Apartments	100 Grand Avenue	O	1522	564718.017588	4185172.851520	Generator
×	20724	FEMA	1111 Broadway	O	9111	564046.420000	4184190.710000	Generator

M	Plant No.	Facility Name	Address	City	SIC code	*x*	*y*	Source Category
×	24194	Former Mobil and Ashland Bulk Fuel Terminals	909 Ferry Street (Port of Oakland, Berth 23)	O	4953	560392.166189	4185875.458610	Soil Vapor Extraction
×	22746	Fox Television Stations Inc. on behalf of KTVU	2 Jack London Square	O	4833	564257.166075	4182885.459060	Generator
×	16749	General Services Administration-East Bay Office	1301 Clay Street	O	9199	563912.165967	4184445.458890	Generator and boiler
–	3737	George V Arth & Son	110 10th St	O	7532	564726.165981	4183733.459040	Spray Booth
×	17588	Global Power Group, Inc	3938 Horton Street	E	5311	562750.510967	4187105.463270	Generator
×	111475	Golden Bay Gas and Food	2200 Telegraph	O	5411	564367.165953	4185153.458910	Gas station
–	5776	Harold's Auto Body & Paint Shop	2126 Market Street	O	7532	563487.166011	4185366.458800	Spray booth
–	10587	HC Fine Finishes	1231 24th Street	O	7641	562909.166023	4185797.458780	Spray booth
–	200331	High End Custom and Collision	1649 28th Street	O	7532	562714.166025	4186218.458670	Autobody
×	19039	Hotel Oakland	270 13th Street	O	7011	564549.987799	4184129.882810	Generator
–	20036	Hustead's Collision Center Inc	2915 Market Street	O	7532	563630.165961	4186090.458730	Autobody
–	378	Ideal Cleaners	322 14th Street	O	7216	564436.165966	4184245.458950	Petroleum dry cleaning
×	16965	Ikea US West Inc - 165 Emeryville	4400 Shellmound Street	E	5021	562311.166002	4187352.458640	Generator
×	112176	J and O Tire	2236 Poplar St	O	5411	562850.165989	4185865.458780	Gas Station
×	20823	Jefferson Oaks Housing	1424 Jefferson St	O	9531	563894.166034	4184557.458880	Generator
×	21940	John Hansen & Sons Inc	327 Clay Street	O	5149	563545.166086	4183682.458970	Coffee roaster
×	3490	Johnson Plating Works Inc	2526 Telegraph Ave	O	3471	564430.165947	4185542.458900	Chrome plating and spray booth
×	23430	Kaiser Permanente	1950 Franklin Street	O	8063	564555.165907	4184744.458970	Generator
×	23431	Kaiser Permanente	1800 Harrison Street	O	8063	564727.165920	4184544.459000	Generator
×	23433	Kaiser Permanente	410 19th Street	O	8063	564328.165955	4184763.458920	Generator
×	24068	KBS SOR II Oakland City Center	505 14th Street	O	6512	564019.165980	4184397.458960	Generator
–	10397	Le Magic Cleaners	1706 Franklin Street	O	7216	564418.165953	4184573.458930	Closed loop dry cleaner
×	18110	Level 3 Communications LLC	1330 Broadway	O	4813	564091.979994	4184356.933650	Generator
×	23231	Level 3 Communications LLC	1970 Broadway	O	4813	564449.165974	4184842.458890	Generator
–	12569	Lithograph Reproductions Inc	4120 Martin Luther King Jr Way	O	2752	564430.165808	4187306.458740	Lithography printing
×	8511	Madison Street Press	614 Madison Street	O	2752	564529.166012	4183455.459030	Printing press
×	109725	Market Street Shell #135692	610 Market St	O	5411	563156.166075	4184124.458940	Gas station
×	12765	MCI,dba Verizon Business	1330 Broadway	O	4813	564223.165967	4184305.458950	Generator

M	Plant No.	Facility Name	Address	City	SIC code	*x*	*y*	Source Category
×	13299	MetroPCS California/Florida Inc	720 2nd Street	O	4911	563163.166110	4183762.458900	Generator
×	110209	Mobile SS#63049	3400 San Pablo	O	5411	563557.165952	4186699.458730	Gas station
×	20742	Modern Coffee Enterprises Inc	4059 Emery Street	E	2095	563233.165888	4187309.458620	Coffee roaster
×	5133	Mr. Espresso	696 3rd Street	O	2095	563275.166087	4183767.458960	Coffee roaster
×	2650	Nor-Cal Metal Fabricators	1121 3rd Street	O	3479	562614.166145	4183939.458950	Sandblaster
×	1500	Northern California Power Agency	2900 Main Street, Site 1	A	4911	562350.166214	4182722.459010	Turbines
×	14423	Oakland 14th Office	475 14th Street	O	6512	564070.166005	4184375.458960	Generator
×	19514	Oakland Center 21	2101 Webster Street	O	6512	564602.165884	4185023.458930	Generator and boiler
×	111332	Oakland Marinas	2 Webster St	O	5411	563852.166087	4183149.459000	Gas Station
×	22781	Oakland Marriott City Center	1001 Broadway	O	7011	564012.166045	4184110.459010	Generator
×	22033	Oakland Museum of California	1000 Oak Street	O	9199	564818.165994	4183721.459080	Spray Booth
×	20527	Oakland Unified School District	1011 Union Street	O	8211	562519.166083	4184691.458810	Generator
×	110551	Oakland Valero Service Center	2225 Telegraph Ave	O	5411	564314.165906	4185166.458910	Gas station
×	109903	OFD Fire Station #2	100 Jack London Square	O	5411	563393.166112	4183400.458970	Gas Station
×	109994	OFD Fire Station #3	1445 14th St	O	5411	562259.166096	4185053.458770	Gas Station
×	20093	Olympic Tug and Barge Co Inc	321 A Avenue	A	5171	562965.166147	4182944.458960	Generator
×	13494	Pacific Bell	1587 Franklin Street	O	4813	564362.165940	4184509.458900	Generator
×	14173	Pacific Gas and Electric	1919 Webster Street	O	4931	564560.165977	4184740.458900	Generator
×	14551	Pacific Gas and Electric	689 2nd Street	O	4931	563202.166106	4183633.458910	Generator
×	8227	Pacific Interment Service	1094 Yerba Buena Ave	E	7261	563548.165902	4187269.458640	Cremator
×	21029	Pacific Renaissance Plaza	388 9th St Ste 229	O	6512	564147.165974	4183921.458950	Generator
×	12318	Peerless Coffee Co	260 Oak Street	O	2095	564511.166029	4183116.459040	Coffee roaster
×	23722	Pinnacle Ag Services	2440 W 14th Street	O	3711	561300.166191	4185579.458760	Generator
×	13682	Port of Oakland	Clay & Water Street at Jack London Square	O	9621	563468.166074	4183346.458990	Generator
×	16715	Port of Oakland	651 Maritime Street	O	1799	560444.166280	4184718.458760	Generator
×	23577	Port of Oakland	1599 Maritime Street	O	4491	560760.166236	4185498.458690	Generator
×	111027	Port of Oakland	651 Maritime St	O	5411	560444.166314	4184583.458760	Gas station
×	3791	Prime Smoked Meats Inc	220 Alice Street	O	5049	564174.166067	4183265.459000	Smoke house
×	200462	Prologis	2420 West 21st Street	O		561611.166143	4186200.458680	Generator
–	18373	PS Printing LLC	2861 Mandela Parkway	O	2752	562528.166041	4186330.458750	Print press
–	6191	Quality Body and Fender	2510 Martin Luther King Way	O	7532	564096.165965	4185558.458880	Autobody

M	Plant No.	Facility Name	Address	City	SIC code	*x*	*y*	Source Category
×	23547	Radio Mirchi	Pole Plaza AHN 18, Pole #110141241	O	7812	559827.166257	4186509.458600	Generator
–	15931	Redline Import - Auto Collision	2300 Market Street #C	O	7532	563540.165986	4185575.458840	Spray area
×	106875	Rino Pacific	1107 5th St	O	5411	562682.166122	4184104.458920	Gas station
×	14607	Rotunda Partners II	300 Frank Ogawa Plaza	O	6552	564150.024407	4184549.804730	Generator
×	23098	Royal Coffee Company	2523 Broadway	O	5812	564682.165897	4185486.458840	coffee roaster
×	14068	S F Bay Area Rapid Transit District	101 8th Street	O	9621	564606.166019	4183538.459010	Generator
×	19696	Safety-Kleen Systems Inc.	400 Market Street	O	4953	563110.166078	4183947.458990	Soil vapor extraction
×	23208	Safeway #3125	3889 San Pablo Ave	E	5141	563353.165963	4187112.458680	Generator
×	18658	San Francisco Bay Bridge Toll Plaza	Bay Bridge East	O	9229	560407.166233	4186541.458600	Generator
–	12725	San Pablo Auto Body	2926 San Pablo Ave	O	7532	563730.165966	4186076.458770	Spray booth
×	20386	Satellite First Communities, L P	540 21st Street	O	8361	564210.165960	4185069.458930	Generator
×	112517	Sausal Corporation	Bay Bridge Toll Plaza	O	5411	560399.166202	4186546.458570	Gas station
×	208	Schnitzer Steel Products Company	Adeline Street	O	5093	562499.999966	4183475.097660	Electric shredder
–	16860	SFPP, L P	Bay Street, off 7th	O	4613	560823.090000	4184843.250000	Diesel additive tank
×	18268	Sierra Pacific	3213 Wood Street	O	3272	562424.166075	4186446.458730	Aggregate
–	23904	Sila Nanotechnologies Inc	2450 Mariner Square Loop	A	2819	563636.166150	4182428.459110	Wipe cleaning
–	22778	Solstice Press	113 Filbert Street	O	2752	562802.166129	4183786.458940	Lithography printing
×	112577	Southern Counties Oil Company LP	105 5th St	O	5411	564515.165988	4183298.459090	Gas station
×	16848	SPRINT	1075 7th Street	O	4812	562783.166090	4184227.458860	Generator
×	16850	SPRINT	114 Brush Street	O	4812	563080.166080	4183689.458930	Generator
×	15760	SSA Terminals (Oakland) LLC	1999 Middle Harbor Rd	O	4731	560385.166356	4183504.458880	Generator
×	111133	SSA Terminals-Oakland LLC	1999 Middle Harbor Rd	O	5411	560352.166317	4184036.458820	Gas station
–	200748	Stanford Cleaners	2134 MARKET ST	O	7389	563492.165996	4185376.458810	Dry cleaning
×	109165	State of CA - Caltrans	Oak Bay Bridge, E Side, Toll Plaza	O	5411	560420.740000	4186547.050000	Gas Station
×	19281	State of California	1515 Clay St, Elihu Harris Building	O	9441	563982.971169	4184583.007780	Generator and boiler
×	14195	State of California Department of Transportation	111 Grand Avenue	O	9621	564732.570000	4185092.270000	Generator and boiler
×	201213	SVF Latham Square Owner LLC	1611 Telegraph Avenue	O		564207.165993	4184578.458940	Boiler

M	Plant No.	Facility Name	Address	City	SIC code	*x*	*y*	Source Category
–	21159	Tam's Auto Body	2300 Market Street Ste B	O	7532	563536.165942	4185564.458800	Spray booth
×	20487	Target Corporation Store #T2767	1555 40th Street	O	5311	562487.166001	4187011.458690	Generator
×	21790	Target Corporation Store #T2829	2700 5th Street	A	5311	563474.166162	4182610.459060	Generator
×	112426	Tfuels Inc. dba Grand Arco AMPM-C Kim	889 West Grand Ave	O	5411	563515.165961	4185422.458780	Gas station
×	20987	The Ellington Community Association	222 Broadway	O	6531	563773.166110	4183461.459050	Generator
×	17703	The Home Depot (Store #0627)	3838 Hollis Street	E	5311	563036.124968	4187011.436650	Generator
×	17073	T-Mobile	720 2nd Street	O	4812	563192.166114	4183660.458950	Generator
×	14837	Trans Pacific Centre	1000 Broadway	O	6512	564090.166016	4184053.459000	Generator
×	200278	Trapac	2800 7TH ST	O	5411	559401.166329	4184726.458700	Gas station
×	17431	Union Pacific Railroad	1400 Middle Harbor Road	O	4011	561766.166221	4183829.458870	Generator
×	100583	Union Pacific Railroad	1400 Middle Harbor Road	O	5411	561771.166175	4183835.458880	Gas station
–	200538	Uptown Body and Fender	401 26th Street	O	7532	564580.165868	4185529.458890	Autobody
×	21130	US Postal Service - Building Maintenance	1675 7th Street	O	4311	561587.340000	4184448.030000	Generator and fire pump
×	23711	USPA City Center LLC	555 12th Street	O	6512	563819.165993	4184285.458950	Generator and boiler
×	14711	Verizon Business	1999 Harrison Street	O	4813	564743.165909	4184727.458960	Generator
×	22412	Verizon Wireless	1404 Franklin Street	O	4812	564296.165973	4184311.458980	Generator
×	16284	Verizon Wireless (Alameda Perm)	114 Brush Street	O	4812	563080.166085	4183688.458990	Generator
×	18297	Verizon Wireless (Bay Bridge East)	107 Burma Road	O	4812	559595.580000	4186253.340000	Standby generator
×	23143	Viridis Fuels	2040 Wake Avenue	O	2861	561701.520000	4186478.240000	Boiler
×	22483	Watermark Bayside, LLC dba Bayside Park	1440 40th Street	E	8051	562722.165936	4187177.458620	Generator
×	5385	Weatherford BMW	575 West Grand Avenue	O	7532	564168.165947	4185174.458840	Spray booth
×	112042	Westco Gas	731 West Macarthur Blvd	O	5411	564109.914073	4186891.051810	Gas station
×	22058	Westcore City Properties, LLC	1221 Broadway	O	2812	564098.166021	4184261.458990	Generator
–	2620	WH Strehle Company	494 36th Street	O	7532	564686.165809	4186614.458780	Autobody
×	23954	Windstream	427 14th Street	O	6531	564224.165990	4184308.458940	Generator

Attachment 3. Truck-Related Businesses

Table A-3-1. Businesses with truck fleet activity operating in the West Oakland Source Domain. Only businesses with an assigned ID were included in this analysis; those excluded were either missing information or had < 4 vehicles per day (VPD). The reference ("Ref.") of the activity information was collected from either a 2019 survey (S19), a 2009 survey (S09), or assumed parameters (A, where a number in parentheses indicates the ID from which the information is based on). A hyphen (–) indicates that the business was excluded from the analysis due to inappropriate business or activity type, and "n/a" indicates that no information was available. The fleet assumed for each business was either HHDT only (all EMFAC2017-based HHDT vehicles except Port Trucks), MHDT only, bus only (BUS), or a mixed fleet (mix) with 0.265 HHDT (Non-Port Truck), 0.10 LHDT, 0.135 MHDT, 0.50 Port Trucks (T7 POAK). All business addresses are located in Oakland, except those with an asterisk (located in Emeryville).

ID	Business Name	Address	VPD	Ref.	Fleet	Activity Type
	All Star Moving & Storage	1468 14th Street	0	–	–	Storage only
	Alpi International Ltd.	1685 34th Street	< 4	–	–	Wholesale product supplier
	American President Lines Ltd	1579 Middle Harbor Road	< 4	–	–	Shipment management
1	AM&S Transportation Co/ Trade Winds Import Export	1700 24th Street	70	S19	mix	Trucking
54	AMPCO Adeline	1599 Adeline Street	1000	S19	mix	Parking facility
53	AMPCO MLK	1 Martin Luther King Jr Way	1000	S19	mix	Parking facility
36	Aramark Uniform Services	330 Chestnut Street	5	A	MHDT	Uniform rental services
2	Atthowe Transportation Co Inc.	3924 Market Street	5	S19	mix	Carrier/broker
24	AV Trucking Co Inc.	1155 3rd Street	41	S19	mix	Office
3	Bay Area Container Transport	3427 Ettie Street	19	S19	mix	Broker
55	Best Bay Trucking	1 Market Street	50	S19	mix	Trucking
4	Cademartori Trucking	1833 Peralta Street	22	S19	mix	Shipping/trucking
5	California Cereal Products	1267 14th Street	5	S19	mix	Food processing
6	California Waste Solutions Inc. - 10th	1820 10th Street	50	S19	mix	Recycling
37	California Waste Solutions Inc. - Wood	3300 Wood Street	50	A (6)	mix	Recycling
7	CASS, Inc	2730 Peralta Street	6	S19	mix	Recycling
38	CCY Inc.	2505 Poplar Street	5	A	mix	Importers

ID	Business Name	Address	VPD	Ref.	Fleet	Activity Type
8	Central Concrete	2400 Peralta Street	13	S19	mix	Concrete
59	CFN Fuel Station	2236 Poplar Street	80	A (63)	mix	Gas station
	Commander Moving	1829 Mandela Pkwy	< 4	–	–	Moving/storage
	Dusty & Sons Truck Tire Center	2201 Mandela Pkwy	< 4	–	–	Tire sales
9	East Bay Resources	2430 Willow Street	5	S19	mix	Recycling
60	EBMUD Adeline	2127 Adeline Street	84	S09	mix	Office and yard
61	EMBUD Wake	2020 Wake Avenue	84	A (60)	mix	Yard
	FBC International Co.		–	–	–	Marketing company
10	Form and Reform	2601 Adeline Street	3	S19	mix	Light manufacturing
40	Golden Bear Produce	315 Franklin Street	112	S09	mix	Carrier
	Green Pro Tech (DPF Cleaning)	18th & Campbell	< 4	–	–	Diesel particulate filter cleaning
41	Green Tech Imports	2811 Adeline Street	5	A	mix	Shipping
42	Greyhound Bus	2103 San Pablo Avenue	55	S09	BUS	Bus
56	GST Transport	1 Market Street	50	S19	mix	Shipping/inspection
57	High Mountain Transport LLC	2505 Bataan Avenue	20	S19	mix	Trucking
43	Iron Mountain Information Management	1350 West Grand Ave	5	A	MHDT	Shredding/storage
11	ISSA Transportation Services, LLC (JB Truck Repair)	1639 18th St	10	S19	mix	Truck repair
	JB Truck Electrical Repair	1433 18th St	< 4	–	–	Truck services
12	J&A Truck Repair	2300 Poplar Street	14	S19	mix	Truck repair
44	J&O Tires/Scales	2401 Union Street	5	S09	mix	Truck services
13	JH Fitzmaurice	2857 Hannah Street *	4	S19	mix	Home construction and improvement
14	Kamal Trucking Corp	526 2nd Street	56	S19	mix	Carrier
	KMC Trading (Chang's)	2505 Poplar St	< 4	–	–	Recycling
15	Lange Trucking/Hoovestol	2226 Campbell Street	26	S19	mix	Trucking
62	Lenger & Sons Produce Express	2565 Buna Street #90	5	A	MHDT	Trucking (food)
45	Matheson Mail Transportation	2500 Poplar Street	30	S09	mix	Local general freight trucking
46	Mayway Corporation	1338 Mandela Pkwy	5	A	mix	Distribution

ID	Business Name	Address	VPD	Ref.	Fleet	Activity Type
16	Mindful Distribution	2935 Adeline Street	4	S19	MHDT	Beer distributor
	MK Enterprises	2225 Campbell St	< 4	–	–	Print advertising
	Mueller Nicholls	2400 Union St	< 4	–	–	Carrier
17	Mutual Express Company	1700 West Grand Avenue	40	S19	mix	Trucking
18	Narayan's Trucking Inc.	1155 3rd Street, Suite 260	41	S19	mix	Office
19	National Recycling	1312 Kirkham Ct	5	S19	mix	Recycling
20	Natural Logistics	Beach Street *	14	S19	mix	Shipping/trucking
58	Oakland Port Trucking	1 Market Street	25	S19	mix	Trucking
21	OMSS	10 Burma Road	1200	S19	mix	Truck parking
22	PACE Supply (Morgan Southern)	425 Market Street	75	S19	mix	Plumbing wholesale
23	Pacific Coast Container (PCC Logistics)	2498 16th Street	58	S19	mix	Broker
25	Pacific Coast Supply	1735 24th Street	10	S19	mix	Building materials
	Pacific Rail Services	1408 Middle Harbor Road	n/a	–	–	Repair
26	Portillo Trucking Company	160 Franklin Street	16	S19	mix	Trucking
27	Quintero Trucking	2270 Poplar Street	21	S19	mix	Trucking
63	Rinehart Oil Truck Fueling Station	1107 5th Street	80	S19	mix	Gas station
	RCM International (Martin Construction)	2850 Poplar Street	< 4	–	–	Concrete mixing
28	S.F. Enterprises (Modern Express and Courier)	2525 Mandela Pkwy	7	S19	mix	Yard
29	Saroni Food Services	1301 26th Street	12	S19	mix	Food (cold storage facility)
30	Sea Logix	1425 Maritime Street Bldg 319	5	A	mix	Trucking/drayage
47	Sierra Concrete	3211 Wood Street	10	A	mix	Concrete
	Skasol	1696 W Grand Avenue	< 4	–	–	Manufacturer
31	Starline Supply Company	2401 Peralta Street	8	S19	mix	Carrier
	Starving Student Movers	2850 Poplar Street	4	–	–	Moving company
	Steel Company (name unknown)	1699 W Grand Avenue	n/a	–	–	Steel
48	Sutta Shredding Company	1221 3rd Street	5	A	MHDT	Recycling
	Sweet Maria's Coffee Warehouse	2823 Adeline Street	< 4	–	–	Retail
	Terminal Maintenance Company	2502 Middle Harbor Drive	n/a	–	–	Carrier

ID	Business Name	Address	VPD	Ref.	Fleet	Activity Type
49	TFS Trucking	2226 Myrtle Street	10	A	mix	Yard
32	Tighe Transportation & Wisle	2230 Willow Street	2	S19	mix	Trucking
	Transpacific Trading	2433 Poplar St	< 4	–	–	Tire sales
50	U.S. Freight Systems	1819 10th Street	10	A	mix	Shipping/trucking
51	U.S. Postal Service Depot	1675 7th Street	1034	S09	HHDT	Postal depot
33	VA Transportation Inc.	1340 Mandela Pkwy	47	S19	mix	Shipping/trucking
	Western Seafare	1297 26th Street	n/a	–	–	Refrigerated warehouse
	Western States Teleport Inc.	2303 Poplar Street	–	–	–	Telephone company
34	Wings Century Trucking	1599 Maritime Street	50	S19	mix	Trucking
35	Wyse Logistics	1301 24th Street	56	S19	mix	Drayage, warehouse, transloading, bulk trucks

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Appendix A – Technical Support Document

Part II: Business-As-Usual Future Year Emissions Inventory and Air Pollutant Dispersion Modeling

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Table of Contents

Notation

Acronyms

AB	Assembly Bill
ABAG	Association of Bay Area Governments
AERMOD	American Meteorological Society/Environmental Protection Agency Regulatory Model
agl	above ground level
BAAQMD	Bay Area Air Quality Management District
BAU	business-as-usual
BY	base year
CARB	California Air Resources Board
CEIDARS	California Emissions Inventory Development and Reporting System
CF	control factor
CHC	commercial harbor craft
CHE	cargo handling equipment
CT-EMFAC	Caltrans-EMissions FACtors (model)
DPM	diesel particulate matter
EIC	Emission Inventory Category
EMFAC	EMission FACtors (model)
EPA	Environmental Protection Agency
EZ	exclusion zone
FY	future year
GCF	growth and control factor
GF	growth factor
HHDT	heavy heavy-duty truck
LHDT	light heavy-duty truck
MHDT	medium heavy-duty truck
MPO	metropolitan planning organization
MTC	Metropolitan Transportation Commission
NAICS	North American Industry Classification System
NEI	National Emissions Inventory
OEHHA	Office of Environmental Health Hazard Assessment
OGRE	Oakland Global Rail Enterprise
OGV	ocean-going vessel
OICT	Oakland International Container Terminal
O&M	operation and maintenance
PM	particulate matter
$PM_{2.5}$	particulate matter 2.5 micrometers or less in diameter
SCC	Source Classification Code
SIC	Standard Industrial Classification
SIP	State Implementation Plan
SMOKE	Sparse Matrix Operator Kernel Emissions (model)
TAC	toxic air contaminant
TRU	transport refrigeration unit

UP	Union Pacific
VMT	vehicle miles traveled
VHT	vehicle hours traveled

Units

g	gram
ton	U.S. ton (2,000 lb)
tpy	tons per year (U.S. ton/year)
µg	microgram
m	meter
mi	mile
h	hour
min	minute
s	second
mph	miles per hour (mi/h)

1. Introduction

This is a companion document to *Appendix A – Technical Support Document Part I: Base Year Emissions Inventory and Air Pollutant Dispersion Modeling* ("Part I"), for the West Oakland Community Action Plan ("Action Plan") pursuant to Assembly Bill (AB) 617, jointly prepared by the Bay Area Air Quality Management District (BAAQMD, "the District") and the West Oakland Environmental Indicators Project (WOEIP). Please refer to Part I for background information, a detailed description of emissions sources the base year (2017) emissions inventory, air dispersion modeling approach, and pollutant and cancer risk assessment.

The technical work performed to develop forecasted (future year) emissions inventories for the Action Plan is described in this document. The objective of this technical work was to create forecasted inventories for $PM_{2.5}$, DPM, and toxic air contaminant (TAC) pollutants to determine which emission sources may impact the West Oakland community in the future; specifically, the future-year emissions inventories were convolved with the dispersion factor fields (developed in Part I) to quantify the effects of changing emissions on potential pollutant concentrations and cancer risk within the West Oakland community.

Forecasted emission inventories were developed for all emissions sources described in Part I:

- permitted stationary sources,
- on-road mobile sources (Truck and Non-Truck vehicles on all surface streets and freeways, and extended idling from vehicles operating at certain "truck-related businesses"),
- maritime and railyard activity at the Port of Oakland (the "Port"),
- locomotives and railyard activities, and
- commuter ferries and excursion vessels.

Forecasted emissions were estimated by combining the base year (BY, where $BY = 2017$ in this analysis) emissions inventories (developed using a bottom-up approach, as described in Part I) with ancillary datasets that provide *growth factors* (GFs) and *control factors* (CFs) based on *business-as-usual* (BAU) conditions. BAU conditions include only the known changes in activity ("growth") and changes in emission characteristics ("control", such as lower emission factors due to new technology introduced into the fleet via fleet turnover) that are currently anticipated through approved ("on the books") regulations. BAU conditions can also be viewed as those conditions that would occur without the implementation of the Action Plan ("without-Plan" scenario).

The base year is used to establish initial pollutant concentrations from which forecasted inventories can be developed. The forecasted emissions inventories with BAU conditions include anticipated reductions from existing regulations reflect the estimated emissions that would occur without any further mitigation measures. Resulting pollutant concentrations and risk estimates can be used to show where high levels of air pollution may persist, and additional actions may be warranted. Identifying emissions sources that contribute to elevated pollutant concentrations in the community is important to develop specific mitigation strategies to reduce forecasted exposures, as the largest emissions sources accounted for within emissions inventories may not directly cause the largest impacts on air quality at downwind locations.

In this analysis, two forecasted inventories were developed: 2024, and 2029 emissions inventories, which correspond to 5 years and 10 years from the adoption of the Action Plan, respectively. As in the 2017 base year analysis (Part I), the forecasted emissions inventories (**Section 2**) were used in conjunction with *air pollution dispersion modeling* (**Section 3**) to support a *source apportionment* analysis (**Section 4**). This is essentially a forecasted version of the *community-scale* modeling as performed in Part I. A brief overview of the results (**Section 5**), and a discussion of sources of uncertainty in the datasets and methods are also presented (**Section 6**).

2. Emissions Inventory

The District forecasted emissions for $PM_{2.5}$ and TACs from emissions sources in West Oakland. A summary of the emissions inventory developed for the Action Plan for the future years (2024, 2029) is described in this section by source category: permitted stationary sources, on-road mobile sources, truck-related businesses, sources due to activity in the Port of Oakland (ocean-going vessels, commercial harbor crafts, cargo handling equipment, Port Trucks at terminals, railyards), locomotives, railyards, and commuter ferries and excursion vessels. Specific temporal and spatial allocation information for emissions source categories are discussed in Part I Section 3; these parameters were not changed for future-year dispersion modeling.

2.1 Development and Overview

2.1.1 Pollutants

AB 617 focuses on evaluating local community risk impacts associated with $PM_{2.5}$ and TACs (including DPM); $PM_{2.5}$ and DPM are the primary air pollutants that pose the greatest risk to the health of residents in West Oakland (California Air Resources Board 2008a). A full list of TACs compounds included in this analysis is provided in Part I Attachment 1. In the following emissions inventories and modeling results, DPM is both included in TAC emission estimates and presented separately from $PM_{2.5}$ and TACs. Only $PM_{2.5}$ emissions and concentrations from directly emitted $PM_{2.5}$ and TACs were evaluated; secondary $PM_{2.5}$ and TACs were not included.

2.1.2 Domain

The same Source Domain used for the 2017 base year emissions inventory was used to develop the forecasted emissions inventories. This domain is 7 km × 5 km and encompassed the entire West Oakland community and Port of Oakland, as well as part of downtown Oakland (see Part I Figure 2-1). All emission sources discussed in this section are located within the Source Domain; if an emissions source's extents were beyond those of the Source Domain, only the emissions associated with the area within the Source Domain were included in the inventory.

2.1.3 Emissions Sources and Future Years

The emissions inventory consists of emissions from various source categories, as shown in **Table 2-1**, including stationary and mobile (on-road, off-road) sources of emissions. Annual emissions estimates were developed for two future years: 2024 and 2029. These years correspond to 5 years and 10 years from the adoption of the Action Plan, respectively.

There were several emissions sources that were omitted in the community-scale air pollutant dispersion modeling and risk assessment, and are thus also omitted in the assessments in future years as well, notably residential wood burning, transport refrigeration units (TRUs), commercial and residential cooking (see Part I for further details). Emissions from these categories were still forecasted and include in the emissions inventory by using the 2017 emissions (estimated using a top-down approach) and appropriate growth and control factors.

Table 2-1. Emission source categories in West Oakland and data source used to derive growth and control factors to forecast emissions. Emissions based on EMFAC2017 emission factors were adjusted to account for reduction programs adopted by CARB after the release of EMFAC2017; the "2016 SIP" dataset is described in **Section 2.1.4**. Emissions inventories developed using a bottom-up approach were used for further air dispersion modeling and analyses; emissions inventory developed using a top-down approach are included in the total emissions inventory, but not included in any subsequent modeling.

Approach	Section	Source Category	Reference/Data Source
Bottom-up	2.2	Permitted stationary sources	District, ABAG
	2.3	On-road mobile sources	EMFAC2017, CARB
	2.4	Truck-related businesses	EMFAC2017, MTC/ABAG, District
	2.5	Ocean-going vessels	2016 SIP, CARB, California Air Resources Board (2019b)
	2.6	Commercial harbor crafts	2016 SIP, District, California Air Resources Board (2019b)
	2.7	Cargo handling equipment	2016 SIP
	2.8	Port Trucks at Terminals	EMFAC2017, California Air Resources Board (2019b), CARB
	2.9	Locomotives	2016 SIP, California Air Resources Board (2017a)
	2.10	Railyards	2016 SIP, UP
	2.11	Commuter ferries and excursion vessels	2016 SIP
Top-down	2.1.5	Other area sources	2016 SIP (v1.0.4), SMOKE
	2.1.5	Non-road sources	2016 SIP (v1.0.4), SMOKE

2.1.4 Approach

The forecasted inventories were based on the community-scale bottom-up emissions inventory developed for the 2017 base year; most Port-related emission were based on the *Port of Oakland 2017 Seaport Air Emissions Inventory* ("2017 Port Inventory"), developed by Ramboll (2018). A bottom-up emissions inventory involves estimating emissions using (1) emission factors (mass of pollutant emitted per unit of activity), and (2) local activity information of the emission processes (e.g., number of events, duration of activity). Emission factors vary by source type and/or emissions process, and can depend on other factors (e.g., source age, model year, control technology, load, fuel type, speed, and ambient conditions, where applicable). Local activity information varies by source and by year (and by season and/or hour, depending on the source). Activity data is convolved with corresponding emission factors to estimate emissions. Forecasted inventories can be developed from bottom-up emissions inventories by source using one of two general approaches:

(1) **Recalculate emissions (bottom-up):** Activity and emission factors are adjusted based on anticipated changes in operations (growth) and technology (control). Changes in operations may be specific to the source (e.g., known changes in permitted activity) or from a related dataset (e.g., projected number of jobs).

(2) **Adjust base year emissions ("top-down" adjustment):** Total emissions of the source category from the base year are adjusted by the fractional change of emissions projected for the source category (or related category) from regional inventories. These fractional changes are the GF, CF, and/or combined growth and control factor (GCF), which are expressed as a factor relative to the base year, where factors less than 1.0 indicate a decrease, factors greater than 1.0 indicate an increase, and factors equal to 1.0 indicate no change in emissions are anticipated in future years. For example, if a regional inventory indicates that $PM_{2.5}$ emissions for a particular source category were 0.9 tpy in 2017 and 1.2 tpy in 2024, then the 2017 bottom-up emissions would be adjusted by a factor of 1.333 to estimate 2024 emissions.

The approach used to forecast emissions depended on the source category (**Table 2-1**); a combination of both approaches can also be used. For example, the District forecasted emissions from on-road mobile sources within West Oakland based on (1) updated emission factors provided by EMFAC2017 and (2) projected activity for Alameda County. For approach (2), the District primarily used forecasted emissions by Emission Inventory Code (EIC) and criteria pollutant obtained from CARB from the California Emission Projection Analysis Model (CEPAM) 2016 State Implementation Plan (SIP) inventory[1] v1.05 (snapshot v19.05.10) for Alameda County, except for rail, which were based on California Air Resources Board (2017a) for passenger rail and the 2019 SIP inventory v1.00 for all other rail. For simplicity, we refer to this enhanced dataset as the "2016 SIP" dataset. EICs are maintained by CARB and consist of 14 digits that describes the source category, type, materials, and process.[2] Within CEPAM, emission forecasts rely on a suite of complex emission models which apply various assumptions regarding fleet, equipment age and

[1] This inventory can be accessed online via https://www.arb.ca.gov/app/emsinv/fcemssumcat/fcemssumcat2016.php. The 2016 SIP inventory is based on a 2012 base year.

[2] A single EIC may be associated with one or more SCC/SIC codes (see **Section 2.2**).

turnover, and control measures to estimate future emissions. Further details about the emission estimation assumptions for a given source category require extracting the model's specific methodology for that equipment category and process, which can be done by CARB upon request.

For each EIC and pollutant, the combined growth and control factors (GCF) were calculated as:

$$GCF_{FY} = \frac{EI_{FY}}{EI_{BY}}$$

where the factor is the ratio between the future-year emissions ($EI_{FY}, FY \in \{2024, 2029\}$) that take into account both forecasted growth and control, and the base-year emissions ($EI_{BY}, BY = 2017$). The GCF can then be applied to the base year emissions developed for the community-scale modeling ($E_{BY}, BY = 2017$) in the Action Plan to obtain the future-year emissions ($E_{FY}, FY \in \{2024, 2029\}$):

$$E_{FY} = GCF_{FY} \cdot E_{BY}$$

Recall that EICs inherently summarize many aspects of an emission source; GCFs therefore vary by year, economic sector, source type, material (e.g., gasoline versus diesel fuel), pollutant, and emission process (e.g., exhaust versus idling).

2.1.5 Emissions by Category

In this section, an overview of the future-year emissions inventories for $PM_{2.5}$, DPM, and TACs are presented and compared to the 2017 base year inventories. A description of how these inventories were developed by source category are presented in the remaining sections.

Based on the bottom-up 2017 base year emissions inventories, $PM_{2.5}$ emissions are forecasted to be 87.09 tpy in 2024 and 94.50 tpy in 2029 in West Oakland (**Figure 2-1**, **Figure 2-2**). From the base year emissions (85.91 tpy), this represents a +1.38% by 2024 and +10.00% increase by 2029. From the base year, DPM emissions are forecasted to decrease by 2024 (21.22 tpy, -11.28%), but nearly return to base year levels by 2029 (23.81 tpy, -0.43%) (**Table 2-3**). The increases can mainly be attributed to a projected increase in Port-related emissions (**Table 2-2**), especially from OGVs and assist tugs. The change in total cancer-risk weighted TAC emissions are also mainly driven by emissions OGV and assist tugs, but emissions decrease from 19,054 tpy in the base year to 16,939tpy in 2024 (+11.1%), and to18,997 tpy (-0.30%) by 2029 (**Table 2-4**).

As discussed Part I, there are several emission sources in West Oakland that were not accounted for in the bottom-up community-scale emissions inventory (and are not included in the subsequent analyses or risk calculations). These emissions sources were namely fuel combustion and commercial area sources, and non-road mobile sources (**Table 2-5**, **Table 2-6, Table 2-7**). Base year emissions from these sources were derived from regional-scale modeling using a top-down approach, and then projected using GCFs derived from the 2016 SIP dataset. Of these emissions sources, only non-road mobile sources emit DPM; it is projected that $PM_{2.5}$, DPM, and TAC emissions from non-road sources will decrease by 2029. However, total $PM_{2.5}$ from these source categories increases, with the largest increase associated with commercial cooking operations (**Table 2-5**).

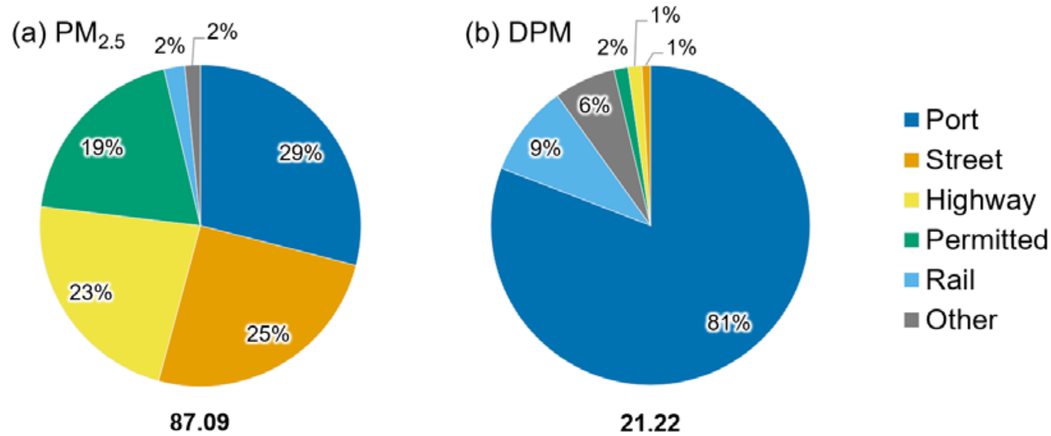

Figure 2-1. Emissions of (a) $PM_{2.5}$ and (b) DPM by source category included in the 2024 community-scale West Oakland emissions inventory within the Source Domain (modeled sources only). Emissions from Highway and Street are composed of emissions from all on-road mobile sources except Port Trucks, which are attributed to the Port category. Total emissions (tpy) of each pollutant are displayed below each pie chart. Source categories are further described in **Table 2-2**.

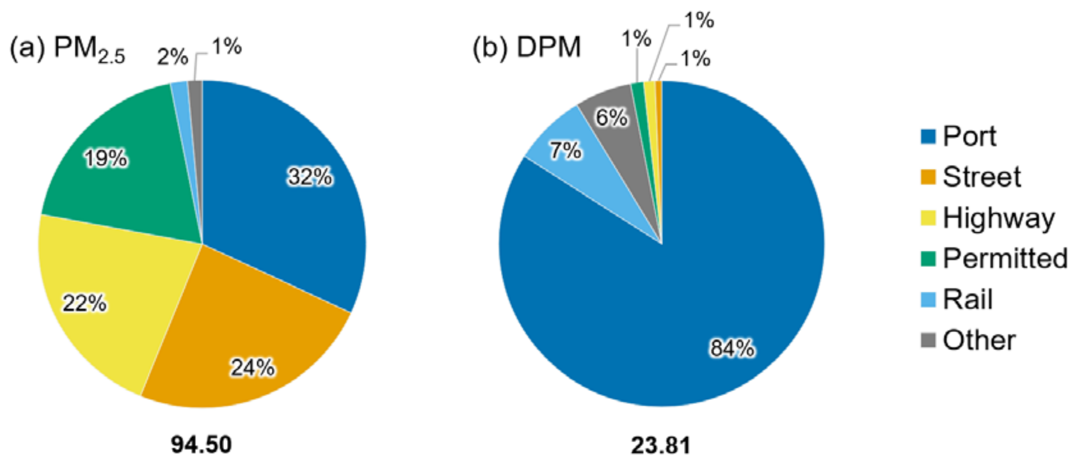

Figure 2-2. As in **Figure 2-1**, but for 2029.

Table 2-2. $PM_{2.5}$ emissions by Source Category within the Source Domain (modeled emissions only). Percentage (%) of emissions are reported as a total of the emissions inventory ("Total" row). The Port Trucks category includes emissions from all Port Trucks, regardless of location (i.e., within the Port and operating on Highways and Surface Streets). See sections in this document (and Part I) for specific emission processes by category.

Source Category	2017		2024		2029	
	tpy	%	tpy	%	tpy	%
Highway	**20.29**	**23.6**	**19.77**	**22.7**	**20.55**	**21.7**
Non-Trucks	12.22	14.2	12.88	14.8	13.33	14.1
LHDT	0.41	0.5	0.42	0.5	0.43	0.5
MHDT/HHDT	2.48	2.9	0.94	1.1	0.98	1.0
Road dust	5.17	6.0	5.53	6.4	5.81	6.1
Surface Streets	**22.38**	**26.1**	**21.97**	**25.2**	**22.94**	**24.3**
Non-Trucks	4.82	5.6	5.02	5.8	5.16	5.5
LHDT	0.35	0.4	0.35	0.4	0.35	0.4
MHDT/HHDT	2.44	2.8	0.77	0.9	0.80	0.9
Road dust	14.77	17.2	15.83	18.2	16.62	17.6
Port	**21.99**	**25.6**	**25.24**	**29.0**	**30.00**	**31.9**
OGV – maneuvering	3.94	4.6	5.61	6.4	7.06	7.5
OGV – berthing	7.83	9.1	10.29	11.8	13.00	13.8
Dredging	1.12	1.3	0.80	0.9	0.64	0.7
Assist Tugs	3.82	4.4	3.07	3.5	2.97	3.1
Bunkering (tugs, pumps)	0.27	0.3	0.25	0.3	0.24	0.3
CHE	1.59	1.9	1.78	2.0	1.96	2.1
Port Trucks	0.93	1.1	0.66	0.8	0.77	0.8
Road dust	2.25	2.6	2.53	2.9	3.25	3.4
Railyard – OGRE	0.07	0.1	0.08	0.1	0.08	0.1
Railyard – BNSF	0.17	0.2	0.18	0.2	0.18	0.2
Rail	**2.04**	**2.4**	**1.82**	**2.1**	**1.60**	**1.7**
Locomotives	1.02	1.2	0.70	0.8	0.43	0.5
Railyard – UP	1.02	1.2	1.12	1.3	1.17	1.2
Permitted	**17.84**	**20.8**	**16.94**	**19.4**	**17.92**	**19.0**
CA Waste (10th Street)	0.46	0.5	0.51	0.6	0.54	0.6
California Cereal	0.58	0.7	0.63	0.7	0.67	0.7
CASS	0.72	0.8	0.78	0.9	0.83	0.9
Dynegy	1.96	2.3	0.00	0.0	0.00	0.0
EBMUD	3.99	4.6	4.28	4.9	4.49	4.8
Pinnacle Ag Services	1.48	1.7	1.62	1.9	1.73	1.8
Schnitzer Steel – stationary	5.20	6.1	5.53	6.3	5.89	6.2
Sierra Pacific	0.91	1.1	1.00	1.1	1.09	1.2
Other	2.53	2.9	2.59	3.0	2.67	2.8
Other	**1.36**	**1.6**	**1.36**	**1.6**	**1.36**	**1.4**
Ferry/Excursion vessels	0.91	1.1	0.92	1.1	0.92	1.0
Schnitzer Steel – OGV	0.30	0.4	0.37	0.4	0.37	0.4
Schnitzer Steel – trucks	0.04	< 0.1	0.04	< 0.1	0.04	< 0.1
Truck-related businesses	0.11	0.1	0.03	< 0.1	0.03	< 0.1
Total	**85.91**	**100.0**	**87.01**	**100.0**	**94.50**	**100.0**

Table 2-3. As in **Table 2-2**, but for DPM emissions.

Source Category	**2017**		**2024**		**2029**	
	tpy	**%**	**tpy**	**%**	**tpy**	**%**
Highway	**2.12**	**8.9**	**0.30**	**1.4**	**0.27**	**1.1**
Non-Trucks	0.19	0.8	0.07	0.3	0.05	0.2
LHDT	0.09	0.4	0.07	0.3	0.06	0.2
MHDT/HHDT	1.84	7.7	0.16	0.8	0.16	0.7
Surface Streets	**2.07**	**8.6**	**0.18**	**0.9**	**0.16**	**0.7**
Non-Trucks	0.09	0.4	0.03	0.1	0.02	0.1
LHDT	0.09	0.4	0.07	0.3	0.06	0.3
MHDT/HHDT	1.88	7.9	0.08	0.4	0.08	0.3
Port	**15.87**	**66.4**	**17.15**	**80.8**	**20.01**	**84.0**
OGV – maneuvering	3.84	16.1	5.57	26.2	7.10	29.8
OGV – berthing	4.31	18.0	5.24	24.7	6.61	27.8
Dredging	1.16	4.9	0.79	3.7	0.58	2.4
Assist Tugs	3.94	16.5	3.16	14.9	3.06	12.8
Bunkering (tugs, pumps)	0.28	1.2	0.26	1.2	0.24	1.0
CHE	1.58	6.6	1.74	8.2	2.01	8.4
Port Trucks	0.50	2.1	0.12	0.6	0.12	0.5
Railyard – OGRE	0.08	0.3	0.08	0.4	0.09	0.4
Railyard – BNSF	0.18	0.8	0.19	0.9	0.20	0.9
Rail	**2.20**	**8.6**	**1.96**	**9.3**	**1.73**	**7.2**
Locomotives	1.09	4.5	0.74	3.5	0.45	1.9
Railyard – UP	1.11	4.6	1.22	5.8	1.27	5.3
Permitted	**0.30**	**1.2**	**0.30**	**1.4**	**0.31**	**1.3**
CA Waste (10th Street)	0.00	0.0	-	-	-	-
California Cereal	0.00	0.0	-	-	-	-
CASS	0.00	0.0	-	-	-	-
Dynegy	< 0.01	< 0.1	0.00	0.0	0.00	0.0
EBMUD	0.09	0.4	0.09	0.4	0.10	0.4
Pinnacle Ag Services	0.00	0.0	-	-	-	-
Sierra Pacific	0.00	0.0	-	-	-	-
Other	0.21	0.8	0.21	1.0	0.21	0.9
Other	**1.36**	**5.7**	**1.33**	**6.2**	**1.35**	**5.7**
Ferry/Excursion vessels	0.93	3.9	0.92	4.4	0.95	4.0
Schnitzer Steel – OGV	0.30	1.3	0.37	1.8	0.37	1.6
Schnitzer Steel – trucks	0.01	< 0.1	< 0.01	< 0.1	< 0.01	< 0.1
Truck-related businesses	0.12	0.5	0.03	0.1	0.03	0.1
Total	**23.91**	**100.0**	**21.22**	**100.0**	**23.81**	**100.0**

Table 2-4. As in **Table 2-2**, but for cancer risk-weighted TAC emissions (including DPM).

Source Category	**2017**		**2024**		**2029**	
	CRW tpy	**%**	**CRW tpy**	**%**	**CRW tpy**	**%**
Highway	**1,791**	**9.4**	**332**	**2.0**	**291**	**1.5**
Non-Trucks	331	1.7	159	0.9	125	0.7
LHDT	69	0.4	52	0.3	45	0.2
MHDT/HHDT	1,392	7.3	120	0.7	121	0.6
Surface Streets	**1,692**	**8.9**	**204**	**1.2**	**176**	**0.9**
Non-Trucks	183	1.0	87	0.5	68	0.4
LHDT	76	0.4	57	0.3	49	0.3
MHDT/HHDT	1,434	7.5	60	0.4	59	0.3
Port	**11,831**	**62.0**	**12,769**	**75.4**	**14,901**	**78.4**
OGV – maneuvering	2,859	15.0	4,145	24.5	5,289	27.8
OGV – berthing	3,212	16.9	3,901	23.0	4,922	25.9
Dredging	864	4.5	592	3.5	430	2.3
Assist Tugs	2,932	15.4	2,355	13.9	2,278	12.0
Bunkering (tugs, pumps)	209	1.1	190	1.1	179	0.9
CHE	1,177	6.2	1,293	7.6	1,494	7.9
Port Trucks	372	2.0	88	0.5	93	0.5
Railyard – OGRE	57	0.3	62	0.4	66	0.3
Railyard – BNSF	136	0.7	143	0.8	151	0.8
Rail	**1,637**	**8.6**	**1,462**	**8.6**	**1,285**	**6.8**
Locomotives	810	4.3	554	3.3	338	1.8
Railyard – UP	826	4.3	909	5.4	946	5.0
Permitted	**1,101**	**5.8**	**1,185**	**7.0**	**1,341**	**7.1**
CA Waste (10th Street)	-	-	-	-	-	-
California Cereal	< 1	< 0.1	< 1	< 0.1	< 1	< 0.1
CASS	< 1	< 0.1	< 1	< 0.1	< 1	< 0.1
Dynegy	1	< 0.1	-	-	-	-
EBMUD	110	0.6	117	0.7	123	0.6
Pinnacle Ag Services	-	-	-	-	-	-
Schnitzer Steel – stationary	823	4.3	900	5.3	1,050	5.5
Sierra Pacific	-	-	-	-	-	-
Other	168	0.9	167	1.0	168	0.9
Other	**1,016**	**5.3**	**987**	**5.8**	**1,003**	**5.3**
Ferry/Excursion vessels	695	3.6	688	4.1	706	3.7
Schnitzer Steel – OGV	225	1.2	277	1.6	277	1.5
Schnitzer Steel – trucks	8	< 0.1	0	0.0	0	0.0
Truck-related businesses	87	0.5	21	0.1	20	0.1
Total	**19,054**	**100.0**	**16,939**	**100.0**	**18,997**	**100.0**

Table 2-5. $PM_{2.5}$ emissions by Source Category within the Source Domain based on regional-scale emissions inventory (not included in community-scale bottom-up emissions inventory). Percentage (%) of emissions are reported as a total of the entire inventory.

Source Category	2017		2024		2029	
	tpy	%	tpy	%	tpy	%
Area	**30.40**	**70.0**	**33.83**	**74.3**	**36.06**	**74.9**
Commercial cooking	20.63	47.5	23.90	52.5	26.08	54.2
Food and agriculture	0.00	0.0	0.00	0.0	0.00	0.0
Fuel combustion – residential	6.93	16.0	6.99	15.4	6.98	14.5
Fuel combustion – Commercial/industrial	2.30	5.3	2.39	5.2	2.44	5.1
Industrial processes	0.03	0.1	0.03	0.1	0.04	0.1
Solvent use	0.00	0.0	0.00	0.0	0.00	0.0
Consumer products	0.00	0.0	0.00	0.0	0.00	0.0
Other	0.50	1.2	0.52	1.1	0.53	1.1
Non-road	**13.00**	**30.0**	**11.71**	**25.7**	**12.08**	**25.1**
Construction – equipment	4.10	9.5	2.39	5.3	2.18	4.5
Construction – dust	6.74	15.5	7.70	16.9	8.40	17.5
Commercial/industrial equipment	1.17	2.7	0.97	2.1	0.92	1.9
Lawn and garden equipment	0.12	0.3	0.13	0.3	0.13	0.3
TRUs	0.24	0.5	0.07	0.2	0.05	0.1
Other	0.63	1.4	0.46	1.0	0.39	0.8
Total	**43.40**	**100.0**	**45.54**	**100.0**	**48.13**	**100.0**

Table 2-6. As in **Table 2-5**, but for DPM emissions.

Source Category	2017		2024		2029	
	tpy	%	tpy	%	tpy	%
Area	**0.00**	**0.0**	**0.00**	**0.0**	**0.00**	**0.0**
Commercial cooking	0.00	0.0	0.00	0.0	0.00	0.0
Food and agriculture	0.00	0.0	0.00	0.0	0.00	0.0
Fuel combustion – residential	0.00	0.0	0.00	0.0	0.00	0.0
Fuel combustion – Commercial/industrial	0.00	0.0	0.00	0.0	0.00	0.0
Industrial processes	0.00	0.0	0.00	0.0	0.00	0.0
Solvent use	0.00	0.0	0.00	0.0	0.00	0.0
Consumer products	0.00	0.0	0.00	0.0	0.00	0.0
Other	0.00	0.0	0.00	0.0	0.00	0.0
Non-road	**4.12**	**100.0**	**1.72**	**100.0**	**1.23**	**100.0**
Construction – equipment	3.33	80.8	1.42	82.4	1.07	87.0
Commercial/industrial equipment	0.51	12.5	0.21	12.1	0.09	7.1
Lawn and garden equipment	0.02	0.5	0.02	1.2	0.02	1.7
TRUs	0.26	6.2	0.07	4.3	0.05	4.2
Other	0.00	0.0	0.00	0.0	0.00	0.0
Total	**4.12**	**100.0**	**1.72**	**100.0**	**1.23**	**100.0**

Table 2-7. As in **Table 2-5**, but for cancer risk-weighted TAC emissions (including DPM).

Source Category	2017		2024		2029	
	CRW tpy	%	CRW tpy	%	CRW tpy	%
Area	**413**	**11.0**	**439**	**22.4**	**460**	**28.8**
Commercial cooking	9	0.2	10	0.5	11	0.7
Food and agriculture	13	0.4	13	0.7	13	0.8
Fuel combustion – residential	18	0.5	16	0.8	16	1.0
Fuel combustion – Commercial/industrial	17	0.5	18	0.9	18	1.1
Industrial processes	176	4.7	192	9.8	205	12.8
Solvent use	125	3.3	135	6.9	142	8.9
Consumer products	41	1.1	44	2.3	46	2.9
Other	13	0.4	11	0.6	10	0.6
Non-road	**3,358**	**89.0**	**1,523**	**77.6**	**1,138**	**71.2**
Construction – equipment	2,501	66.3	1,074	54.8	814	51.0
Construction – dust	0	0.0	0	0.0	0	0.0
Commercial/industrial equipment	436	11.6	205	10.5	117	7.3
Lawn and garden equipment	79	2.1	77	3.9	78	4.9
TRUs	192	5.1	57	2.9	40	2.5
Other	151	4.0	109	5.5	88	5.5
Total	**3,771**	**100.0**	**1,962**	**100.0**	**1,599**	**100.0**

Total emissions from the community-scale bottom-up and top-down emissions inventories can be summed to obtain the grand total of emissions in West Oakland (**Figure 2-3**, **Table 2-8**). In summary:

- **$PM_{2.5}$:** total emissions increase in future years, as both the bottom-up and top-down portion (i.e., not included for dispersion modeling) increases over time. The overall increase by 2024 is approximately +2.57% (**Table 2-8**), mainly due to a projected increase in emissions from Port-related sources (**Table 2-2**). According to the District's analysis presented herein, the portion of $PM_{2.5}$ emissions represented by the bottom-up emissions inventory is nearly constant from the base year to future years (~ 66%).

- **DPM:** total emissions decrease by 2024 (-18.17%) and then increase by 2029, towards 2017 levels (-10.67%). Emissions from categories that were not included decrease over time; accordingly, a greater proportion of the total emissions inventory for DPM is represented in the total emissions inventory in future years (**Table 2-8**).

- **Cancer risk-weighted TACs:** changes in emissions in future years are similar to those for DPM: total emissions decrease by 2024 but increase to 2029, though 2029 emissions remain below the base year (-9.77%), and the estimated portion of the inventory that was not modeled decreases in future years.

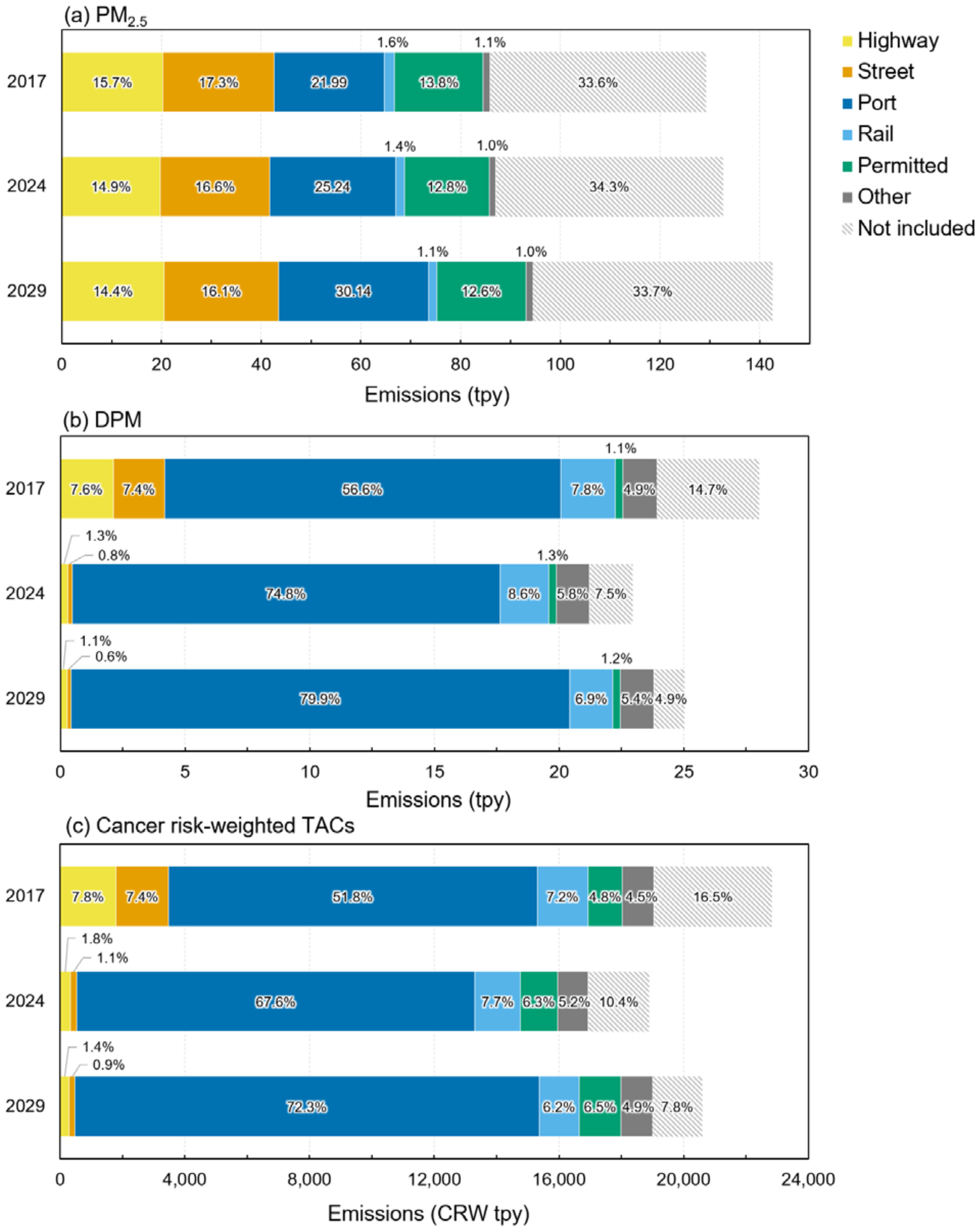

Figure 2-3. Emissions of (a) $PM_{2.5}$, (b) DPM, and (c) cancer risk-weighted TACs by source category for the 2017 base year and future year (2024, 2029) for West Oakland. Emissions that were "Not included" in the community-scale modeling (top-down, "not modeled") and analysis are also shown; the absolute length of the horizontal bars represents the total emissions estimated in West Oakland (sum of bottom-up and top-down).

Table 2-8. Summary of $PM_{2.5}$ (tpy), DPM (tpy), and cancer risk-weighted (CRW) TAC (CRW tpy) emissions in West Oakland. Business-as-usual conditions are assumed for future years (2024, 2029). All percent changes (% change) are relative to the base year (2017). The percent modeled ("% modeled") is equal to the "Bottom-up" value divided by the "Total" value, multiplied by 100.

Pollutant	Year	Bottom-up (modeled)	% change	Top-down (not modeled)	% change	Total	% change	% modeled
$PM_{2.5}$	2017	85.91	–	43.40	–	129.31	–	66.4
	2024	87.09	+1.38	45.54	+4.94	132.63	+2.57	65.7
	2029	94.50	+10.00	48.13	+10.91	142.63	+10.31	66.3
DPM	2017	23.91	–	4.12	–	28.03	–	85.3
	2024	21.22	-11.28	1.72	-58.17	22.94	-18.17	92.5
	2029	23.81	-0.43	1.23	-70.14	25.04	-10.67	95.1
CRW TACs	2017	19,054	–	3,371	–	22,825	–	83.5
	2024	16,939	-11.10	1,962	-17.20	18,900	-17.20	89.6
	2029	18,997	-0.30	1,599	-57.61	20,596	-9.77	92.2

2.2 Permitted Stationary Sources

Permitted stationary sources can be categorized using one or more systems of codes that describe a facility's primary activity, specific processes, and/or industry classification:

- **Standard Industrial Classification (SIC):** The SIC system was developed in the 1930s by the U.S. Office of Management and Budget to help classify facilities under the appropriate industrial group, and to help government agencies collect and analyze data in a uniform manner. An SIC code consists of four digits, where the first two digits describe the major line of business contributing the majority of revenue, the third digit identifies the subgroup of the establishment, and the fourth digit identifies the specific industry sector in which the establishment operates.

- **North American Industry Classification System (NAICS):** The NAICS[3] has since replaced the SIC system. NAICS codes consist of six digits that allow for more flexibility to expand and include industry sectors operating in the U.S., Canada, and Mexico.

- **Source Classification Code (SCC):** An SCC is used by the U.S. Environmental Protection Agency (EPA) to classify different types of activities that generate emissions. Each SCC represents a unique source category-specific process or function that can emit more than one air pollutant. For example, the same SCC can be applied to a combustion boiler used to generate energy for an electricity generating facility or for a pulp and paper manufacturer. The SCCs are used as a primary identifying data element in national and state level databases, such as EPA's National Emissions Inventory (NEI) and CARB's California Emissions Inventory Development and Reporting System (CEIDARS) database.

[3] https://www.naics.com/search/.

The District typically assigns an SIC and/or a NAICS code to each permitted facility in the Bay Area. Together, these codes describe a facility's process and industry. Compliant with CEIDARS reporting requirements, the District also assigns SIC and SCC code pairs for each permitted source by using a crosswalk that connects the SIC and/or NAICS codes to SCCs. Every three years, the District develops an emissions inventory that includes GCFs for future years for each source category by SIC. The GFs take into account the expected increase in throughput by category, predicted growth profile from CARB, total population growth profile and employment growth by sectors from Association of Bay Area Government (ABAG) projections, and economic considerations. The growth is offset by CFs required under existing and upcoming regulations adopted by the District, local, state, or federal agencies and projected reductions through incentive funding.

To forecast emissions from permitted stationary sources, the District used the GCFs that were submitted to CARB as part of its emissions inventory submission for 2011 (Bay Area Air Quality Management District 2014). Adjustments were made to the profiles using ABAG's 2013 projections for employment and population. The 2017 base year emissions were multiplied by the GCFs for 2024 and 2029 by SCC. The same GCFs were applied to industries with the same SCC except if differing fuel types were used (e.g., diesel fuel versus gasoline). In a few cases, the District used GCFs for area sources developed by CARB based on SCC. For facilities where only emissions were available for 2016 (as noted in Part I Section 2.2), GCFs were adjusted using 2016 as the base year. Permitted sources where emission factors or facility operations had significantly changed in 2019 were accordingly grown using 2019 as the base year. Standby generators used solely for emergency situations were the only source where no GFs or CFs were applied.

To forecast emissions from permitted sources at Schnitzer Steel, the District used the SIC-based GCFs on the 2017 base year emissions; two Venturi Scrubbers were installed during this year at the facility to abate emissions from the shredder and in-feed conveyor, which are accounted for in the base year emissions inventory.

2.3 On-Road Mobile Sources

Emissions from on-road mobile sources were forecasted based GFs and emissions factors in future years from CARB's most recent version of the EMission FACtors (EMFAC) model, EMFAC2017 (California Air Resources Board 2017b), and the Caltrans-EMFAC2017 (CT-EMFAC2017) model (California Department of Transportation 2019), and additional CFs to account for emissions reductions from regulations adopted since the release of EMFAC2017 (December 22, 2017). The methodology, data requirements, and data sources used for developing future year emissions inventories are described in the following sections.

2.3.1 Travel Activity

Future-year travel activity is needed to estimate future-year emissions from on-road mobile sources. Ideally, the local metropolitan planning organization (MPO) should provide future activity levels simulated by a travel demand model (TDM) to reflect the best understanding and prediction of traffic volume and congestion levels. In this analysis, the future-year (2024, 2029) activity data was not available from the local MPO. Given that the road network and travel activity data for the base year were also obtained elsewhere (Citilabs), a simplified approach was used to project the travel activity from the 2017 base year to the future years using GFs derived from total vehicle miles traveled (VMT) data from EMFAC2017. It was therefore assumed that no changes in roadway conditions, fleet mix (by vehicle category), vehicle speed, and diurnal volume profile would occur in future years. However, changes in fleet average vehicle weight (W_{fleet}) were incorporated (which is used to calculate road dust emission factors): while the fleet mix by vehicle categories (Non-Truck, Truck 1, Non POAK-Truck 2, POAK) was kept constant,[4] the underlying composition of each vehicle category in EMFAC2017 varies in future years, which causes small changes in overall fleet average vehicle weight.

The GFs were derived from the total VMT of Alameda County in EMFAC2017 following:

$$GF_{FY} = \frac{VMT_{FY}}{VMT_{BY}}$$

where

GF_{FY} = growth factor for future year FY (unitless)
VMT_x = total fleet VMT for year x (BY or FY) from EMFAC2017 (mi)

In this analysis, $BY = 2017$, and $FY \in \{2024, 2029\}$. For each roadway link, the year-specific GF was then multiplied by the hourly VMT (or vehicle hours traveled [VHT]) for each vehicle category and day type (weekday, weekend) to develop future-year travel activity. The GFs applied to the base year activity levels were 1.078 (+7.8% growth) for 2024, and 1.133 (+13.3% growth) for 2029. The GFs were the same for all vehicle categories and roadway types.

2.3.2 Emission Factors

EMFAC2017 estimates operational emission factors from 2000 to 2050, where changes in emission factors over time result from vehicle fleet turnover and emissions benefits from state and federal laws, regulations, and legislative actions that were adopted as of December 2017 (California Air Resources Board 2018a).

In this analysis, emission factors for the future years were calculated for each vehicle category, emission process (running exhaust, running loss, tire wear, and brake wear only), and pollutant using the EMFAC2017 and CT-EMFAC2017 emission factors, following the same approach as described in Part I Section 2.3.3. However, the resulting emission factors do not account for additional emissions benefits from regulations adopted after the release of EMFAC2017; these were applied to total forecasted emissions, as discussed in Section 2.3.3.

For re-entrained road dust emission factors, the future year emission factors were calculated as described in Part I Section 2.3.3, using the updated fleet average vehicle weight and by assuming no changes in road conditions (e.g., silt loading), vehicle category fleet mix, and meteorology (precipitation).

[4] Total VMT was used to derive the growth rate, rather than VMT by vehicle category. This was to ensure that the fleet mix of vehicle categories remained constant in future years.

2.3.3 Additional Control Factors

EMFAC2017 generates emission factors that already take into account future CFs. However, at the time of this analysis, there were three statewide regulations implemented by CARB after the release of EMFAC2017 that must be accounted for in BAU future-year emissions inventories (**Table 2-9**). Additional emission benefits (reductions) from these regulations should affect operational emission processes only. To reflect these additional benefits, the CFs were applied to total emissions estimated in future years. For each regulation (R), the CFs were derived by pollutant (p), process (P), and vehicle type (VT) for a given future year following:

$$CF(p, P, FY, VT)_R = \frac{E_{regulated}\ (p, P, FY, VT)}{E_{baseline}\ (p, P, FY, VT)}$$

where $E_{baseline}$ are the baseline emissions, and $E_{regulated}$ are the regulated emissions estimated by CARB in the rulemaking process.[5]

The CFs were then weighted by the emissions[6] from the EMFAC2017 web database[7] to obtain the control factors by vehicle category, which could then be applied directly to emissions by vehicle category from the 2017 base year inventory (Non-Truck, Truck 1, non-POAK-Truck 2, POAK).

A caveat of these CFs is that the baseline and regulated emissions from CARB are not specific to the West Oakland community. As a result, the CFs are derived based on statewide or San Francisco Bay Area-specific emissions (see **Table 2-9**).

2.3.4 Emissions

The travel activity (**Section 2.3.1**) and emission factors (**Section 2.3.2**) were combined to estimate future-year emissions following the same approach described in Part I Section 2.3.4. Where applicable, additional CFs (**Section 2.3.3**) were applied to obtain the adjusted emissions for BAU conditions:

$$E(p, P, FY, VC) = E(p, P, FY, VC)' \cdot \prod_{r} CF(p, P, FY, VC)_R$$

where the emissions (E) are for a particular pollutant (p), process (P), future year (FY), and vehicle category (VC). The prime ($'$) indicates the emissions before the additional adjustment using the CF for all regulations. This emissions adjustment assumes that all regulations are independent, and that their impacts are linear and additive.

[5] Based on information provided to the District by CARB on June 7, 2019.
[6] Emissions were obtained for the area to which the regulation applied (i.e., statewide or area-wide, as noted in **Table 2-6**).
[7] https://www.arb.ca.gov/emfac/2017/.

Table 2-9. Regulations for on-road mobile sources approved after the release of EMFAC2017. Truck 2 includes POAK and Non-POAK-Truck 2 vehicles.* Process indicates only the emission processes that are affected in this emissions inventory (CARB's regulations may apply to other emission processes; see References); idling is for extended idling events only.

Program	Region	Vehicle	Pollutant	Process	Reference
Amendments to Heavy-Duty Vehicle Inspection Program and Periodic Smoke Inspection Program	Statewide	Diesel: Truck 2	DPM PM_{10} $PM_{2.5}$	running idling	California Air Resources Board (2019a), California Air Resources Board (2018c). See also [1].
Amendments to California Emission Control System Warranty Regulations and Maintenance Provisions for 2022 and Subsequent Model Year On-Road Heavy- Duty Diesel Vehicles with Gross Vehicle weight Ratings Greater Than 14,000 Pounds and Heavy-Duty Diesel Engines in such Vehicles	Statewide	Diesel: Truck 2, school bus, other bus, motorhomes	DPM PM_{10} $PM_{2.5}$ NO_x	running idling	California Air Resources Board (2018d). See also [2].
Innovative Clean Transit (ICT)	San Francisco Bay Area	Urban buses	DPM PM_{10} $PM_{2.5}$ NO_x	running	California Air Resources Board (2018b). See also [3].

* see Part I Table 2-6 for a definition of these vehicle types.
[1] https://ww2.arb.ca.gov/rulemaking/2018/heavy-duty-vehicle-inspection-program-and-periodic-smoke-inspection-program.
[2] https://ww2.arb.ca.gov/rulemaking/2018/hd-warranty-2018.
[3] https://ww3.arb.ca.gov/msprog/ict/background_materials.htm.

2.4 Truck-Related Businesses

2.4.1 Surveyed Businesses

In this analysis, emissions from surveyed truck-related businesses include only idling exhaust while the vehicle is on the business premises. Emissions in future years from truck-related businesses surveyed in West Oakland were estimated, where:

(1) activity (truck trips per day at each facility) from the base year survey was adjusted by using a GF developed using the San Francisco Bay Area's Metropolitan Transportation Commission (MTC) Plan Bay Area 2040[8] projections for "Manufacturing, Wholesale and Transportation Jobs" in Oakland;
(2) idling exhaust emission factors by vehicle type in future years were taken from EMFAC2017 and CT-EMFAC2017; and
(3) total emissions were adjusted by additional CFs, where applicable (as described in **Section 2.3.3**).

For (1), the projected number of jobs are available every five years, from 2010 to 2040 (inclusive). In this dataset, the base year is 2010, where data are based on 2010 Census counts. Data were linearly interpolated between years to obtain the number of jobs in the analysis future years (2024, 2029). The Plan Bay Area 2040 data indicated that jobs in the transportation section are forecasted to slightly decrease in future years (GF of 0.98 in 2024, 0.97 in 2029); emission factors are also expected to decrease (due to fleet turnover, new regulations, etc.). Assuming BAU conditions, vehicle activity in future years was assumed to remain constant, with 15 min of idling per truck trip.

2.4.2 Schnitzer Steel

Total emissions from trucks operating at Schnitzer Steel include emissions due to running exhaust, idle exhaust, tire wear, brake wear, and road dust. The District used a bottom-up approach to forecast emissions. First, the number of truck trips per year was projected based on the observed trend in number of truck trips between 2017 and 2018 up to the current permitted limit (63,875 truck trips/year). No other adjustments to activity parameters (driving distance, driving speed, idling time, road type) were applied. Emission factors for future years were based on data derived from EMFAC2017 and CT-EMFAC2017 for diesel medium-heavy duty trucks (MHDT) and heavy heavy-duty trucks (HHDT). Total emissions were adjusted by the additional CFs (**Section 2.3.3**) to account for additional regulations in the future, where applicable.

[8] Data provided by MTC; see also: https://mtc.ca.gov/our-work/plans-projects/plan-bay-area-2040.

2.5 Ocean-Going Vessels

2.5.1 Port of Oakland

OGVs use propulsion engines for transiting, auxiliary engines for on-board electrical power, and small boilers to meet steam and hot water demands. Emissions from transiting, maneuvering, and berthing from OGVs were forecasted for active marine terminals at the Port in 2017 (TraPac, Nutter, Oakland International Container Terminal [OICT], and Matson). The District assumed that all marine terminals would remain active in future years, and that the spatial allocation of emissions would not change.

For OGV maneuvering emissions, GCFs were derived from the 2016 SIP dataset for propulsion engines, auxiliary engines, and boilers. The 2017 base year emissions were multiplied by the corresponding GCFs to estimate future-year emissions. For berthing, future-year emissions estimates were provided directly from CARB (personal communication, 12 July, 2019).[9]

2.5.2 Schnitzer Steel

Schnitzer Steel receives only bulk carriers calling for scrap metal, and operates its own berth. Emissions from assist tugs (used to assist OGV movements upon arrival and departure) are included in the total OGV emissions.

For the 2017 base year emissions, the District used the current permit limit of 26 ship calls/year. The District is currently modifying the permit at the request of Schnitzer Steel to increase the annual permitted ship calls to 32 ship calls/year. Future emissions for 2024 and 2029 were estimated following the same methodology used to estimate the base year emissions except that 32 ship calls/year were used instead ($GF = 1.231$, or +23.1%). This also includes an increase in the number of assist tugs; total emissions reflect the total from OGVs and assist tugs. Without any supplemental data, no CFs were applied to estimate future-year emissions.

2.6 Commercial Harbor Crafts

2.6.1 Operation and Maintenance Dredging and Disposal

Future emissions for operation and maintenance (O&M) dredging and disposal activities were estimated using GCFs from the 2016 SIP dataset; the 2017 base year emissions were multiplied by the corresponding GCFs to estimate future-year emissions. This estimate generally assumes that the same amount of material will be dredged in future years.

2.6.2 Assist Tugs

Tug boats are used to assist cargo vessel movements upon arrival, berthing, and departure from the Port, and to tow or push a wide variety of barges and other equipment. The 2017 base year

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[9] These emissions are consistent with the current draft OGV at-berth inventory (California Air Resources Board 2019b; the final version will be publicly posted 60 days before the CARB Board hearing for the At-Berth Regulation Amendment).

emissions were estimated based on the activity of the five companies operating tugs: AMNAV, Foss Maritime, Starlight Marine, Crowley, and BayDelta.

Between 2017 and 2019, the District incentivized repowers (Tier 1 to Tier 3) of two tugs frequently serving the Port, reducing emissions in the Source Domain. These tugs would have needed upgrades to come into compliance with CARB's regulation for Commercial Harbor Crafts[10] by 2022, when CHCs will be required to have engines of model year 2007 or newer; the incentive funding resulted in reduced emissions in advance of the regulation. Following guidance from CARB, BAU emissions from assist tugs in 2024 were estimated by subtracting the emission reductions due to repowers from the 2017 base year emissions. For 2029, emissions were estimated by developing a GCF from the 2016 SIP dataset from 2024 to 2029, and applying that factor to the 2024 emissions.

2.6.3 Bunkering Barges

Future-year emissions from bunkering barges were forecasted separately for the barge main engine, auxiliary engine, and pumps as CARB's 2016 SIP dataset includes projected emissions for these separate emissions sources. The 2017 base year emissions were multiplied by the corresponding GCFs to estimate future-year emissions.

2.7 Cargo Handling Equipment

Cargo handling equipment (CHE) is primarily used to move shipping containers between marine vessels and trucks or between trains and trucks. As such, the types of CHE at the Port are limited to yard tractors, on-road yard tractors, rubber-tired gantry (RTG) cranes, top or side handlers (materials handling equipment), and forklifts.[11]

In the 2017 base year emissions inventory, total emissions from CHE were allocated to each equipment type based on the 2017 Port Inventory (Ramboll 2018). The 2017 base year emissions were multiplied by the corresponding GCFs from the 2016 SIP dataset to estimate future-year emissions.

2.8 Port Trucks at Terminals

Port trucks operating at terminals transport containers between marine terminals (TraPac, Nutter, OICT, Matson), freeway interchanges (Maritime Street/West Grand Street, 7th Street, and Adeline Street), which are the only access points to the Port property, and nearby railyards (BNSF, UP).

Emissions from Port Trucks operating at terminals in 2017 were based on the 2017 Port Inventory (Ramboll 2018). These emissions were expressed as totals by general emissions process: "driving" and idling. For PM_{10} and $PM_{2.5}$, driving emissions include running exhaust, tire wear, and brake

[10] For more information, see: https://ww2.arb.ca.gov/our-work/programs/commercial-harbor-craft.

[11] Other off-road equipment, such as sweepers, bulldozers, backhoes, excavators, and other off-road equipment, were not included as part of the CHE category since they are used at the Port for facility maintenance and construction instead.

wear emissions; for other pollutants, driving emissions are running exhaust emissions only. Road dust emissions were also estimated by the District for PM and included in the 2017 base year inventory for West Oakland (see Part I Section 2.8 for a description of the methodology).

Future-year emissions can be estimated by multiplying the total 2017 base year emissions by the fractional change in activity (GF, i.e., projected number of truck tips) and the fractional change in emission factors (CF[12]) for the vehicle category (represented as T7 POAK in EMFAC2017 Alameda County) to a given future year. Emission factors vary by emission process; therefore, total emissions must be disaggregated by emission process to estimate future-year emissions. The proportion of emissions by process in turn vary by terminal type (marine or railyard) and operation (in-terminal, or on-route to terminal). The process of disaggregating the total base year emissions are presented in **Figure 2-4**, and described below.

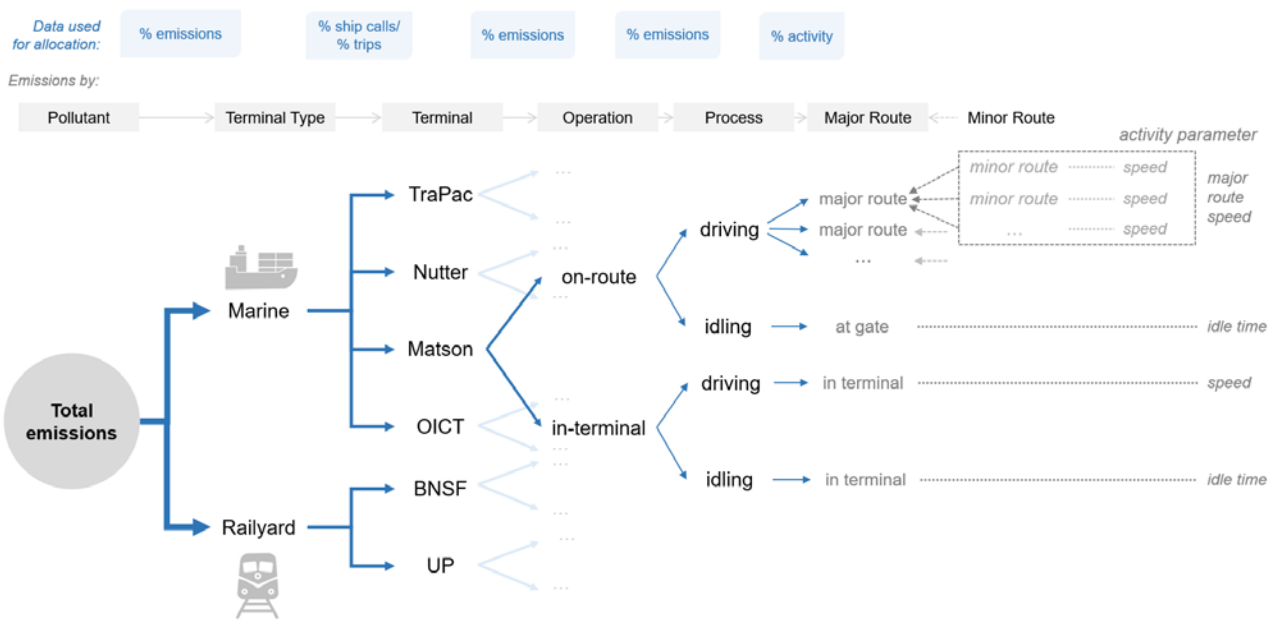

Figure 2-4. Illustration of process used to allocation total emissions from Port Trucks at terminals to specific locations and emissions processes. Only the disaggregation for the Matson marine terminal is illustrated for simplicity; analogous disaggregation schemes were used for all other terminals (not shown). The subsequent data used (blue rectangles) to obtain the aggregation level of emissions data (grey rectangles) are indicated. To develop the future year emission inventories, base year emissions were disaggregated to the Major Route level.

[12] When emission factors are aggregated over a portion of the fleet (e.g., for vehicle types within categories, or over model years for a particular vehicle type), this generally represents a combined growth and control factor, as the population of specific vehicle types change over time, as well as the emission factors of newer vehicles.

(1) Based on information provided by Ramboll (Till Stoeckenius, Ramboll, personal communications, 25 February, 2019, and 12 June, 2019), total emissions by pollutant were first allocated to terminal type (marine, railyard) (e.g., Part I Table 2-25).
(2) Emissions were spatially allocated to terminals:
  (a) For marine terminals, Port Truck emissions were further assigned to each terminal based on the proportion of ship calls made to each terminal in 2017.
  (b) For railyards, it was assumed that two-thirds (66.66%) of Port Trucks travelling to railyards went to the UP railyard, while the remaining one-third (33.33%) went to the BNSF railyard, consistent with the 2017 Port Inventory.
(3) Emissions by terminal were allocated to general emission processes (driving and idling) and operation based on information provided by Ramboll (Till Stoeckenius, Ramboll, personal communications, 12 June, 2019).
(4) Emissions were then allocated to Major Route, where:
  (a) For on-route driving to marine terminals, a Major Route represents the terminal-freeway interchange access point pair (e.g., TraPac–7th Street). Each Major Route can be made up of one or more Minor Routes, which associate a specific berth within the terminal to the access point (e.g., TraPac/Berth 32–7th Street). Emissions from Major Routes were allocated using the percentage of truck trips from each terminal to each access point (Ramboll (2018) Table 5-3).
  (b) For on-route idling (at gate) and in-terminal driving and idling, the process and Major Route are a one-to-one mapping (**Figure 2-4**; i.e., there are no associated Minor Routes).

Fleet volume information was not available by Minor Route, therefore the lowest level of aggregation of the Port Truck emissions was by Major Route by process, operation, and specific terminal.

However, a complication arises when disaggregating PM emissions; as aforementioned, PM emissions were reported by Ramboll (2018) as idling exhaust ($IDLEX$) and total driving emissions ($drive$), which is the total of running exhaust ($RUNEX$), tire wear ($PMTW$), and brake wear ($PMBW$). Therefore, the driving emissions must be further disaggregated into these three emissions processes. Since $RUNEX$ emissions are speed-dependent (**Figure 2-5**), an average travel speed by Major Route was derived by taking the average of all average travel speeds on associated Minor Routes (Ramboll 2018, Table 5-4; **Table 2-10**).

Since PM emissions from $RUNEX$, $PMTW$, and $PMBW$ are all proportional to VMT, the total of these emissions by Major Route can be derived using the proportion of emission factors taken from EMFAC2017 (2017 Alameda County):[13]

[13] These may not exactly correspond to the emission factors used by Ramboll (2018), but the proportion of emission factors should be similar.

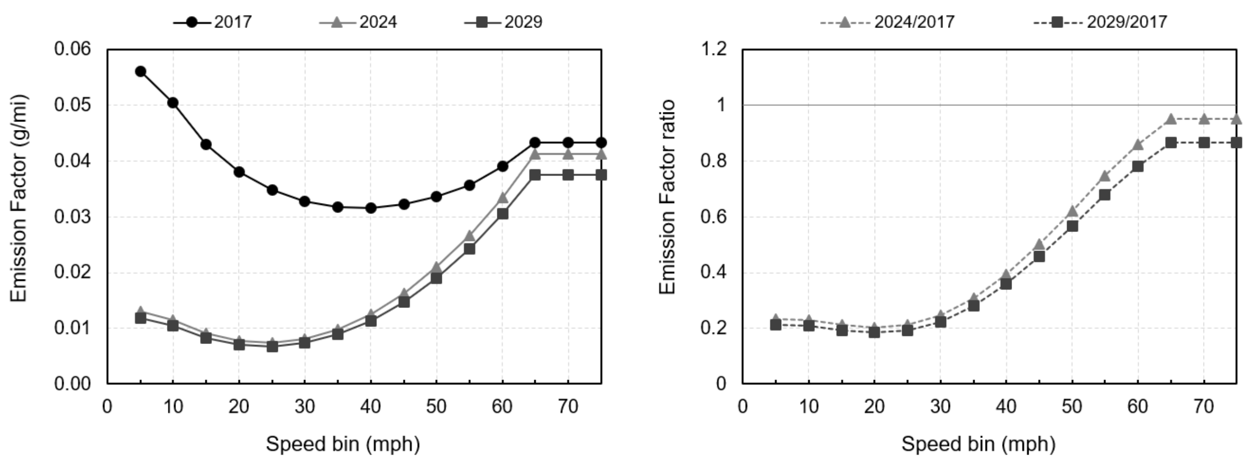

Figure 2-5. EMFAC2017 running exhaust emission factors for Port Trucks (T7 POAK, 2017 Alameda County), (left) by speed, and (right) as a ratio of future year (2024, 2029) emission factors to base year (2017) emission factors by speed bin.

Table 2-10. Method used to derive average Major Route travel speed. Speed bins are defined as in EMFAC2017.

Terminal type	Operation	Speed Data (Major Route)
Marine	On route	Length-weighted average speed of all associated Minor Routes (Ramboll 2018, Table 5-4).*
	In terminal	13.5 mph (10 mph speed bin, Ramboll 2018, Table 5-5).
Railyard	On route	Length-weighted average speed from all Minor Routes from all marine terminals to railyard (Ramboll 2018, Table 5-4).*
	In terminal	13.5 mph (10 mph speed bin, Ramboll 2018, Table 5-5).

* Ideally, the weighted average travel speed would be weighted by the fleet volume among Minor Routes; this data was not available.

$$E_{RUNEX} = E_{drive} \cdot \frac{EF_{RUNEX}(s)}{EF_{drive}}$$

$$E_{PMTW} = E_{drive} \cdot \frac{EF_{PMTW}}{EF_{drive}}$$

$$E_{PMBW} = E_{drive} \cdot \frac{EF_{PMBW}}{EF_{drive}}$$

where

E_p = base year PM emissions, where $p \in \{RUNEX, PMTW, PMBW, drive\}$, and $drive = RUNEX + PMTW + PMBW$ (g) (E_{drive} from Ramboll 2018)
EF_p = emission factor from EMFAC2017 (2017 Alameda County) (g/mi)
s = average travel speed bin on Major Route (used to determine EF_{RUNEX} from EMFAC2017 only; **Figure 2-5**)

Finally, as described above, a change in emissions from base year to future year can be estimated by using the fractional change of emission factors by emission process, and projected changes in activity:

$$E_{FY} = (E_{BY} \cdot GF_{FY} \cdot CF_{FY}) \cdot \prod_r CF_{R,FY}$$
$$CF_{FY} = \frac{EF_{FY}}{EF_{BY}}$$

where

E_{FY} = emissions of pollutant in future year FY (g)
E_{BY} = emission of pollutant in base year BY (g)
GF_{FY} = growth factor of pollutant from BY to FY (unitless) (1.05 per year, compounded)
CF_{FY} = control factor of pollutant from BY to FY, expressed as the ratio of future-year emission factor to base year emission factor for process $p \in \{RUNEX,\ PMTW,\ PMBW,\ IDLEX\}$ (unitless)
$CF_{R,FY}$ = additional control factors (as described in **Section 2.3.3**) (unitless)

In this analysis, the GF was taken as the projected increase in container ship activity at the Port (+5.0% per year, compounded; California Air Resources Board 2019b).[14]

[14] The +5.0% growth rate is based on the projected container ship activity in Appendix C (p. 67), approximated to 2029 only. Projections for all container ship sizes are identical.

2.9 Locomotives (Rail Lines)

2.9.1 Freight Haul Lines

BNSF and UP are the two major freight rail carriers that transport goods to and from the Bay Area. To forecast emissions, the District multiplied the 2017 base year emissions by the corresponding GCFs derived from the 2016 SIP dataset.[15]

2.9.2 Passenger Rail Lines

Passenger rail in West Oakland includes locomotives traveling on the Amtrak Capital Corridor, California Zephyr, Coastal Starlight, and San Joaquin lines. To forecast emissions, the District used emission estimates from California Air Resources Board (2017a); GCFs were derived using the same methods as those based on the 2016 SIP data, where future-year emissions are divided by the base year emissions. The 2017 base year emissions were multiplied by corresponding GCFs by process (exhaust and idling) to obtain estimates of future-year emissions.

2.10 Railyards

2.10.1 BNSF

The BNSF railyard is a near-dock transfer point, where emissions from locomotives come from both line-haul operations and switching operations (switchers). To forecast emissions, the 2017 base year emissions were multiplied by corresponding GCFs derived from the 2016 SIP dataset to obtain estimates of future-year emissions by locomotive type.

2.10.2 OGRE

OGRE is a Class III, Surface Transportation Board-certified short line rail company, exclusively serving non-marine facilities on the Army Base. Only switchers operate in this yard. Future-year emissions were estimated by multiplying the 2017 base year emissions were by corresponding GCFs derived from the 2016 SIP dataset for switchers only.

2.10.3 UP

The UP Oakland Railyard is a cargo handling facility that facilitates intermodal transport and locomotive service and repair. For the 2017 base year emissions, UP provided the District with total emissions estimates associated with several source categories: railyard operation from switchers, line-hauls locomotives, service and testing of locomotives, transport refrigeration units

[15] These GCFs are consistent with those available from CARB's sector-specific inventories (California Air Resources Board 2017a), available at: https://ww3.arb.ca.gov/msei/ordiesel.htm.

(TRUs) and refrigeration cars ("reefer cars"), and CHE. Through communications with UP, an updated emissions allocation profile by equipment type was developed,[16] as shown in **Table 2-11**.

Table 2-11. Percentage of PM emissions by source category at UP railyard for 2017 base year.

Source Category	**% total emissions**
Haul line freight and service/repairs	2.4
Switchers	76.4
TRUs/Reefer cars	2.0
CHE	19.2
Total	**100.0**

Consistent with other emissions sources in this analysis, the District used GCFs derived from the 2016 SIP inventory provided by CARB to estimate future-year emissions line-haul freight locomotives (Class I), switchers, and CHE; emissions associated with TRUs and reefer cars were not provided by CARB in the 2016 SIP dataset and thus were accounted for and projected with the freight locomotive category. Future-year emissions were estimated by multiplying the 2017 base year emissions were by corresponding GCFs.

2.11 Commuter Ferries and Excursion Vessels

Without detailed information regarding potential future increase in ferry service or fleet turnover, emissions for commuter ferries and excursion vessels were forecasted using GCFs from the 2016 SIP dataset. Emissions from navigating were forecasted by engine type: main engine, and auxiliary engine. Emissions from berthing are due to operations of the auxiliary engine only. The 2017 base year emissions were multiplied by the corresponding GCFs to estimate future-year emissions.

[16] UP found that the allocation of total DPM to source categories from CARB's health risk assessment of the UP railyard (California Air Resources Board 2008b) was no longer applicable to current operating conditions, and the emissions have significantly declined from several of the source categories.

3. Air Dispersion Modeling

A community-scale modeling approach was used to quantify the local impacts from emissions sources on air pollutant concentrations in West Oakland. Dispersion factors were generated using the American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD) system (Cimorelli *et al.* 2004) with a single year of representative meteorological data. Dispersion models use a time-averaged, simplified representation of turbulent atmospheric dispersion to approximate how pollutants are transported and diluted. Year-specific emissions inventories were convolved with dispersion factors to obtain year-specific air pollutant concentrations for the West Oakland community.

Generally, the same air pollutant dispersion model and configuration from the base year analysis (Part I Section 3) were used for assessing potential air pollutant concentrations in the West Oakland community in future years. That is, AERMOD (version 18081, dated March 22, 2018) was used to perform dispersion modeling using unit emission rates to represent the emissions from the sources accounted for in the community-scale emissions inventory (**Section 2**). A full description of the modeling approach is detailed in Part I; a summary of the model configuration and modeling procedure are summarized in **Table 3-1**.

Because meteorological data in 2014 was determined to be generally representative of meteorological conditions in West Oakland, the dataset was also used for future-year dispersion modeling. No changes were made to these emission rate profiles; it was assumed that the diurnal and/or seasonal patterns of the emissions sources will be unchanged in future years. The District also assumed that all emissions sources remained in the same geographical location, with the same physical characteristics.[17] For simplicity, no future background concentrations were estimated.[18]

To summarize, the same modeling approach for the base year analysis was used for the future year analysis; the only difference in the subsequent results are due to the changes in the strength of emissions. This approach allows direct comparisons between resulting pollutant concentrations and source apportionment results from base year to future years.

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[17] This assumption may not hold for certain large emissions sources (see **Section 6**).

[18] Background concentrations can be estimated using a modeling platform that combines regional-scale meteorological fields, emissions inventories, and photochemical transport modeling. This approach was used to derive background pollutant concentrations in West Oakland for the 2017 base year analysis (see Part I Section 3.6). Background concentrations are meant to provide a reasonable estimate of expected pollutant concentration and cancer risk levels in the absence of any local (West Oakland) emissions. Due to time and resource limitations, background concentrations were not developed for future years; however, proposed mitigation actions and targets do not depend on such estimates.

Table 3-1. Summary of AERMOD configuration for air dispersion modeling for the future year simulations.

Component	Setting/Data
Meteorological data	• Data period: January 1, 2014, through December 31, 2014. • Surface data from Oakland Sewage Treatment Plant station (OST) (+37.826º N, –122.299º W) • Upper-air data from Oakland International Airport station (KOAK) (+37.744408º N, –122.223510º W); soundings available twice daily.
Model configuration	• Default regulatory model options. • No wet or dry deposition. • No building downwash effects. • Accounted for elevated terrain. • Annual simulation used to produce average annual daily dispersion factors at Receptor locations.
Sources	• Used AERMOD point, area, or volume (single or adjacent) sources to represent emissions from sources within the community-scale emissions inventory. • Each source configured with geographic location, physical characteristics (e.g., stack height), and emissions characteristics. • Unit emission rates used, where temporal changes in the rate were scaled using the emissions or activity profile of the source.
Receptors	• Receptors placed every 20 m in the *x* and *y* directions within the Receptor Domain (a subset of the modeling domain used to spatially constrain receptors so that they are located in areas where the population could be exposed). • Receptors configured as "flagpole receptors", placed at 1.8 m agl (average "breathing height" of adults). • Receptors removed if intersecting a volume source exclusion zone (EZ); results imputed to these locations in a post-processing step.
Background concentration	• No background pollutant concentrations estimated for future years.

4. Analysis Methods

The same analysis methods used for the base year emissions inventory and dispersion modeling, as described in Part I, were applied to the future year emissions inventories and modeling. In particular, the same inhalation slope factors and sensitivity factors outlined by the Office of Environmental Health Hazard Assessment (OEHHA), dose and cancer risk equations, and spatial aggregation methods were used. Pollutant concentrations, cancer risk, and graphics can thus easily be compared between analysis years.

5. Results

Annual average local $PM_{2.5}$, DPM, and cancer risk results derived from dispersion modeling are presented in this section in a series of maps and tables; results are presented for the 2024 emissions scenario (2024 BAU) only. Additionally, a source apportionment is performed where information is provided on the relative contributions of the source categories described in previous sections: permitted stationary sources, on-road mobile sources (by road type and vehicle category), Port-related sources (e.g., OGVs, CHE), locomotives on rail lines and at railyards, and other sources (e.g., truck-related businesses).

5.1 $PM_{2.5}$ Concentrations

Based on combined AERMOD modeling results, the annual average $PM_{2.5}$ concentration associated with local sources in the West Oakland was 1.74 $\mu g/m^3$ (averaged over the community domain; **Table 5-1**). This represents a +1.8% change (increase) from the base year average $PM_{2.5}$ concentration (1.71 $\mu g/m^3$). The spatial distribution and magnitude of $PM_{2.5}$ concentrations given the 2024 BAU emissions are similar to those based on 2017 base year emissions: local concentration contributions exceed 4.0 $\mu g/m^3$ in areas that are proximate to large emission sources and roadways (**Figure 5-1**). The local average population-weighted (residential; see Part I Section 4.2.3 for methods) $PM_{2.5}$ concentration was 1.75 $\mu g/m^3$.

5.2 DPM Concentrations

The annual average local DPM concentration associated with sources in the West Oakland community domain was 0.30 $\mu g/m^3$ (**Table 5-2**), which is a -23.1% change (decrease) compared to the 2017 base year results. When the local average is population-weighted, the annual average local DPM concentration decreases to 0.15 $\mu g/m^3$, as the highest DPM concentrations are generally near the Port rather than residential areas. This represents a -40.0% change (decrease) compared to the 2017 base year results. While the spatial distribution of local DPM concentrations are similar to those in the base year, there is a perceivable decrease in concentrations near roadways (**Figure 5-2**, *c.f.* Part I Figure 5-2).

5.3 Cancer Risk

The annual average excess cancer risk within the West Oakland community associated with BAU 2024 BAU emissions was 235 in-a-million (**Table 5-3**). This represents a -22% change (decrease) in excess cancer risk compared to base year emissions (303 in-a-million). The changes in the spatial distribution of excess cancer risk from the base year to 2024 BAU conditions are similar to those for DPM (**Figure 5-3**, *c.f.* **Figure 5-2**). The annual excess cancer risk is 120 in-a-million when weighted by population. Areas with highest excess cancer risk remain in areas that are proximate large emission sources, especially those that emit high levels of DPM.

Table 5-1. Source contributions to the annual average $PM_{2.5}$ concentrations in the West Oakland community. Port Truck contributions represent those from Port Trucks on all roads and within Port terminals.

Source Category	2017		2024	
	μg/m³	**% of total**	**μg/m³**	**% of total**
Highway				
Non-Trucks	0.242	14	0.255	15
LHDT	0.009	1	0.010	1
MHDT/HHDT	0.058	3	0.022	1
Road dust	0.103	6	0.110	6
Surface Streets				
Non-Trucks	0.107	6	0.111	6
LHDT	0.005	< 1	0.005	< 1
MHDT/HHDT	0.038	2	0.012	1
Road dust	0.395	23	0.423	24
Port				
OGV – maneuvering	0.023	1	0.033	2
OGV – berthing	0.048	3	0.063	4
Dredging	0.020	1	0.014	1
Assist Tugs	0.071	4	0.056	3
Bunkering (tugs, pumps)	0.005	< 1	0.005	< 1
CHE	0.027	2	0.031	2
Port Trucks	0.023	1	0.016	1
Road dust	0.043	3	0.047	2
Railyard – OGRE	0.004	< 1	0.005	< 1
Railyard – BNSF	0.009	1	0.005	1
Rail				
Locomotives	0.026	2	0.019	1
Railyard – UP	0.057	3	0.062	4
Permitted				
CA Waste (10th Street)	0.029	2	0.032	2
California Cereal	0.034	2	0.037	2
CASS	0.005	< 1	0.005	< 1
Dynegy	0.001	< 1	0.001	< 1
EBMUD	0.056	3	0.060	3
Pinnacle Ag Services	0.095	6	0.104	6
Schnitzer Steel – stationary	0.090	5	0.096	6
Sierra Pacific	0.054	3	0.059	3
Other	0.022	1	0.022	1
Other				
Ferry/Excursion vessels	0.006	< 1	0.006	< 1
Schnitzer Steel – OGV	0.002	< 1	0.003	< 1
Schnitzer Steel – trucks	0.001	< 1	0.001	< 1
Truck-related businesses	0.002	< 1	0.001	< 1
Total	**1.710**	**100**	**1.736**	**100**
Total population-weighted	**1.732**		**1.745**	

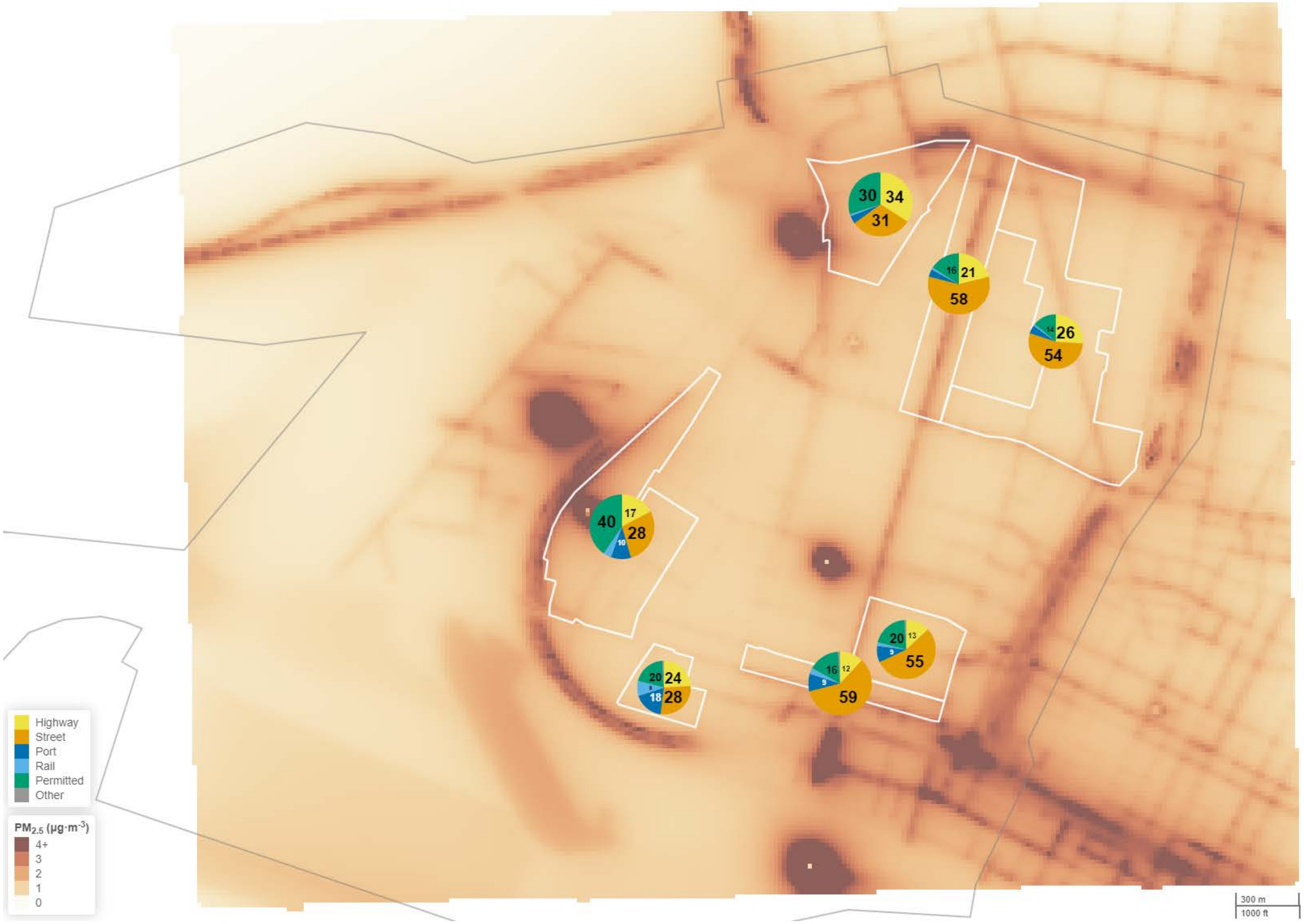

Figure 5-1. Annual average $PM_{2.5}$ concentrations associated with modeled local sources in the West Oakland Receptor Domain (colored extents) for 2024 BAU. Pie charts indicate the percentage of concentrations contributed from specific Source Categories in each zone (white polygons, Part I Figure 4-1); the size of the pie chart indicates the total magnitude of the concentration. The grey line indicates West Oakland Community Boundary. Outlines of other geographical features (roadways, etc.) are omitted.

Table 5-2. As in **Table 5-1**, but for DPM concentrations.

Source Category	**2017**		**2024**	
	μg/m^3	**% of total**	**μg/m^3**	**% of total**
Highway				
Non-Trucks	0.004	1	0.004	1
LHDT	0.002	1	0.002	1
MHDT/HHDT	0.043	11	0.001	< 1
Surface Streets				
Non-Trucks	0.002	1	0.001	< 1
LHDT	0.001	< 1	0.001	< 1
MHDT/HHDT	0.029	8	0.001	< 1
Port				
OGV – maneuvering	0.023	6	0.033	11
OGV – berthing	0.026	7	0.032	11
Dredging	0.020	5	0.014	5
Assist Tugs	0.073	19	0.058	19
Bunkering (tugs, pumps)	0.005	1	0.005	2
CHE	0.027	7	0.031	10
Port Trucks	0.012	3	0.003	1
Railyard – OGRE	0.005	1	0.005	2
Railyard – BNSF	0.010	3	0.011	4
Rail				
Locomotives	0.028	7	0.020	7
Railyard – UP	0.062	16	0.068	22
Permitted				
CA Waste (10th Street)	-	-	-	-
California Cereal	-	-	-	-
CASS	-	-	-	-
Dynegy	< 0.001	< 1	-	-
EBMUD	0.002	1	0.002	1
Pinnacle Ag Services	-	-	-	-
Schnitzer Steel – stationary	-	-	-	-
Sierra Pacific	-	-	-	-
Other	< 0.001	< 1	0.001	< 1
Other				
Ferry/Excursion vessels	0.006	2	0.006	2
Schnitzer Steel – OGV	0.002	1	0.003	1
Schnitzer Steel – trucks	< 0.001	< 1	< 0.001	< 1
Truck-related businesses	0.002	1	0.001	< 1
Total	**0.385**	**100**	**0.303**	**100**
Total population-weighted	**0.247**		**0.146**	

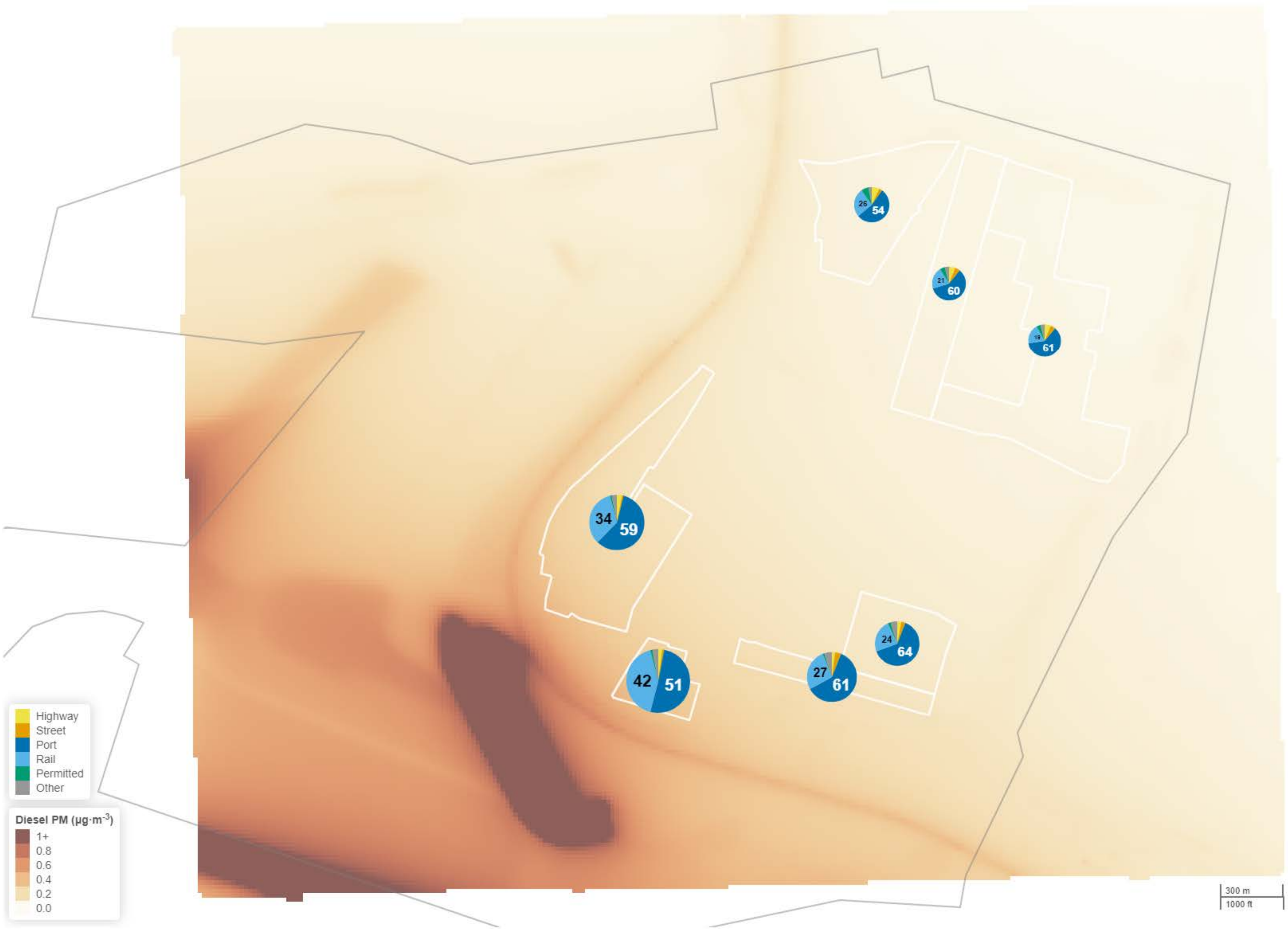

Figure 5-2. As in Figure 5-1, but for DPM concentrations.

Table 5-3. As in **Table 5-1**, but for excess cancer risk.

Source Category	**2017**		**2024**	
	per million	**% of total**	**per million**	**% of total**
Highway				
Non-Trucks	7	2	3	1
LHDT	2	1	3	1
MHDT/HHDT	33	11	1	1
Surface Streets				
Non-Trucks	4	1	2	1
LHDT	1	< 1	1	< 1
MHDT/HHDT	22	7	1	< 1
Port				
OGV – maneuvering	17	6	25	10
OGV – berthing	20	7	24	10
Dredging	15	5	10	4
Assist Tugs	55	18	43	18
Bunkering (tugs, pumps)	4	1	4	1
CHE	20	7	23	10
Port Trucks	10	3	2	1
Railyard – OGRE	4	1	4	2
Railyard – BNSF	8	2	8	3
Rail				
Locomotives	21	7	15	6
Railyard – UP	46	15	51	22
Permitted				
CA Waste (10th Street)	–	–	–	–
California Cereal	< 1	< 1	< 1	< 1
CASS	< 1	< 1	< 1	< 1
Dynegy	< 1	< 1	< 1	< 1
EBMUD	2	1	2	1
Pinnacle Ag Services	–	–	–	–
Schnitzer Steel – stationary	5	2	6	3
Sierra Pacific	–	–	–	–
Other	2	1	3	1
Other				
Ferry/Excursion vessels	5	2	5	2
Schnitzer Steel – OGV	2	1	2	1
Schnitzer Steel – trucks	< 1	< 1	< 1	< 1
Truck-related businesses	2	1	< 1	< 1
Total	**303**	**100**	**235**	**100**
Total population-weighted	**199**		**120**	

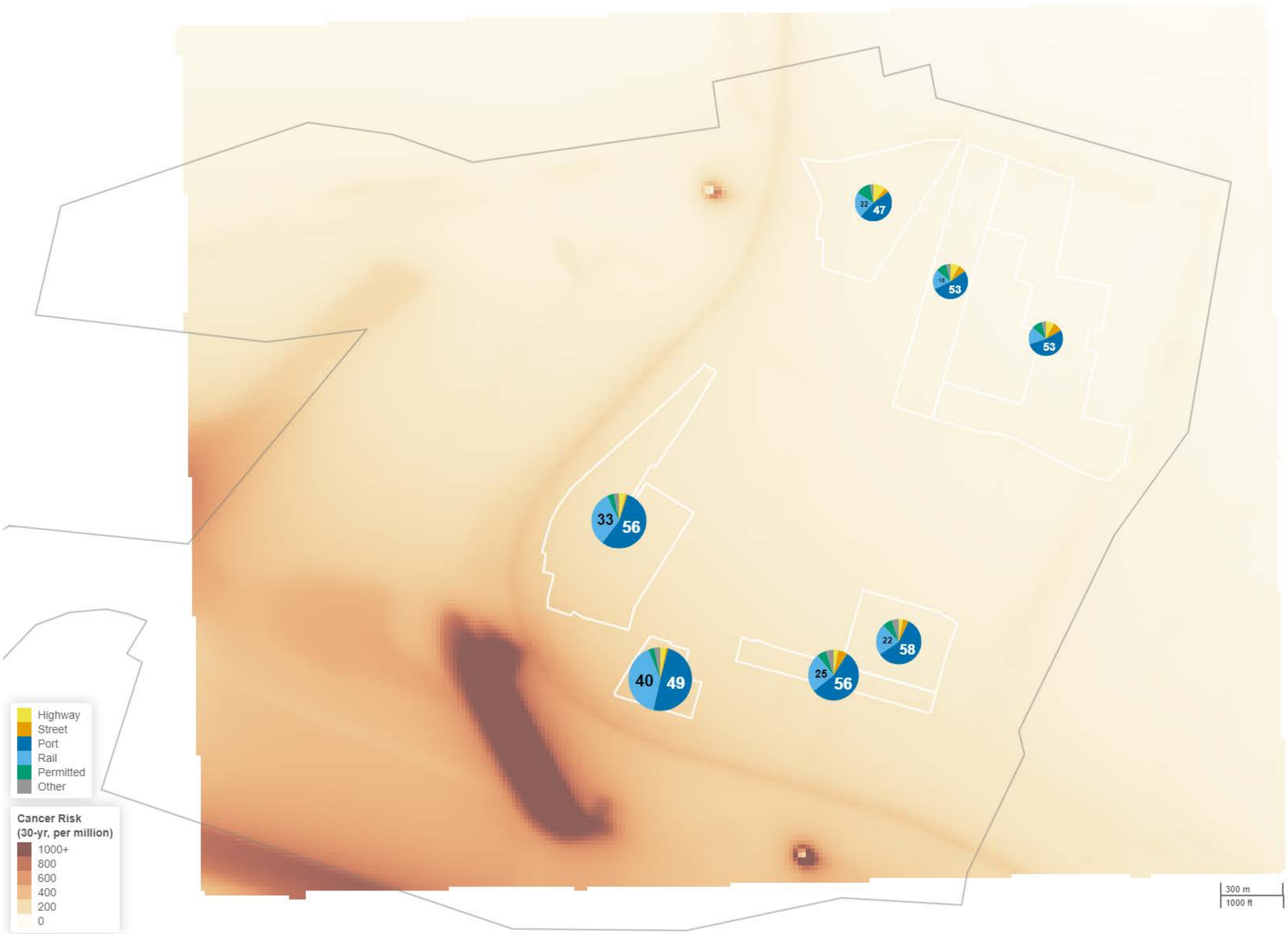

Figure 5-3. As in Figure 5-1, but for excess cancer risk.

5.4 Source Apportionment

To support a source apportionment analysis of the local modeled concentrations and cancer risk, the percentage contribution from source categories to the domain-wide averages, and by location or zone were generated, as depicted by the pie charts in **Figure 5-1**, **5-2**, and **5-3**. Source contributions to annual average $PM_{2.5}$ concentration (1.74 µg/m^3), annual average DPM concentration (0.30 µg/m^3), and excess cancer risk (235 in-a-million) are tabulated by emissions source category, and compared to the results from the base year, in **Table 5-1**, **5-2**, and **5-3**, respectively.

For 2024 BAU conditions, the main emissions sources contributing to annual average local $PM_{2.5}$ concentrations within the West Oakland community are related to on-road mobile sources, especially Non-Trucks and road dust (**Table 5-1**). Population-weighted $PM_{2.5}$ concentrations are similar across Zones (**Figure 5-4**), while the largest contributions to local $PM_{2.5}$ within these zones are also from on-road mobile sources and permitted stationary sources.

For DPM and cancer risk, the main sources that contribute to local concentrations in 2024 BAU are namely those sources related to Port and rail activities, especially OGVs (22% total, community-wide) and the UP railyard (**Table 5-2**). Compared to annual average local $PM_{2.5}$ concentrations, there is more between-Zone (spatial) variation in local contributions to annual average DPM (**Figure 5-5**) and excess cancer risk (**Figure 5-6**), where these quantities are highest in Zone 1 (Lower Bottoms/West Prescott) and Zone 2 (3rd Street), which are closest to the Port and the UP railyard, and lowest in Zone 5 (Upper Adeline), 6 (Clawson), and 7 (West Grand & San Pablo), which are on the to the north of the West Oakland community and furthest from the active terminals in the Port.

The source apportionment analysis helps to highlight the main emission sources that contribute to local air pollutant concentrations, and clarify the relationship between emissions versus impacts on local air pollution: while some emission source categories may make up a largest (smallest) portion of the overall emissions inventory, the effects on local air quality are not always greatest (smallest) at certain locations within the analysis domain.

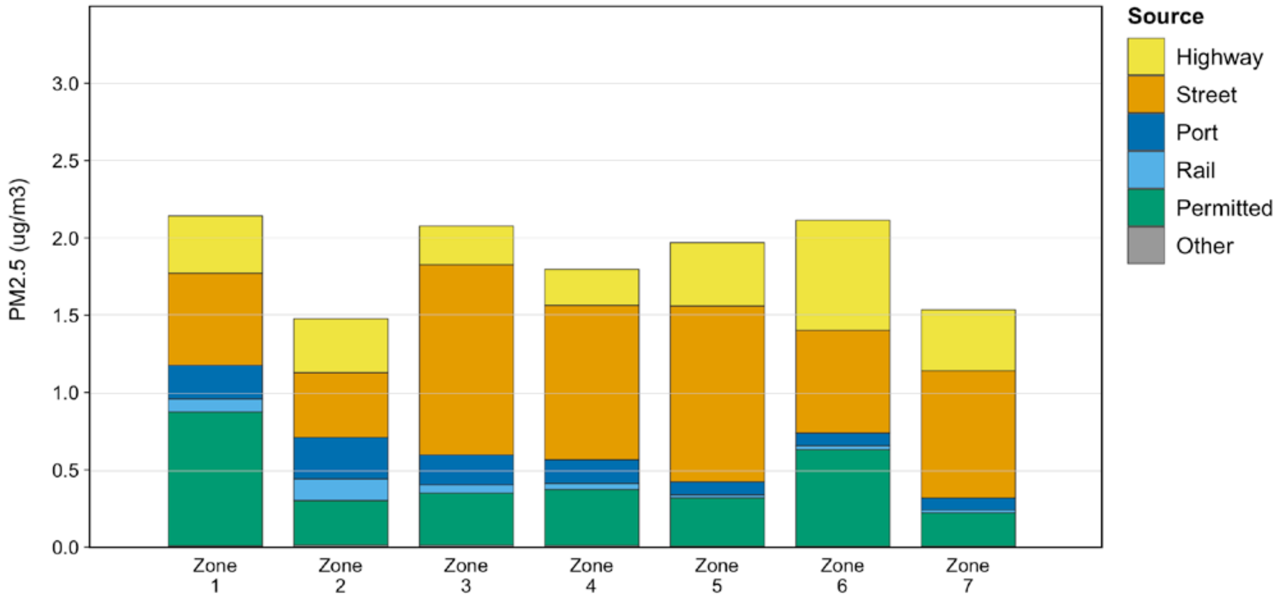

Figure 5-4. Source apportionment of population-weighted annual average local $PM_{2.5}$ concentrations within Zones (Part I Figure 4-1) in the West Oakland community forecasted in 2024 (BAU conditions). The values here correspond to pie charts in **Figure 5-1**.

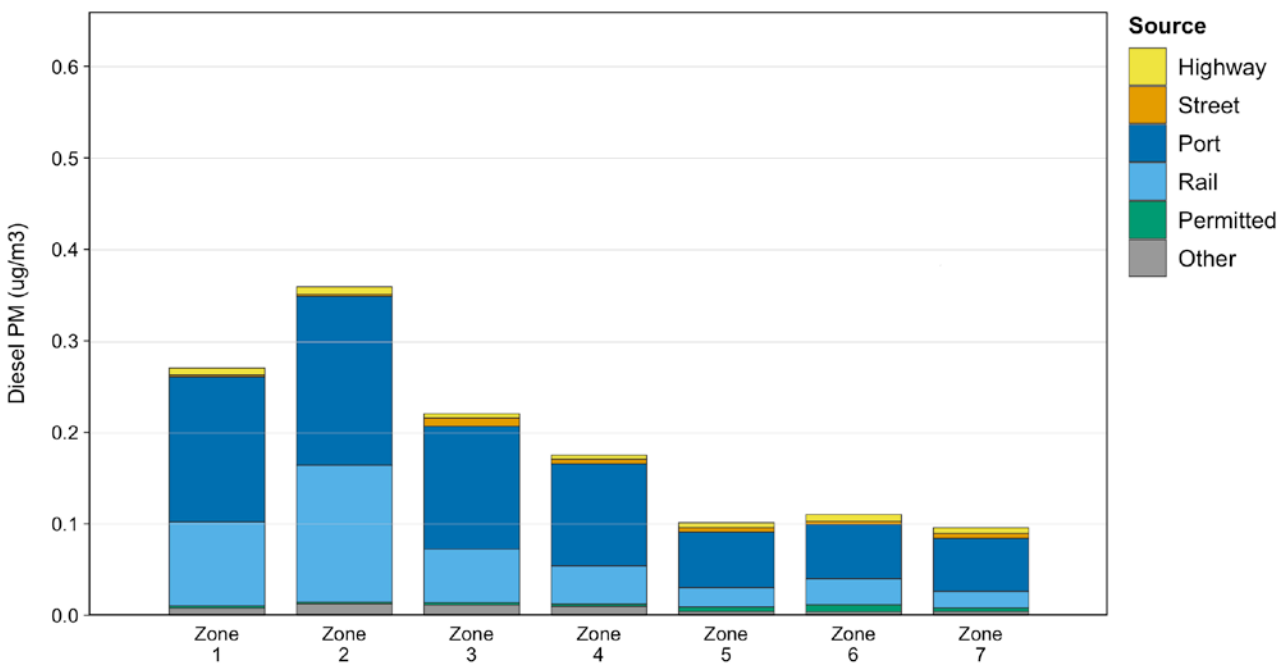

Figure 5-5. As in **Figure 5-4**, but for DPM (corresponding to pie charts in **Figure 5-2**).

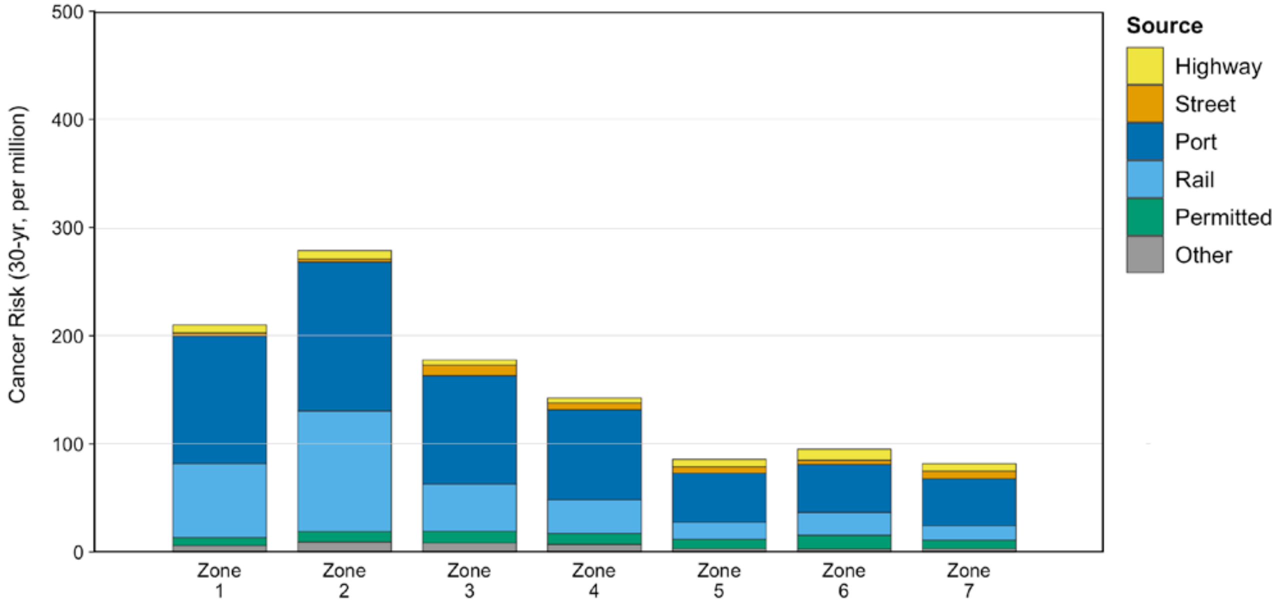

Figure 5-6. As in **Figure 5-4**, but for excess cancer risk (corresponding to pie charts in **Figure 5-3**).

6. Limitations, Uncertainties, and Future Improvements

A discussion of the limitations and uncertainties inherent in developing community-scale emissions inventories, air dispersion modeling, and risk estimation are presented in Part I Section 6. Many of these factors also apply to the future-year emissions inventories and analysis presented in this document. Here, the uncertainties related to forecasting emissions inventories are discussed. Some of the uncertainties in future-year emissions inventories related to the base year emissions inventory from which projections are made (see Part I Section 6), while others relate to predicting and understanding future trends in source-specific activity growth and emission control technologies. Such assumptions are inherent in efforts to characterize emissions and associated risk in complex settings and can result in or under- or over-predictions in concentration and risk estimates.

There are several sources of uncertainty associated with the methods used to forecast emissions that may affect the subsequent estimation of exposure concentrations and risk characterization in future years. Some of the sources of uncertainty relate to (in no particular order):

- **Emissions source configuration:** At present, the District is not aware of any specific future changes to emissions source configurations within West Oakland. Therefore, it was assumed that there would be no changes to the emissions sources in future years except for strength of emissions. This may be an over-simplification for some sources. Emissions sources may change in two ways:

    - **Physical characteristics:** This includes changes to abatement technologies installed at permitted stationary sources, stack parameters, the physical footprint of a facility or business, or the physical location (if a source moves within the Source Domain). These changes would lead to different dispersion characteristics and/or location of the emissions within the community, and therefore changes to downwind impacts.

    - **Emission profiles:** This includes changes to total operating hours of an emissions source, or changes to diurnal or seasonal profiles of the emissions. For example, total VMT was used to forecast activity of on-road mobile sources on each roadway segment, but there was no compensation for potential changes in fleet average travel speed, which could lead to different emission profile characteristics.

- **Vehicle Fleet Mix:** For future-year emissions inventories, the fleet mix, represented as the fraction of trucks by category of the total fleet volume, was kept constant (i.e., the same fleet mix that was developed for the base year emissions inventory). Fleet mix information can have significant uncertainties, and the proportion of different vehicle categories may change in the future. The fleet mix information for the base year emissions inventory was developed by the District based on field studies and vehicle telematics data platforms, rather than relying on EMFAC2017; for consistency, the District used this information for future years as well.

- **Specific emissions sources/regulations:**

  - **Regulation 11-18:** There may be additional emissions reductions that may occur due to the implementation of Regulation 11-18 that have not been quantified in the BAU emissions forecasts.

  - **Construction:** Emissions from construction equipment and construction dust were not included in the bottom-up emissions inventory; instead, the 2017 base year emissions were estimated and projected using data provided by CARB. Construction activities are highly transient, changing in scope and location from year to year. The emissions estimates, both for the base year and future years, are therefore highly uncertain. The District will continue to explore other sources of information for recent and projected construction activity in West Oakland.

  - **UP Railyard:** UP is in the process of developing a detailed, comprehensive emissions inventory for the Oakland railyard, which is expected to be completed by the end of 2019. UP expects to capture individual locomotive characteristics and movements to develop a bottom-up inventory of sources and emissions in the railyard. The District plans to use this detailed inventory in future UP emissions estimates that will address uncertainties in the spatial and temporal allocation of emissions, as well as the equipment types and quantities included. This information can then be used to improve forecasted emissions inventories.

  - **Commuter ferries:** Future-year emissions from commuter ferries were projected using only the GCFs developed from CARB's 2016 SIP dataset. These GCFs may not include specific information related to potential fleet turnover from the San Francisco Bay Area Water Emergency Transportation Authority (WETA) commuter ferry fleet that operates to and from West Oakland. WETA does currently list that some of the ferries in its fleet are scheduled to retire and/or be replaced by 2029,[19] which would lead to emissions reductions, but to the District's knowledge, none of these ferries service the routes to West Oakland. The forecasted emissions inventories also do not take into account any potential increase in service that may be implemented in future years.

- **New emissions sources:** Emissions from new emissions sources cannot be predicted or quantified, and are therefore not included in future-year emissions estimates. Emissions from new facilities (both from the construction of the facility and from subsequent operations) that are planned but that are not officially "on the books" were also not included (e.g., proposed Oakland A's stadium at Howard Terminal near Jack London Square, Oakland Bulk and Oversized Terminal).

[19] https://sanfranciscobayferry.com/sites/default/files/SFBFfleet.pdf (accessed December 2018).

- **Growth projections:** Growth projections are generally based on the best available estimates of activity trends for a specific source or related surrogate data (e.g., population). There may be several growth projections available for a specific source, which could be used to estimate the possible range of emissions in the future. The District has currently used a single set of growth projections specific to source category for the sources in the West Oakland emissions inventory, but may consider replacing or combining growth projections for certain sources in the future (e.g., for Port-related sources). This could help quantify uncertainties, and help to align growth projections for sources whose activities are closely coupled (e.g., Port Truck activity and Port-related activity projections). For example, the District may consider comparing the projected emissions estimates for Port-related sources presented in this document (which are namely based on data provided by CARB) compared to those that would be estimated by using growth projections developed by the San Francisco Bay Conservation and Development Commission (BCDC). BCDC's growth rates for the Port of Oakland may differ, especially for far-term future years; by evaluating each set of growth rates and resulting emissions, the District may be able to better assess changes in emissions and exposures that West Oakland will experience in the future. If alternative emissions projections are estimated, the District will continue to work with relevant partners and agencies (e.g., CARB) to ensure the most recent estimates of regulations and controls are incorporated.

- **Census population data:** Population-weighted air pollutant concentration and cancer risk results are dependent on the 2010 Census data. Changes in population distribution over time, as well as possible re-zoning of land, may change the location of where the majority of the population in the West Oakland community are exposed.

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Appendix A – Technical Support Document

Part III: Community Action Plan Emission Reduction Estimates

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Community Action Plan Emission Reduction Estimates

This is a companion document to *Appendix A – Technical Support Document Part I: Base Year Emissions Inventory and Air Pollutant Dispersion Modeling* ("Part I"), and *Appendix A – Technical Support Document Part II: Business-As-Usual Future Year Emissions Inventory and Air Pollutant Dispersion Modeling* ("Part II") for the West Oakland Community Action Plan ("Action Plan") pursuant to Assembly Bill (AB) 617, jointly prepared by the Bay Area Air Quality Management District (BAAQMD, "the District") and the West Oakland Environmental Indicators Project (WOEIP). Please refer to Part I for background information, emission source descriptions, and a detailed description of the base year (2017) emissions inventory, air dispersion modeling, and pollutant and cancer risk assessment, and to Part II for a detailed description of how emissions from each source category was forecasted to future years (2024, 2029).

These emission reduction estimates can be applied to the future-year (FY) business-as-usual (BAU) emission estimates to obtain future-year "with Plan" emissions inventories; that is, the emissions inventory expected as the strategies[1] of the Action Plan are implemented.

The following tables present the estimated emission reductions of $PM_{2.5}$, DPM, and cancer risk-weighted emissions.

[1] Only for those reductions that have been quantified.

Table 1. Strategies with quantified emission reduction estimates from the Action Plan. The data indicates the source of information used to estimate the emission reductions. See **Table 2** for further information of strategies for on-road mobile sources.

Source Category	Strategy	Data
Highway		
Non-Trucks	Heavy-Duty Inspection and Maintenance Program Advanced Clean Trucks	CARB
LHDT	Heavy-Duty Inspection and Maintenance Program Advanced Clean Trucks	CARB
MHDT/HHDT	Heavy-Duty Inspection and Maintenance Program Advanced Clean Trucks	CARB
Surface Streets		
Non-Trucks	Heavy-Duty Inspection and Maintenance Program Advanced Clean Trucks	CARB
LHDT	Heavy-Duty Inspection and Maintenance Program Advanced Clean Trucks	CARB
MHDT/HHDT	Heavy-Duty Inspection and Maintenance Program Advanced Clean Trucks	CARB
Road dust	Enhanced street sweeping program.	South Coast Air Quality Management District (1997)
Port		
OGV – berthing	CARB At-Berth Regulation	CARB
Assist Tugs	Upgrade three vessels to Tier 3 (repowers).	Ramboll
Port Trucks	Heavy-Duty Inspection and Maintenance Program Advanced Clean Trucks	CARB
Rail		
Railyard – UP	Implemented Action Plan Strategy 46; quantified assuming upgrades to five switcher engines (to Tier 4).	District
Permitted		
Schnitzer Steel – stationary	Accelerate implementation of Rule 11-18 (install a control device to reduce volatile organic emissions by at least 70% by the year 2024).	District
Other		
Schnitzer Steel – trucks	Heavy-Duty Inspection and Maintenance Program Advanced Clean Trucks	CARB
Truck-related businesses	Heavy-Duty Inspection and Maintenance Program Advanced Clean Trucks	CARB

Table 2. Strategies for on-road mobile sources leading to emission reductions as part of the Action Plan. Buses and motor coaches are part of the Non-Truck vehicle category. Truck 2 includes POAK and Non-POAK-Truck 2 vehicles[1] Only processes and pollutants that are impacted in this emissions inventory are listed.[2] Idling is for extended idling events only.

Program	Region	Authority	Vehicle	Pollutant	Process	Reference
Heavy-Duty Inspection and Maintenance Program	Statewide	CARB	Diesel Truck 2, diesel buses (except urban buses), motor coaches	DPM PM_{10} $PM_{2.5}$	running idling	https://ww2.arb.ca.gov/our-work/programs/heavy-duty-inspection-and-maintenance-program.
Advanced Clean Trucks	Statewide	CARB	Truck 1, Truck 2, buses (except urban buses)	DPM PM_{10} $PM_{2.5}$	running idling brake wear	https://ww2.arb.ca.gov/our-work/programs/advanced-clean-trucks.
Enhanced street sweeping program	West Oakland Community	City of Oakland	– (surface street only)	PM_{10} $PM_{2.5}$	road dust	Proposed Strategy #54 of the West Oakland Community Action Plan

[1] see Part I Table 2-6 for a definition of these vehicle types.

[2] CARB's regulations may apply to other emission processes and pollutants; implementation of these and other strategies may also deliver emissions reductions from other pollutants, such as oxides of nitrogen (NO_x) and greenhouse gases, but these benefits are not quantified in this Action Plan.

Table 3. Estimates of $PM_{2.5}$ emission reductions from strategies of the Action Plan. Emission reductions can also be expressed as negative changes in emissions. All changes are relative to BAU emissions of a given year. The percentage (%) represents the percentage of reductions for a given emissions source. Not all reduction estimates for each strategy have been quantified here.

Source Category	2024		2029	
	tpy	**%**	**tpy**	**%**
Highway				
Non-Trucks	0.01	0.1	0.01	0.1
LHDT	< 0.01	< 0.1	0.01	1.4
MHDT/HHDT	0.06	6.3	0.08	7.9
Surface Streets				
Non-Trucks	< 0.01	0.1	0.01	0.1
LHDT	< 0.01	< 0.1	< 0.01	1.3
MHDT/HHDT	0.03	3.8	0.04	5.1
Road dust	1.46	9.2	1.53	9.2
Port				
OGV – berthing	1.20	11.7	2.77	21.3
Assist Tugs	0.57	18.7	0.56	18.7
Port Trucks	0.02	2.9	0.02	2.8
Rail				
Railyard – UP	0.35	30.9	0.37	31.7
Other				
Schnitzer Steel – trucks	< 0.01	0.4	< 0.01	0.5
Truck-related businesses	0.01	37.3	0.01	42.6
Total	**3.71**	**4.3**	**5.40**	**5.7**

Table 4. As in **Table 3**, but for DPM emissions.

Source Category	**2024**		**2029**	
	tpy	**%**	**tpy**	**%**
Highway				
Non-Trucks	< 0.01	0.8	< 0.01	1.0
LHDT	< 0.01	< 0.1	< 0.01	1.0
MHDT/HHDT	0.06	37.3	0.07	42.7
Surface Streets				
Non-Trucks	< 0.01	0.8	< 0.01	1.0
LHDT	< 0.01	< 0.1	< 0.01	1.0
MHDT/HHDT	0.03	37.3	0.03	42.7
Port				
OGV – berthing	1.31	25.0	3.01	45.5
Assist Tugs	0.59	18.7	0.57	18.7
Port Trucks	0.02	17.1	0.02	17.4
Rail				
Railyard – UP	0.38	30.9	0.40	31.7
Other				
Schnitzer Steel – trucks	< 0.01	37.3	< 0.01	42.7
Truck-related businesses	0.01	37.3	0.01	42.6
Total	**2.40**	**11.4**	**4.12**	**17.4**

Table 5. As in **Table 3**, but for cancer risk-weighted TAC emissions.

Source Category	**2024**		**2029**	
	CRW tpy	**%**	**CTW tpy**	**%**
Highway				
Non-Trucks	0.45	0.3	0.35	0.3
LHDT	0.01	< 0.1	0.41	0.9
MHDT/HHDT	44.40	36.9	51.13	42.2
Surface Streets				
Non-Trucks	0.19	0.2	0.14	0.2
LHDT	0.01	< 0.1	0.43	0.9
MHDT/HHDT	21.82	36.1	24.54	41.3
Port				
OGV – berthing	975.14	25.0	2,241.17	45.5
Assist Tugs	440.94	18.7	426.56	18.7
Port Trucks	15.08	16.9	16.08	17.2
Rail				
Railyard – UP	280.75	30.9	300.11	31.7
Permitted				
Schnitzer Steel – stationary	550.53	61.1	642.04	61.1
Other				
Schnitzer Steel – trucks	0.10	37.3	0.11	42.7
Truck-related businesses	8.03	37.3	8.67	42.6
Total	**2,337.47**	**13.9**	**3,711.74**	**19.7**

References

South Coast Air Quality Management District. (1997). Revised Final Staff Report for: Proposed amended Rule 403 – Fugitive Dust and Proposed Rule 1186 – PM_{10} emissions from paved and unpaved roads, and livestock operations, Appendix F: Emissions reductions estimates. 14 February, 1997.

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Appendix B – Community Engagement Materials

Welcome Letter

BAY AREA AIR QUALITY MANAGEMENT DISTRICT

West Oakland Environmental Indicators Project

June 2018

Welcome and thank you for joining the West Oakland Community Action Plan Steering Committee!

On behalf of the West Oakland Environmental Indicators Project (WOEIP) and the Bay Area Air Quality Management District (Air District), we sincerely appreciate your commitment to help inform the policies and strategies to reduce air pollution in West Oakland. State Assembly Bill 617 (AB 617) provides a new community-focused approach to reduce exposure to criteria air pollutants and toxic air contaminants in communities most impacted by air pollution. As a recognized West Oakland stakeholder, your participation is essential to inform this community-based approach.

This orientation packet contains the following materials to orient steering committee members to the overall AB 617 process and to provide guidance as to what they can expect to accomplish and tackle:

- Orientation Meeting Agenda
- AB 617 Handout
- Steering Committee Partnership Agreement
- Draft Steering Committee Governing Charter (committee to adopt)
- Draft Timeline and Schedule

Background on AB617 and Community Air Plans

AB 617 is a State-mandated program that focuses resources through the regional Air District to help better understand, address, and mitigate local air pollution in the State's most disadvantaged communities. West Oakland—which includes the Port of Oakland, Oakland Army Base, East Bay Municipal Utility District's (EBMUD) waste treatment facility, surrounding freeways and various industrial facilities—has been selected as the first community in our Bay Area region to develop an air pollution action plan. The Action Plan can build upon many of the existing studies and community air monitoring efforts—many of which WOEIP has led—but will require a robust community stakeholder input process to gather input and formulate a collaborative plan of action. The key elements of the Action Plan will need to be completed by early 2019 in preparation for State adoption in October 2019.

Steering Committee Responsibilities

Steering committee meetings are planned every two-months for two-hour meetings (time and place to be determined). We ask steering committee members to commit to six meetings in addition to 2-4 community townhall meetings over the course of the year. Members who wish to be further involved may choose to participate in ad-hoc sub-committees or steering committee governance. For all formal meetings, childcare, food and interpretation can be made available. Stipends may be available for folks not paid for attendance as part of their job.

Steering committee members will be responsible for developing the proposed content of the community plan as well as disseminate information and transmit input from your representative sectors as appropriate. Prospective members need to be able and willing to review ongoing plans, studies, reports on air quality, and think critically and strategically to provide input. All educational levels and backgrounds are welcomed and any desired trainings on aspects of this planning process will be made available.

Thank you for your interests and your contributions to the health and vitality of the West Oakland community.

Sincerely,

____

Ms. Margaret Gordon

West Oakland Environmental Indicators Project

____

Brian Beveridge

____

David Ralston

Bay Area Air Quality Management District

____

Yvette DiCarlo

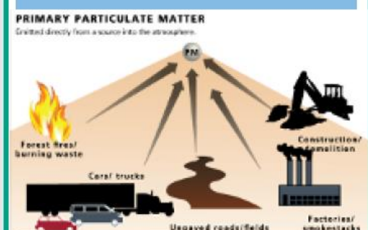
West Oakland Air Quality Action Plan Fact Sheet

HOW CAN OAKLAND RESIDENTS REDUCE EXPOSURE TO POOR AIR QUALITY?

PARTICULATE MATTER (PM):

Very small liquid and solid particles that float in the air. These particles, which come from cars and fireplaces, can penetrate into the lungs and bloodstream and **cause serious health problems.**

Particulates smaller than 2.5 microns (1/30 the width of human hair) are linked to respiratory diseases, heart attacks, and decreased lung function. Fine PM is projected to **increase throughout Oakland** and will be even greater in West Oakland.



LOCAL RESOURCES

California Air Resources Board (CARB)

Air Pollution Complaints

1-800-952-5588

Bay Area Air Quality Management District *Air Pollution Complaints*

1-800-334-ODOR (1-800-334-6367)

Daily Air Quality & Open Burn Forecasts
1-800-HELP AIR (1-800-435-7247)

West Oakland Environmental Indicators Project (WOEIP)

(510) 257-5640

WHO DO I CALL IN CASE OF AN EMERGENCY?

Alameda County Office of Emergency Services
925.803.7800

Alameda County Poison Control 1800.523.2222

American Red Cross 510.595.4400

City of Oakland Fire Dispatch 510.444.1616

City of Oakland Police Dispatch 510.777.3211

City of Oakland Office of Emergency Services
510.238.3938

EBMUD 510.835.3000

PG&E 1800.743.5000

National Response Center (Toxic Spills) 1800.424.8802

AB 617: AIR QUALITY MANAGEMENT

West Oakland's
Air Quality Action Plan

This fact sheet was made possible by the
West Oakland Environmental Indicators Project

Bay Area Air Quality Management District

Summary of Attendance at Steering Committee Meetings

	Meeting Date	Meeting Time	Meeting Location	Number of Participants[1]
Kick-off	Friday, July 27, 2018	10:00 AM - 1:00 PM	Oakland City Hall, Hearing Room 3 1 Frank H Ogawa Plaza, Oakland, CA 94612	Approximately 50
1	Wednesday, September 5, 2018	6:00 PM - 8:30 PM	Alameda County Department of Public Health, 5th Floor 1000 Broadway, Oakland, CA 94607	Approximately 50
2	Wednesday, October 3, 2018	6:00 PM - 8:30 PM	West Oakland Senior Center 1724 Adeline Street, Oakland, CA 94607	51
3	Wednesday, November 7, 2018	6:00 PM - 8:30 PM	West Oakland Senior Center 1724 Adeline Street, Oakland, CA 94607	55
4	Wednesday, December 5, 2018	6:00 PM - 8:30 PM	West Oakland Senior Center 1724 Adeline Street, Oakland, CA 94607	54
5	Wednesday, January 9, 2019	6:00 PM - 8:30 PM	West Oakland Senior Center 1724 Adeline Street, Oakland, CA 94607	54
6	Wednesday, February 6, 2019	6:00 PM - 8:30 PM	West Oakland Senior Center 1724 Adeline Street, Oakland, CA 94607	52
7	Wednesday, March 6, 2019	6:00 PM - 8:30 PM	West Oakland Senior Center 1724 Adeline Street, Oakland, CA 94607	66

[1] Participant counts include steering committee members, Air District and CARB staff, and members of the public.

	Meeting Date	Meeting Time	Meeting Location	Number of Participants[1]
8	Monday, March 11, 2019	6:00 PM - 9:00 PM	Alameda County Department of Public Health, 5th Floor 1000 Broadway, Oakland, CA 94607	47
9	Wednesday, April 3, 2019	6:00 PM - 8:30 PM	West Oakland Senior Center 1724 Adeline Street, Oakland, CA 94607	51
10	Wednesday, May 1, 2019	6:00 PM - 8:30 PM	West Oakland Senior Center 1724 Adeline Street, Oakland, CA 94607	58
11	Wednesday, June 5, 2019	6:00 PM - 8:30 PM	West Oakland Senior Center 1724 Adeline Street, Oakland, CA 94607	67
12	Wednesday, June 26, 2019	6:00 PM - 8:30 PM	Alameda County Department of Public Health, 5th Floor 1000 Broadway, Oakland, CA 94607	48
13	Wednesday, July 10, 2019	6:00 PM - 8:30 PM	West Oakland Senior Center 1724 Adeline Street, Oakland, CA 94607	48
14	Wednesday, August 7, 2019	6:00 PM - 8:30 PM	West Oakland Senior Center 1724 Adeline Street, Oakland, CA 94607	51
15	Saturday, August 17, 2019[2]	10 AM to 2 PM	West Oakland Youth Center 3233 Market Street, Oakland, CA	122

[2] Town Hall open house to introduce the Draft Plan to the community.

Steering Committee Members

West Oakland Community Action Plan Steering Committee Roster (as of June 27, 2019)			
Primary Name	**Alternate Name**	**Affiliation**	**Sector**
Steering Committee Members			
Aboudi, Bill		AB Trucking	Business
Arreola, Laura	Tharpe, Amy	Port of Oakland	Government
Bullock, JoAnna		Metropolitan Transportation Commission	Government
Chung, Bo		Dellums Institute for Social Justice	Environmental Advocates
Cook, Brigitte		Oakland City Council	Government
Foucre, Renata		West Oakland Neighbors	Neighborhood Association
Grow, Richard		U.S. Environmental Protection Agency	Government
Johnson, Barbara		West Oakland Neighbors	Neighborhood Association
Katz, Andy	Johannesson, Chandra Bonnarens, Maura	East Bay Municipal Utility District	Government
Lee, Anna	Kimi Watkins-Tartt Sandi Galvez Jennifer Lucky	Alameda County Public Health Department	Government
Lowe, Steve		West Oakland Commerce Association	Business
Mac Donald, Karin	Elder, Scott	Prescott Oakland Point Neighborhood Association	Neighborhood Association

McGowan, Patricia		City of Oakland	Government
Prier, Megan		Urban Biofilters	Environmental Advocates
Rodriguez, Mercedes S.		BayPorte Village Neighborhood Watch	Neighborhood Association
Scodel, Anna*	Davis, Monique*	California Air Resources Board	Government
Uennatornwaranggoon, Fern	Zayas, Gabriela Harris, Maria	Environmental Defense Fund	Environmental Advocates
Zambrano, Carlos		New Voices Are Rising	Youth
Co-Leads			
Ms. Margaret Gordon		West Oakland Environmental Indicators Project	Environmental Advocates
Brian Beveridge		West Oakland Environmental Indicators Project	Environmental Advocates
Elizabeth Yura		Bay Area Air Quality Management District	Government
Yvette DiCarlo		Bay Area Air Quality Management District	Government
Consultant Team			
Anuja Mendiratta		Philanthropic + Nonprofit Consulting	Consultant
Marybelle Nzegwu Tobias		Environmental Justice Solutions	Consultant
Mey F. Saechao		Project Management Consultant	Consultant

* CARB staff will participate on the committee with a non-voting observer status.

Appendix C – Steering Committee Charter and Participation Agreement

WEST OAKLAND COMMUNITY AIR ACTION PLAN
STEERING COMMITTEE CHARTER AND PARTICIPATION AGREEMENT

Amended August 29, 2018

1. **Mission Statement**

   Assembly Bill 617 (Garcia, C., Chapter 136, Statutes of 2017) is a State-mandated program that uses a community-based approach to reduce local air pollution in communities around the State that continue to experience disproportionate impacts from air pollution. West Oakland— which includes the Port of Oakland, Oakland Army Base, East Bay Municipal Utility District's (EBMUD) waste treatment facility, surrounding freeways and various industrial facilities—is the region's initial focus under the AB 617 program to develop an action plan to reduce air pollution and exposure in the West Oakland community.

   The steering committee will be responsible for advising the development of the community plan as well as disseminate information and transmit input from your representative sectors as appropriate. The key elements of the West Oakland Community Air Action Plan (Plan) will need to be completed by early 2019 in preparation for State adoption in October 2019.

2. **Committee Objectives**

   The West Oakland Community Air Action Plan Steering Committee is a special committee that will serve for the designated purpose outlined in the mission statement. Committee objectives include identifying the West Oakland community boundary, identifying areas of concern for air pollution sources and sensitive receptor sites, reviewing existing plans, studies and reports on air quality to provide strategic input towards Plan development. Committee objectives also include disseminating and soliciting information with community stakeholders for which the committee members represent. The goal is for the Plan to be adopted by the Bay Area Air Quality Management District Board by October 2019. Upon adoption of the Plan, the steering committee may elect to continue to meet quarterly to support and provide guidance on implementation, and develop progress reports.

3. Membership

Criteria for Community Steering Committee Membership

To ensure the Plan focuses on the impacts to people and businesses within the defined study area, steering committee membership is limited to residents or businesses with street addresses within the West Oakland study area. Additional members may include city/county officials, land use planning agencies, transportation agencies and local health departments. Interested stakeholders, and larger representation groups such as regional associations, are encouraged to participate as non-voting members at all open meetings.

The official roster will contain one primary name for each affiliation to be represented on the committee. One alternate name can substitute for the primary member if the primary member is unable to attend a meeting. However, only one member from each affiliation will be allowed to deliberate at meetings to reach consensus. The committee meetings are open to the public and additional members may be added to the roster if agreed upon by the West Oakland Environmental Indicators Project and the Bay Area Air Quality Management District who will serve as co-leads of the Steering Committee.

4. Roles and Responsibilities

Community Steering Committee Members

Steering committee members will be responsible for assisting Air District and WOEIP staff in identifying all air pollution issues and sources of air pollution in the West Oakland community and the development of the West Oakland Community Air Action Plan. Committee members may be asked to review local community plans, health impact studies, and air quality data to assist in developing the Plan. Committee members will help develop emission reduction goals or targets that will be used to evaluate the success of the Plan in reducing emissions and exposure.

Steering committee members are expected to attend a minimum of ten committee meetings (in their entirety) and to participate in 2-4 community townhall meetings throughout the course of the year prior to the Plan adoption.

Steering Committee members who participate in this process are expected to sign the West Oakland Air Action Plan Committee Participation Agreement (Page 5 of this Charter) which outlines the expected conduct of all Steering Committee members.

Co-leads

The West Oakland Environmental Indicators Projects and Bay Area Air Quality Management District serve as partnering co-leads for the development of the West Oakland Community Steering Committee. As co-leads, they will be responsible for providing necessary background materials for committee members, developing meeting agendas, coordination with the meeting facilitator and establishing and maintaining a community website for Steering Committee activities. Co-leads will also be responsible for providing technical support and other relevant technical assessment information to the Committee.

Facilitator

A professional and impartial facilitator will be used for moderating the steering committee meetings and for helping the committee reach consensus on issues.

5. Standard Committee Meeting Procedures

Deliberation and Consensus

A professional and impartial facilitator(s) will be employed to support the steering committee in the overall organization, order and focus of the meeting, resolve conflicts and help reach consensus to ensure the goals and objectives of this charter are met. Achieving full consensus of the steering committee may not always be possible. In the event of an impasse, the co-leads shall be the final decision-makers, carefully weighing the consequences of any decision where there is a lack of consensus. If the co-leads cannot agree, then the action in question will not proceed. Community Steering Committee members who do not agree with a majority consensus on a decision may submit a minority position statement.

Member Participation

Only one member from each affiliation may participate as part of the steering committee deliberative process in any individual meeting. If the primary member is unable to attend, the designated alternate on the steering committee roster may attend in their absence and deliberate on the primary member's behalf.

If a primary member or their alternate is not able to attend a scheduled meeting, they may submit written comments for consideration on relevant agenda topics to the Committee chair or the co-leads prior to the scheduled meeting. Written communications may inform, but not substitute, for being physically present during deliberations of the committee. If a primary member or their alternate has not attended three consecutive steering committee meetings, their membership may be revoked as determined by the co-leads.

Open Meetings

All meetings are open to the general public and will provide a formal opportunity for members of the public to provide their perspective on the development of the Plan. Stakeholder input is welcome and encouraged.

Meeting Schedule and Agendas

Steering committee members are expected to attend monthly meetings. Upon consensus agreement of the committee, meeting schedules may be adjusted with adequate advance notice. Agenda topics will be developed by the co-leads and will include the time, date, duration, location and topics to be discussed. Individual committee members may request relevant items be added to an agenda at least one week prior to the schedule meeting.

Subcommittees

Members who wish to be further involved may choose to participate in ad-hoc sub-committees such as technical assessment, community surveys and outreach or other relevant topics. Subcommittees would meet every other month between full steering committee meetings and will report back their findings and/or recommendations at the next full steering committee.

6. Accessibility/Accommodation

The steering committee meetings and other outreach events associated with the committee must be held at facilities that can accommodate members covered by the Americans with Disabilities Act. Language interpretation services will be provided as needed with a minimum 48-hour advance request.

7. Dissemination of Materials

Any materials, presentations, documents, correspondence or other written communications generated or disseminated by the committee, or on behalf of the committee or its members, must be approved by the co-leads prior to release. All final correspondence will include the logos of West Oakland Environmental Indicators Project and Bay Area Air Quality Management District.

8. Website

A website will be developed and maintained by the co-leads to provide information to the community on the Steering Committee actions and development of the Plan.

Participation Agreement

By signing below, I agree to abide by all conditions of the West Oakland Community Air Action Plan Steering Committee Charter. I also agree to the following principles, goals and expected conduct to demonstrate how agencies, communities and other stakeholders working in concert can achieve meaningful improvements in public health for the West Oakland community:

- Adopt and support the principles of ensuring healthy air in West Oakland:
    - Our goal is to remedy persistent air pollution problems and excessive local health risk exposures to people who live, work and play in and around West Oakland. We are committed to working collectively and cooperatively with all stakeholders within the community—local residents, businesses and organizations, youth groups, schools, local, regional and State governments, health agencies and faith-based organizations—to ensure all represented parties are heard and can agree on an outcome that protects public health.
- Provide strategic guidance, vision, and oversight including:
    - Informing the development of the West Oakland Community Air Action Plan
    - Using data to inform strategy development analysis
    - Tracking progress of the work using agreed-upon indicators at Steering Committee and subcommittee levels
    - Identifying fair, effective and feasible goals to bring about reduced health risk in West Oakland.
- Provide leadership and accountability by:
    - Identifying obstacles to achieving the goal and develop solutions to overcome them. Considering how my own organization or those in my network can align to the common goals and principles of the Steering Committee
    - Serving as a vocal champion of the collective impact effort in the community
    - To work towards consensus while recognizing that not everyone will agree on every issue and to resolve conflicts in a positive, swift and constructive manner.
- Play an active role by:
    - Participating in-person at the regularly scheduled meetings
    - Reviewing pre-read materials prior to meetings and coming prepared for engaged discussion, active listening, and respectful dialogue
    - Committing to monthly Steering Committee meetings and a few hours of preparation in between. Attending occasional community town hall meetings to share the work of the Steering Committee.

Printed Name: ____ Date: ____________________________

Signature: ____

Appendix D – Strategies and Implementation Background

GOVERNMENT COLLABORATION

This Plan requires collaboration among government agencies. This section of Appendix D describes agencies and their recent planning activities. As noted in Chapter 1, the Steering Committee reviewed past and ongoing planning efforts while creating this Plan, and the Plan builds on these existing efforts. Past plans seek to bring jobs, retail, and services to the community; to address blighted properties and incompatible land uses; to improve transit, bike, and pedestrian access; to increase mixed-use development; to preserve the existing housing stock; to increase the supply of affordable housing; and to reduce the community's exposure to diesel PM and other air pollutants.

Air District

The Air District is the regional agency responsible for assuring clean air in the nine counties that surround the San Francisco Bay (except in northeastern Solano and northern Sonoma counties). The Air District writes and implements air quality plans, adopts and enforces regulations to control air pollution from stationary sources, offers incentives to government, businesses, and individuals to voluntarily reduce air pollution, engages with communities and provides technical and policy guidance regarding air quality, and manages the Spare the Air program.

The Air District's current air quality management plan is the 2017 Clean Air Plan: Spare the Air, Cool the Climate. The Plan provides a regional strategy to protect public health and protect the climate. To protect public health, the plan describes how the Air District will continue our progress toward attaining all state and federal air quality standards and eliminating health risk disparities from exposure to air pollution among Bay Area communities. To protect the climate, the plan defines a vision for transitioning the region to a post-carbon economy needed to achieve ambitious greenhouse gas (GHG) reduction targets for 2030 and 2050, and provides a regional climate protection strategy that will put the Bay Area on a pathway to achieve those GHG reduction targets.

The 2017 Plan includes a wide range of control measures designed to decrease emissions of the air pollutants that are most harmful to Bay Area residents, such as particulate matter, ozone, and toxic air contaminants; to reduce emissions of methane and other "super-GHGs" that are potent climate pollutants in the near-term; and to decrease emissions of carbon dioxide by reducing fossil fuel combustion.

City of Oakland

The City of Oakland is the local agency responsible for land-use and transportation decisions. The City Council makes land-use decisions by adopting general and specific plans, zoning regulations, and certifying environmental reports for land-use projects, such as housing, commercial, and industrial developments. The West Oakland Specific Plan is an example of a land-use plan that the City has adopted. The West Oakland Truck Management Plan is an example of a measure required by an environmental report on a land-use development project and an example of City transportation authority. For the Plan, the City of Oakland will implement strategies that address air pollution impacts from land use and transportation.

The City and Port of Oakland approved the West Oakland Truck Management Plan in April 2019. The goal of the Plan is to reduce the effects of transport trucks on local streets in West Oakland. The Plan reflects extensive outreach and input from the West Oakland residential and business community. In the Plan, the City and Port commit to ten strategies. The strategies commit to improving safety at street intersections near the Port; updating truck routes, truck prohibited streets, truck parking regulations and signage; conducting targeted traffic enforcement spot-checks and parking enforcement; improved training for issuing parking tickets; and considering increasing truck parking fines.

The West Oakland Specific Plan (2014) seeks to build on the existing vitality, cultural and social diversity, industry and transportation assets in West Oakland, while creating a community with clean industries, living-wage jobs, successful small businesses, mixed-use transit-oriented development and mixed-income housing, where environmental quality and community health are improved. Developed in partnership by the City, affected property owners, and adjacent business and residential communities, the Plan is a tool for developing commercial and industrial enterprises in West Oakland.

Metropolitan Transportation Commission (MTC)

The Metropolitan Transportation Commission (MTC) is the regional agency responsible for transportation planning, financing, and coordinating for the nine-county San Francisco Bay Area. The San Francisco Bay Area Goods Movement Plan and MTC Resolution No. 4244: Goods Movement Investment Strategy are examples of MTC's effort to plan, finance, and coordinate transportation in the Bay Area. For the Plan, MTC will help implement Strategies that address air pollution from mobile sources such as heavy-duty trucks and light-duty vehicles that travel through West Oakland and on the surrounding roadways and freeways, and air pollution from Port and Port tenant goods movement activities, for example through electric vehicle charging infrastructure, and improved bicycling and pedestrian infrastructure.

In 2016, MTC adopted the San Francisco Bay Area Goods Movement Plan. In 2018, the Commission passed MTC Resolution No. 4244: Goods Movement Investment Strategy. The Strategy addresses the Plan's freight movement impacts in communities like West Oakland. By adopting the Strategy, MTC made a commitment to work with the Air District, the Alameda County Transportation Commission, the Port of Oakland, and public health and environmental groups to reduce the impacts of pollution on communities from freight activities. The Strategy includes a list of potential projects to protect communities from air pollution.

The Strategy will direct \$3.8 billion over 10 years to 20 different projects in the Bay Area, with a strong focus on Interstate Corridors and the Port of Oakland in Alameda County. Approximately \$1.2 billion of this investment will be directed to Rail Strategy projects and \$350 million will be directed to Community Protection projects which will reduce emissions from equipment, facilities, and vehicles in communities that are heavily impacted by goods movement activities such as West Oakland. Over 50% of the funds will come from state and regional sources while the remaining funds will come from federal, local, and other sources. In the near term, it is probable that financial support for the Community Protection projects will come from SB 1 – Trade Corridors funds and will come from future bridge toll increases in later years (Regional Measure 3).

Port of Oakland

The Port of Oakland is the local agency responsible for managing the Oakland Seaport, Oakland International Airport, and Jack London Square. Under the Charter of the City of Oakland (the "Charter"), the Board of Port Commissioners (the "Port Board") is the legislative body of the City having complete and exclusive power and duty to control the Port Area, as defined in the Charter, and has the power and duty to adopt and enforce general rules and regulation necessary for port purposes and harbor development and in carrying out the powers of the Port. To carry out its powers and duties, the Port Board has the "complete and exclusive powers" with respect to the Port Area, including, among other things, the power to sue and defend; to take charge of and control all waterfront properties, including certain tidelands in the Port Area granted to the City in trust by the State of California; to acquire and hold property rights, leases, easements and personal property; to enter into contracts; and to exercise the right of eminent domain. The Port Area includes all the waterfront properties and lands adjacent thereto, including trust lands granted to the City by the State of California. The Port is not a typical public agency. As an enterprise department of the City of Oakland, the Port of Oakland does not collect tax revenues for itself, but instead must generate revenue to be self-supporting.

In 2009, the Port of Oakland adopted the Maritime Air Quality Improvement Plan (MAQIP) to guide their response to community concerns over existing exposure to pollution and proposed development at the Port, rule-making by CARB to control emissions from marine vessels, drayage trucks and other port-based engines, and the publication of a health risk assessment of the West Oakland area by CARB and Air District showing very high cancer risk levels due to exposure to diesel PM.

The MAQIP committed the Port and its tenants to an 85% reduction in diesel PM emissions by 2020. In 2018, the Port reconvened the Task Force to update the MAQIP and to identify issues for seaport air quality planning beyond the Year 2020.[3] This work resulted in the adoption of the Seaport Air Quality 2020 and Beyond Plan in 2019.

The Seaport Air Quality 2020 and Beyond Plan is an example of the Port's effort to manage operations and air pollution from the Port. The Port of Oakland's Board directed Port staff to submit an Agenda Report to the Board by June 1, 2020, on Port-related strategies and/or

[3] Port of Oakland, "Project Statement: Maritime Air Quality Improvement Plan: 2018 Update and Planning for '2020 and Beyond'," February 21, 2018

implementing actions that are legally required or that, in the Port's judgment, may meet the 2020 and Beyond Plan feasibility criteria (Table D-2), as a result of the final West Oakland Community Air Action Plan prepared pursuant to AB 617 and any potential related updates to the 2020 and Beyond Plan For the Plan, the Port will implement strategies that address air pollution from Port and Port tenant activities, such as the movement of inbound and outbound freight on cargo equipment, port trucks, locomotives, and ocean-going ships and harbor craft in the San Francisco Bay. The goals of the Plan are to keep the Port competitive, financially sustainable, and a source of jobs and economic development; minimize air pollution from Port activities; build partnerships among Port, tenants, government agencies, community organizers, and other stakeholders; and provide meaningful stakeholder engagement. The Plan commits to deploying certain levels of zero-emission trucks, cargo handling equipment, and other equipment by certain deadlines. In response to advocacy by community members, the Air District and others, the Port Commissioners adopted the 2020 and Beyond Plan in 2019 with the condition that the Port would review and incorporate applicable measures from this Community Action Plan.

Alameda County Public Health Department

The Alameda County Public Health Department is the county department responsible for providing public health services. The Health Department delivers services such as access to quality medical care services, disease prevention education and control, community education and outreach, and health policy development. The Healthy Development Guidelines is an example of the policy work that the Public Health Department delivers. For the Plan, the Public Health Department will implement strategies such as those that help the community access health services and educate the community about health risks, treatment, and prevention.

The Healthy Development Guidelines (2018), developed in collaboration with the City of Oakland and East Oakland Building Healthy Communities, is a reference tool of current and potential policies in the City of Oakland. The policies address a broad range of health and equity-related issues, including preventing human exposure to air pollution.

California Air Resources Board (CARB)

CARB is the state agency responsible for controlling emissions from mobile sources and consumer products (except where federal law preempts CARB's authority), controlling toxic emissions from mobile and stationary sources, controlling greenhouse gases from mobile and stationary sources, developing fuel specifications, and coordinating State-level air quality planning strategies with other agencies. CARB is also responsible for establishing the state's air quality standards to protect human health.

AB 617 directs CARB to work with local air districts in California to address the disproportionate air quality and health challenges in communities like West Oakland. For the Plan, CARB will adopt and enforce regulations for mobile sources such as heavy-duty trucks and light-duty vehicles that travel through West Oakland and on the surrounding roadways and freeways, and sources at the Port of Oakland, such as cargo equipment, port trucks, locomotives, and ocean-going ships and harbor craft in the San Francisco Bay.

CARB staff develop, and the CARB board considers and adopts, regulatory programs designed to reduce emissions to protect public health, achieve air quality standards, reduce greenhouse gas emissions, and reduce exposure to toxic air contaminants. CARB establishes regulatory requirements for cleaner technologies (both zero and near-zero emissions) and their deployment into the fleet, for cleaner fuels, and to ensure in-use performance. CARB's regulatory programs are broad, impacting mobile sources and multiple points within product supply chains from manufacturers to distributors, retailers, and end-users. CARB's regulations affect cars, trucks, ships, off-road equipment, consumer products, fuels, and stationary sources.

One of CARB's important and relevant regulatory authorities is to adopt measures to reduce emissions of toxic air contaminants from mobile sources, known as Airborne Toxic Control Measures (ATCM).[4] These regulatory measures include emissions limits, process requirements, and/or specify low emission technology. Much of the progress to-date in improving air quality in West Oakland is due to compliance with CARB's existing diesel PM ATCMs and new engine standards. CARB is proposing a suite of amendments to existing ATCMs and adoption of new programs to further reduce emissions of diesel PM. CARB's schedule for their programs dealing with many of the main sources of diesel PM emissions in West Oakland is shown in Figure D-1.

[4] California Health and Safety Code § 39650 et seq.

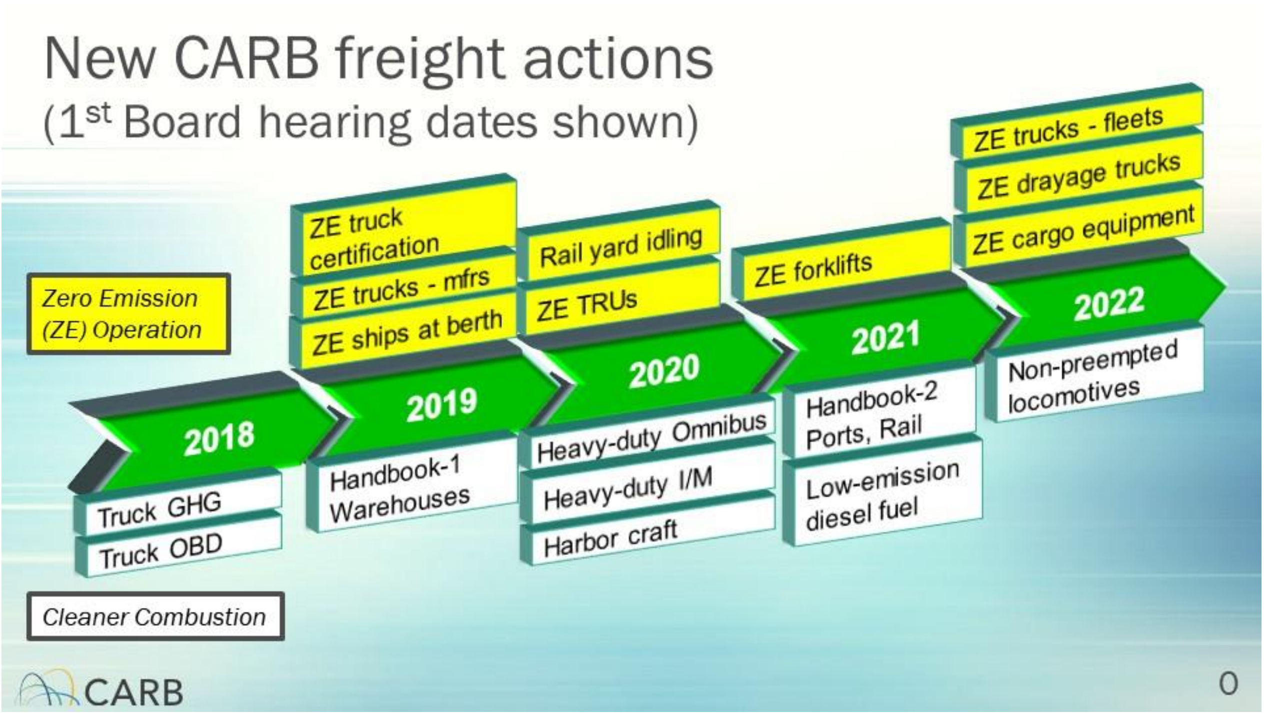


Figure D-1. CARB Freight Actions Benefiting West Oakland. Presented to the BAAQMD Board of Directors on May 1, 2019.

Additionally, CARB has pursued agreements with industry that result in voluntary adoption of the cleanest technologies or practices and provide assurance that emissions reductions will be realized. CARB's agreement with the Union Pacific Railroad Company and BNSF Railway Company to accelerate introduction of cleaner locomotives in the South Coast Air Basin is an example of such a voluntary agreement.

Most of the CARB Strategies included in the Plan will require CARB to consider and to adopt new or amended regulations. Prior to starting formal regulatory proceeding, CARB staff will be undertaking studies of some of these Strategies. For instance, given the community concerns with truck idling, CARB will work with the West Oakland community and the Steering Committee to collect data to better understand idling activity. CARB, with technical assistance from the Air District, will integrate the community-level activity data with updated emissions data to evaluate whether the current idling regulations provide adequate health protection. As shown in Figure D-1 above, CARB will consider regulations requiring zero-emission drayage trucks and cargo-handling equipment in 2022. It is unclear at this time if the regulations will begin requiring phase-in of the zero-emission equipment and trucks prior to 2025.

Alameda County Transportation Commission

The Alameda County Transportation Commission is the county agency responsible for managing the county's one-cent transportation sales tax funds and funding transportation projects and programs. The Alameda CTC is responsible for delivering the County's bicycle, pedestrian, highway improvements, road, and transit projects. For the Plan, the Alameda CTC will implement transportation-related Plan Strategies, including those that advocate for improved bicycling and pedestrian infrastructure in West Oakland.

California Department of Transportation (Caltrans)

The California Department of Transportation (Caltrans) is the state agency responsible for maintaining and improving state highways and transportation projects. For the Plan, Caltrans will implement Plan Strategies such as studies to determine the feasibility of vegetative biofilters between the Prescott neighborhood and Interstate 880 and work with WOEIP and the Air District to address air quality issues from truck parking leases on Caltrans right-of-way.

INCENTIVE FUNDING

Listed below are brief descriptions of current ongoing funding opportunities. Figure D-2 presents a matrix of air quality incentive funding programs and the types of projects the program will fund. Table D-1 presents a sample of emissions reduction projects that will reduce emissions in West Oakland. The Air District is funding these projects through existing incentive programs.

Air District administered incentive programs

Carl Moyer Program - The Bay Area Air Quality Management District (Air District) has participated in the Carl Moyer Program (CMP), in cooperation with the CARB, since the program began in fiscal year 1998-1999. The CMP provides grants to public and private entities to reduce emissions of oxides of nitrogen (NOx), reactive organic gases (ROG) and particulate matter (PM) from existing heavy-duty engines by either replacing or retrofitting them. Eligible heavy-duty diesel engine applications include on-road trucks and buses, off-road equipment, marine vessels, locomotives, and stationary agricultural pump engines.
www.baaqmd.gov/moyer

Assembly Bill 923 (AB 923 - Firebaugh), enacted in 2004 (codified as Health and Safety Code (HSC) Section 44225), authorized local air districts to increase their motor vehicle registration surcharge up to an additional $2 per vehicle. The revenues from the additional $2 surcharge are deposited in the Air District's Mobile Source Incentive Fund (MSIF). AB 923 stipulates that air districts may use the revenues generated by the additional $2 surcharge for projects eligible under the CMP.

Community Health Protection Grant Program - In 2017, Assembly Bill (AB) 617 directed CARB, in conjunction with local air districts to establish the Community Air Protection Program. AB 617 provides a new community-focused action framework to improve air quality and reduce exposure to criteria air pollutants and toxic air contaminants in communities most impacted by air pollution. In advance of the development of the Community Air Protection Program, the Governor and legislature established an early action component to AB 617 to use existing incentive programs to get immediate emission reductions in the communities most affected by air pollution. AB 134 appropriated $250 million from the Greenhouse Gas Reduction Fund

(GGRF) to reduce mobile source emissions including criteria pollutants, toxic air contaminants, and greenhouse gases in those communities. The Bay Area has been allocated $50 million of these funds for emission reduction projects. These funds will be used to implement projects under the CMP, and optionally on-road truck replacements under the Proposition 1B Goods Movement Emission Reduction Program.

In 2018, Senate Bill (SB) 856 appropriated an additional $245 million in incentives to reduce emissions from both mobile and stationary sources. The Air District will receive about $40 million of these funds for Bay Area projects. Mobile sources will follow the Carl Moyer Program and Proposition 1B Goods Movement Emission Reduction Program guidelines like Program Year 1. Funding will also be available for stationary source projects as defined by CARB Community Air Protection Grant Program guidelines and other programs/projects consistent with the actions identified in the applicable AB 617 community emission reduction program.
www.baaqmd.gov/ab617grants

Transportation Fund for Clean Air - In 1991, the California State Legislature authorized the Air District to impose a $4 surcharge on motor vehicles registered within the nine-county Bay Area to fund projects that reduce on-road motor vehicle emissions within the Air District's jurisdiction. The statutory authority for the Transportation Fund for Clean Air (TFCA) and requirements of the program are set forth in the HSC Sections 44241 and 44242. Sixty percent of TFCA funds are awarded by the Air District to eligible projects and programs implemented directly by the Air District (e.g., Spare the Air, electric vehicle charging station program) and to a program referred to as the TFCA Regional Fund. Each year, the Board allocates funding and adopts policies and evaluation criteria that govern the expenditure of TFCA funding. The primary Air District administered incentive programs include:

- Trip reduction projects - www.baaqmd.gov/PTR
- Public electric vehicle charging stations - www.baaqmd.gov/charge
- Light & Medium Duty zero-emission vehicles - www.baaqmd.gov/cleanfleets
- Electronic bicycle lockers – www.baaqmd.gov/funding-and-incentives/public-agencies/bike-racks-and-lockers
- Bikeways, roads, lanes, paths – www.baaqmd.gov/bikeways

VW Environmental Mitigation Trust - CARB has been designated as Lead Agency to act on the State's behalf in implementing California's allocation of the VW Environmental Mitigation Trust (VW Trust). On May 25, 2018, the ARB approved the Beneficiary Mitigation Plan (Plan) which, through the VW Trust, will provide about $423 million for projects in California to mitigate the excess nitrogen oxide (NOx) emissions caused by VW's use of illegal defeat devices in certain diesel vehicles. The VW Trust funding will provide funding opportunities for settlement specified eligible actions that are focused mostly on "scrap and replace" projects for the heavy-duty sector, including on-road freight trucks, transit and shuttle buses, school buses, forklifts and port cargo-handling equipment, commercial marine vessels, and freight switcher locomotives. CARB staff estimates the Plan's funding actions in aggregate will reduce about 10,000 tons of NOx statewide over a 10-year period. https://ww2.arb.ca.gov/our-work/programs/volkswagen-environmental-mitigation-trust-california

Climate Tech Finance - The Air District's Climate Tech Finance program offers subsidized financing and technical guidance to spur the adoption of emerging technologies that reduce greenhouse gas emissions. The Air District also provides engineering evaluation and technical assistance to borrowers to evaluate proposed projects. This program is being offered through a partnership with the California Infrastructure and Economic Development Bank (IBank). www.baaqmd.gov/ctf

Other incentive programs

U.S. EPA Diesel Emission Reduction Act - The United States Environmental Protection Agency (U.S. EPA) Clean Diesel Program provides support for projects that protect human health and improve air quality by reducing harmful emissions from diesel engines. This program includes grants and rebates funded under the Diesel Emissions Reduction Act (DERA). Funding is typically available annually on a competitive basis. The Air District has successfully implemented several DERA grants over the past decade. https://www.epa.gov/cleandiesel/clean-diesel-national-grants

CARB Low Carbon Transportation Program - The Low Carbon Transportation Program is part of California Climate Investments, a statewide program that puts billions of Cap-and-Trade dollars to work reducing GHG emissions, strengthening the economy, and improving public health and the environment—particularly in disadvantaged communities. CARB's Low Carbon Transportation Program is designed to accelerate the transition to advanced technology low carbon freight and passenger transportation with a priority on providing health and economic benefits to California's most disadvantaged communities. These investments support the state's climate change, air quality, ZEV deployment, and petroleum reduction goals. https://www.arb.ca.gov/msprog/aqip/fundplan/fundplan.htm

CARB Clean Vehicle Rebate Project - The Clean Vehicle Rebate Project (CVRP) promotes clean vehicle adoption in California by offering rebates of up to $7,000 for the purchase or lease of new, eligible zero-emission vehicles, including electric, plug-in hybrid electric and fuel cell vehicles. The Center for Sustainable Energy (CSE) administers CVRP throughout the state for CARB. https://cleanvehiclerebate.org/eng

CARB Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project (HVIP) - The Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project (HVIP) and Low NOx Engine Incentives was formed by CARB as a result of the Air Quality Improvement Program (AQIP) following the passing of the California Alternative and Renewable Fuel, Vehicle Technology, Clean Air, and Carbon Reduction Act of 2007 (AB 118, Statutes of 2007, Chapter 750). AQIP offers funding for projects and initiatives focused on supporting the development and deployment of the advanced technologies needed to meet California's longer-term, post-2020 air quality goals. The fuel efficiency and zero- to low-emission benefits of zero-emission, hybrid, and natural gas vehicle technologies provide a strong public health benefit by reducing harmful greenhouse gas (GHG) and criteria emissions. https://www.californiahvip.org/

Incentive Programs ↓ / Equipment / Project Type →	Heavy-duty vehicles (trucks, buses, school buses, shuttles)	Light-duty/ passenger vehicles	Trip reduction program	Transportation programs/ projects	Marine vessels	Locomotives	Agriculture equipment	Industrial/ Port/ Cargo handling equipment	Construction equipment	Portable engines	Supporting Infrastructure (charging/fueling)	Bikeways, raods, lanes, paths, lockers	Stationary sources	Fireplaces and wood stoves
Carl Moyer Program (CMP)	•				•	•	•	•	•	•	•			
Community Health Protection Grant Program	•				•	•	•	•	•	•	•		•	
Transportation Fund for Clean Air	•	•	•	•							•	•		
Volkswagen (VW) Settlement Funds	•				•	•		•	•		•			
Clean cars for all		•												
Vehicle buyback program (VBB)		•												
FARMER Program	•						•							
Woodsmoke rebate program														•
Climate Tech Finance													•	
CARB Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project (HVIP)	•													
CARB Clean Vehicle Rebate Project (CVRP)		•												
CARB Low Carbon Transportation Program	•				•	•	•	•	•		•			
CA Energy Commission (CEC) funding opportunities	•										•			
CA State Transportation Agency	•					•					•			
U.S. Environmental Protection Agency's (EPA) Diesel Emissions Reduction Act (DERA) Program	•				•	•	•	•	•		•			
Federal Highway Administration's (FHWA) Congestion Mitigation and Air Quality Program (CMAQ)			•									•		
Federal Transit Authority (FTA)	•													
Pacific Gas & Electric (PG&E) Funds											•			

Air District administered funding sources	• (green)
Non-Air District funding sources	• (orange)

Figure D-2. Incentive Programs

Table D-1: A sample of upcoming emissions reduction projects

Project	**Grantee Name**	**Incentive Funds Awarded**	**Grantee Contribution**	**Total Project Cost**	**PM2.5 Emissions Reduced (tpy)**
One switcher locomotive	Oakland Global Rail Enterprise	$1,080,500	$1,139,500	$2,220,000	0.040
Two main engines in a tugboat (Sandra Hugh)	Amnav Maritime Corporation	$743,000	$743,656	$ 1,486,656	1.130
Two main engines in a tugboat (Revolution)	Amnav Maritime Corporation	$743,000	$743,656	$ 1,486,656	1.130
Two auxiliary engines in a tugboat (Sandra Hugh)	Amnav Maritime Corporation	$134,000	$16,068	$150,068	0.019
Two auxiliary engines in a tugboat (Revolution)	Amnav Maritime Corporation	$134,000	$16,068	$150,068	0.019
13 hybrid cranes	SSA Terminals	$5,011,500	$885,183	$ 5,896,683	0.166
On-road	Alameda-Contra Costa Transit District	$1,011,000	$5,464,000	$ 6,475,000	0.002
Two main and two auxiliary engines in a tugboat (Z-3)	Harley Marine Services, Inc. Vessel: Z-Three	$1,613,500	$186,943	$1,800,443	0.364
Two main and two auxiliary engines in a tugboat (Z-5)	Harley Marine Services, Inc. Vessel Z-Four	$1,613,500	$186,943	$1,800,443	0.364
Two main and two auxiliary engines in a tugboat	Harley Marine Services, Inc. Vessel Z-Five	$1,613,500	$186,943	$1,800,443	0.364
Totals		**$13,697,500**	**$9,568,960**	**$23,266,460**	**3.598**

Appendix E – Enforcement Support Document

LIST OF PERMITTED FACILITIES IN WEST OAKLAND

Name	Address	City	Zip Code	Permit Type	Source Type
AAA San Pablo Fuel Inc.	3420 San Pablo Avenue	Oakland	94608	Air District	Gas Station
Acorn Restoration	2914 Poplar Street	Oakland	94608	Air District	Paint Operation
Alameda County Public Works Agency	3455 Ettie Street	Oakland	94608	Air District	Emergency Generator
Amber Flooring Inc	3441 Louise Street	Oakland	94608	Air District	Paint Operation
Amtrak	120 Magnolia Street	Oakland	94607	Air District	Emergency Generator
Aramark Uniform Services	330 Chestnut Street	Oakland	94607	Air District	Boiler
Bart Gas & Food	1395 7th Street	Oakland	94607	Air District	Gas Station
Berkeley Millwork & Furniture Co	2279 Poplar Street	Oakland	94607	Air District	Paint Operation
Berkeley Repertory Theatre	2526 Wood Street	Oakland	94607	Air District	Paint Operation
BNSF Intermodal	333 Maritime Street	Oakland	94607	Air District	Gas Station
BNSF Railway Co	333 Maritime Street	Oakland	94607	Air District	Emergency Generator
Bolero Co	2905 Union Street	Oakland	94608	Air District	Auto Body
California Cereal Products Inc	1267 14th Street	Oakland	94607	Air District	Food Processing
California Finest Body & Frame	1415 18th Street	Oakland	94607	Air District	Auto Body
California Hotel	3501 San Pablo Avenue	Oakland	94608	Air District	Emergency Generator
California Waste Solutions - Wood Street	3300 Wood Street	Oakland	94607	Air District	Recycling Plant
California Waste Solutions- 10St Street	1820 10th Street	Oakland	94607	Air District	Recycling Plant
Caltrans	200 Burma Road	Oakland	94607	Air District	Emergency Generator
Caltrans - East Bay Yard	Burma Road	Oakland	94608	Air District	Gas Station
CalTrans SFOBB Maintenance Complex	200 Burma Road	Oakland	94607	Air District	Gas Station
CASS Inc	2730 Peralta Street	Oakland	94607	Air District	Metal Facility
Cathedral Gardens Oakland	638 21st Street	Oakland	94612	Air District	Emergency Generator
Central Concrete Supply A U S Concrete Company	2400 Peralta Street	Oakland	94607	Air District	Cement Plant
Chevron SS #9-4800	1700 Castro Street	Oakland	94612	Air District	Gas Station
City of Oakland Envr Scvs Division	1605 Martin Luther King Jr Way	Oakland	94612	Air District	Emergency Generator
City of Oakland Envr Scvs Division	14th & Mandela Way	Oakland	94607	Air District	Emergency Generator
City of Oakland Fire Station 1	1605 Martin Luther King Way	Oakland	94612	Air District	Gas Station
Clear Channel Outdoor	2857 Hannah Street	Oakland	94608	Air District	Gas Station
Clear Channel Outdoor	2865 Hannah Street	Oakland	94608	Air District	Paint Operation
Color Folio Design	1467 Park Avenue	Emeryville	94608	Air District	Paint Operation
ConGlobal Industries	555A Maritime Street	Oakland	94607	Air District	Auto Body

Name	Address	City	Zip Code	Permit Type	Source Type
Continental Auto Body	1355 Park Ave	Emeryville	94608	Air District	Auto Body
Coolport LLC	575 Maritime Street	Oakland	94607	Air District	Emergency Generator
Custom Wood Finishing	2311 Adeline Street	Oakland	94607	Air District	Emergency Generator
Department of Transportation	Toll Operations Bldg, SF-Oakland Bay Bridge	Oakland	94608	Air District	Emergency Generator
Digital 720 2nd LLC	720 2nd Street	Oakland	94607	Air District	Emergency Generator
Dynegy Oakland LLC	50 Martin Luther King Jr Way	Oakland	94607	Title V	Power Plant
East Bay Municipal Utility District	1100 21st Street	Oakland	94607	Air District	Emergency Generator
East Bay Municipal Utility District	1200 21st Street	Oakland	94607	Air District	Paint Operation
East Bay Municipal Utility District	2144 Poplar Street	Oakland	94607	Air District	Gas Station
East Bay Municipal Utility District PSK	2101 7th Street	Oakland	94607	Air District	Emergency Generator
East Bay Municipal Utility District	2020 Wake Avenue	Oakland	94607	Title V	Sewage Treatment
Englund Studio	1850 Campbell Street	Oakland	94607	Air District	Paint Operation
ExxonMobil c/o Acton Mickelson Environmental	909 Ferry Street (Port of Berth 23	Oakland	94607	Air District	Soil Vapor Extraction
Four Barrel Coffee Co	325 Martin Luther King Way	Oakland	94607	Air District	Coffee Roaster
Global Power Group, Inc	3938 Horton Street	Emeryville	94608	Air District	Emergency Generator
Harold's Auto Body & Paint Shop	2126 Market Street	Oakland	94607	Air District	Auto Body
HC Fine Finishes	1231 24th Street	Oakland	94607	Air District	Spray Booth
High End Custom and Collision	1649 28th Street	Oakland	94608	Air District	Auto Body
Hustead's Collision Center Inc	2915 Market Street	Oakland	94608	Air District	Auto Body
J and O Tire	2236 Poplar Street	Oakland	94607	Air District	Gas Station
Market Street Shell #135692	610 Market Street	Oakland	94607	Air District	Gas Station
MetroPCS California/Florida Inc	720 2nd Street	Oakland	94607	Air District	Emergency Generator
Mobile SS#63049	3400 San Pablo Avenue	Oakland	94608	Air District	Gas Station
Mr Espresso	696 3rd Street	Oakland	94607	Air District	Coffee Roaster
Nor-Cal Metal Fabricators	1121 3rd Street	Oakland	94607	Air District	Sandblasting
Oakland Unified School District	1011 Union Street	Oakland	94607	Air District	Emergency Generator
OFD Fire Station #3	1445 14th Street	Oakland	94607	Air District	Gas Station
Pacific Gas and Electric	689 2nd Street	Oakland	94607	Air District	Emergency Generator
Pinnacle Ag Services	2440 W 14th Street	Oakland	94607	Air District	Emergency Generator
Port of Oakland	651 Maritime Street	Oakland	94607	Air District	Gas Station
Port of Oakland	651 Maritime Street	Oakland	94607	Air District	Emergency Generator
Port of Oakland	1599 Maritime Street	Oakland	94607	Air District	Emergency Generator
Prologis	2420 West 21st Street	Oakland	94607	Air District	Emergency Generator

Name	Address	City	Zip Code	Permit Type	Source Type
PS Printing LLC	2861 Mandela Parkway	Oakland	94608	Air District	Print Shop
Quality Body and Fender	2510 Martin Luther King Way	Oakland	94612	Air District	Auto Body
Radio Mirchi	Pole Plaza AHN 18, Pole #110141241	Oakland	94608	Air District	Emergency Generator
Redline Import - Auto Collision	2300 Market Street #C	Oakland	94607	Air District	Auto Body
Rino Pacific	1107 5th Street	Oakland	94607	Air District	Gas Station
Safety-Kleen Systems Inc	400 Market Street	Oakland	94607	Air District	Soil Vapor Extraction
San Francisco Bay Bridge Toll Plaza	Bay Bridge East	Oakland	94607	Air District	Emergency Generator
San Pablo Auto Body	2926 San Pablo Avenue	Oakland	94612	Air District	Auto Body
Sausal Corporation	Bay Bridge Toll Plaza	Oakland	94608	Air District	Gas Station
Schnitzer Steel Products Company	Adeline Street, Foot of	Oakland	94607	Air District	Metal Facility
SFPP, L P	Bay Street, off 7th Street	Oakland	94666	Air District	Fuel Storage
Sierra Pacific	3213 Wood Street	Oakland	94608	Air District	Cement Plant
Solstice Press	113 Filbert Street	Oakland	94607	Air District	Print Shop
SPRINT	114 Brush Street	Oakland	94607	Air District	Emergency Generator
SPRINT	1075 7th Street	Oakland	94607	Air District	Emergency Generator
SSA Terminals (Oakland) LLC	1999 Middle Harbor Road	Oakland	94607	Air District	Emergency Generator
SSA Terminals-Oakland LLC	1999 Middle Harbor Road	Oakland	94607	Air District	Gas Station
Stanford Cleaners	2134 Market Street	Oakland	94607	Air District	Dry Cleaning
State of CA - Caltrans	Oak Bay Bridge, E Side, Toll Plaza	Oakland	94608	Air District	Gas Station
Tam's Auto Body	2300 Market Street Suite B	Oakland	94607	Air District	Auto Body
Target Corporation Store #T2767	1555 40th Street	Oakland	94608	Air District	Emergency Generator
T-fuels Inc dba Grand Arco AMPM-C Kim	889 W Grand Avenue	Oakland	94607	Air District	Gas Station
The Home Depot (Store #0627)	3838 Hollis Street	Emeryville	94608	Air District	Emergency Generator
T-Mobile	720 2nd Street	Oakland	94607	Air District	Emergency Generator
Trapac	2800 7th Street	Oakland	94607	Air District	Gas Station
Union Pacific Railroad	1400 Middle Harbor Road	Oakland	94607	Air District	Emergency Generator
Union Pacific Railroad	1400 Middle Harbor Road	Oakland	94607	Air District	Gas Station
US Postal Service - Building Maintenance	1675 7th Street	Oakland	94615	Air District	Emergency Generator
Verizon Wireless (Alameda Perm)	114 Brush Street	Oakland	94607	Air District	Emergency Generator
Verizon Wireless (Bay Bridge East)	107 Burma Road	Oakland	94617	Air District	Emergency Generator
Viridis Fuels	2040 Wake Avenue	Oakland	94607	Air District	Boiler
Watermark Bayside, LLC dba Bayside Park	1440 40th Street	Emeryville	94608	Air District	Emergency Generator

LIST OF COMPLAINTS RECEIVED IN WEST OAKLAND (JANUARY 2016 – DECEMBER 2018)

Complaint Number	Complaint Type	Date Received	Alleged Site	Address	City	Description	Pertinent Information
226887	Odor	6/8/2016	Ant's Body Shop	2300 Market Street	Oakland	paint fumes	
231961	Gas Station	6/26/2017	Arco	899 West Grand Ave	Oakland	no latches	
232755	Dust	9/14/2017	Blue Bottle Coffee	300 Webster	Oakland	Heavy dust	
226026	Smoke	4/21/2016	Business	291 3rd St	Oakland	heavy black	Intermittent smoke but very heavy
234011	Odor	1/9/2018	Cafe Tartine	55 Harrison St	Oakland	burnt	
234046	Dust	1/16/2018	Cafe Tartine	55 Harrison St	Oakland	particulate matter	
232628	Smoke	9/5/2017	California Cereal Products	1267 14th St	Oakland	black	
224468	Odor	2/4/2016	California Waste Solutions	1820 10th Street	Oakland		
224473	Odor	2/4/2016	California Waste Solutions	1820 10th Street	Oakland	garbage	
224474	Odor	2/4/2016	California Waste Solutions	1820 10th Street	Oakland	garbage	
224476	Odor	2/4/2016	California Waste Solutions	1820 10th Street	Oakland	dead fish	
224477	Odor	2/4/2016	California Waste Solutions	1820 10th Street	Oakland	nauseating	
224491	Odor	2/5/2016	California Waste Solutions	1820 10th Street	Oakland		
224580	Odor	2/9/2016	California Waste Solutions	1820 10th Street	Oakland	sour garbage	
224581	Odor	2/9/2016	California Waste Solutions	1820 10th Street	Oakland	unbearable	
224604	Odor	2/10/2016	California Waste Solutions	1820 10th Street	Oakland		smelled at wood street
226378	Odor	5/5/2016	California Waste Solutions	1820 10th Street	Oakland		
231970	Idling Commercial Vehicle	6/27/2017	California Waste Solutions	1820 10th Street	Oakland	trucks	
235203	Odor	4/22/2018	California Waste Solutions	10th ST/Pine St	Oakland	burning plastic	
228920	Odor	11/23/2016	Construction	311 Burma Rd	Oakland	Burning/ smoke	

Complaint Number	Complaint Type	Date Received	Alleged Site	Address	City	Description	Pertinent Information
231960	Odor	6/26/2017	Construction	11th St & Frontage Rd	Oakland	fumes	Complained by leaving VM with our Public Info office
227331	Asbestos	7/28/2016	Construction Site	1919 Market St	Oakland	dust everywhere	
227488	Asbestos	8/17/2016	Construction Site	1919 Market St	Oakland	no containment	
227741	Dust	9/14/2016	Construction Site	1919 Market St	Oakland		
231574	Dust	5/13/2017	Construction Site	Frontage Rd/14th St	Oakland	not watering down	
231950	Odor	6/24/2017	Construction Site	Frontage Rd/14th St	Oakland	exhaust	
232676	Dust	9/7/2017	Construction Site	West St/West Grand St	Oakland	not watering down	
232695	Dust	9/8/2017	Construction Site	Filbert St/Myrtle St	Oakland	not watering down	
235995	Dust	6/25/2018	Construction Site	17th St & Campbell St	Oakland		
224172	Odor	1/8/2016	Custom Alloy	2730 Peralta Street	Oakland		
224220	Odor	1/13/2016	Custom Alloy	2730 Peralta Street	Oakland		
225587	Odor	3/26/2016	Custom Alloy	2730 Peralta Street	Oakland	disgusting	
225892	Odor	4/16/2016	Custom Alloy	2730 Peralta Street	Oakland	burning metal	
227017	Odor	6/27/2016	Custom Alloy	2730 Peralta Street	Oakland	metallic	
227585	Odor	8/28/2016	Custom Alloy	2730 Peralta Street	Oakland	burning metal	
227590	Odor	8/29/2016	Custom Alloy	2730 Peralta Street	Oakland	burning metal	
227607	Odor	8/30/2016	Custom Alloy	2730 Peralta Street	Oakland	metallic/chlorine	
227786	Odor	9/17/2016	Custom Alloy	2730 Peralta Street	Oakland	metallic	
228421	Odor	10/10/2016	Custom Alloy	2730 Peralta Street	Oakland	burnt metal	
231225	Odor	4/23/2017	Custom Alloy	2730 Peralta Street	Oakland		
231331	Odor	4/30/2017	Custom Alloy	2730 Peralta Street	Oakland		
231597	Odor	5/16/2017	Custom Alloy	2730 Peralta Street	Oakland	metallic	
232240	Odor	7/28/2017	Custom Alloy	2730 Peralta Street	Oakland	bad	
232242	Odor	7/28/2017	Custom Alloy	2730 Peralta Street	Oakland	burning smell	had also noticed the odor this morning
232362	Odor	8/6/2017	Custom Alloy	2730 Peralta Street	Oakland	burning metal	
232814	Odor	9/24/2017	Custom Alloy	2730 Peralta Street	Oakland	melting metal	
233114	Odor	10/20/2017	Custom Alloy	2730 Peralta Street	Oakland	metal	
233749	Odor	12/10/2017	Custom Alloy	2730 Peralta Street	Oakland	burning metal	
233837	Odor	12/17/2017	Custom Alloy	2730 Peralta Street	Oakland	melting	
234800	Odor	3/28/2018	Custom Alloy	2730 Peralta St	Oakland	burning metal	
235174	Odor	4/19/2018	Custom Alloy	2730 Peralta Street	Oakland	acrid/burnt plastic	

Complaint Number	Complaint Type	Date Received	Alleged Site	Address	City	Description	Pertinent Information
235186	Odor	4/20/2018	Custom Alloy	2730 Peralta	Oakland	chlorine, bleach	
235202	Odor	4/22/2018	Custom Alloy	2730 Peralta Street	Oakland	chlorine	
235242	Odor	4/25/2018	Custom Alloy	2730 Peralta Street	Oakland	burning metal	
235265	Odor	4/27/2018	Custom Alloy	2730 Peralta Street	Oakland	plastic/chlorine	
235271	Odor	4/28/2018	Custom Alloy	2730 Peralta Street	Oakland	burning metal	
235276	Odor	4/29/2018	Custom Alloy	2730 Peralta Street	Oakland	chemical	THERE ARE WHITE CLOUDS OF SMOKE THAT SMELL LIKE CHLORINE COMING FROM RECYCLE PLANT
235283	Odor	4/30/2018	Custom Alloy	2730 Peralta	Oakland	burnt circuit boards	occurs in the afternoon; 3-7pm; if c doesn't answer call again
235682	Odor	5/29/2018	Custom Alloy	2730 Peralta Street	Oakland	CHLORINE BITTER CHEM	
235709	Odor	5/31/2018	Custom Alloy	2730 Peralta Street	Oakland	burning metal	
235715	Odor	6/1/2018	Custom Alloy	2730 Peralta	Oakland	burnt plastic	
235777	Odor	6/4/2018	Custom Alloy	2430 Peralta St	Oakland	burning metal	burning metal odor - burning after 7p when not supposed to
236312	Odor	7/13/2018	Custom Alloy	2730 Peralta Street	Oakland	chemical	
236378	Odor	7/18/2018	Custom Alloy	2730 Peralta	Oakland	burnt chlorine	
236592	Odor	7/25/2018	Custom Alloy	2730 Peralta Street	Oakland		
237249	Odor	9/8/2018	Custom Alloy	2730 Peralta Street	Oakland	bad	
237629	Odor	10/4/2018	Custom Alloy	2730 Peralta Street	Oakland	burning plastic	
237631	Odor	10/4/2018	Custom Alloy	2730 Peralta Street	Oakland	acrid	
237752	Odor	10/15/2018	Custom Alloy	2730 Peralta Street	Oakland	chemical	
231968	Idling Commercial Vehicle	6/27/2017	Garbage Trucks	Pine & 11th St	Oakland	many trucks	
238505	Odor	11/27/2018	Jack Truck Repair	2226 Myrtle St	Oakland	repair fumes	
233148	Odor	10/23/2017	Jac's Truck Repair	West Ave	Oakland	exhaust	

Complaint Number	Complaint Type	Date Received	Alleged Site	Address	City	Description	Pertinent Information
231949	Odor	6/24/2017	LJP Construction Services	121 Pine St	Oakland	chemical	
226900	Asbestos	6/9/2016	MFD	392 11th Street	Oakland	construction	improper removal and containment
227159	Asbestos	7/7/2016	MFD	7 Embarcadero West Unit 202	Oakland	improper removal	no containment and when asked the contractor said they didn't need to
228039	Odor	9/26/2016	MFD	2407 Adeline Street	Oakland	noxious	spraying foam on roof / noxious odor
224267	Odor	1/19/2016	NONE	NONE	Oakland	bad	
224475	Odor	2/4/2016	NONE	NONE	Oakland		
224492	Odor	2/5/2016	NONE	NONE	Oakland	bad dairy	
225033	Odor	2/25/2016	NONE	NONE	Oakland	chemical	
227730	Odor	9/12/2016	NONE	NONE	Oakland	burning bread	smells it mostly in the morning but smells it again now at Laney College
228152	Odor	9/28/2016	NONE	NONE	Oakland	bad plastic	
229220	Odor	12/22/2016	NONE	Fallon St/7th St	Oakland	burnt metal	
229477	Odor	1/9/2017	NONE	NONE	Oakland	burning	
229710	Odor	1/28/2017	NONE	NONE	Oakland	clorox	says smell is coming from Warehouses on 3rd/Center St, Oakland
229857	Odor	2/6/2017	NONE	3rd St / Center St	Oakland	clorox	
229912	Odor	2/13/2017	NONE	NONE	Oakland	clorox	1448 3rd and Center St
230255	Odor	2/27/2017	NONE	NONE	Oakland	burning	
230876	Odor	3/24/2017	NONE	NONE	Oakland	bleach	
232232	Odor	7/27/2017	NONE	NONE	Oakland	burning pot handles	
232537	Odor	8/28/2017	NONE	3rd St / Center St	Oakland	Chemicals	
232581	Odor	8/31/2017	NONE	NONE	Oakland	chemical like	She had stated odor is coming from the west of her...
232661	Dust	9/6/2017	NONE	15th and Center	Oakland	Dust from construction	
232732	Dust	9/11/2017	NONE	305 Center St	Oakland	Dust & gas odors	
233219	Odor	10/25/2017	NONE	NONE	Oakland	bleach	

Complaint Number	Complaint Type	Date Received	Alleged Site	Address	City	Description	Pertinent Information
234005	Odor	1/9/2018	NONE	3rd St / Center St	Oakland	Chemical smell	
234018	Odor	1/10/2018	NONE	3rd St / Center St	Oakland		
234024	Odor	1/11/2018	NONE	NONE	Oakland	chlorine/ bleach	
235033	Odor	4/9/2018	NONE	3rd St / Center St	Oakland	bleach	Complaint #68 Chemical or bleach odor from a warehouse across the street coming into apt
235685	Dust	5/30/2018	NONE	1600 block 10th St	Oakland	white	
235687	Soot	5/30/2018	NONE	NONE	Oakland		
235991	Dust	6/25/2018	NONE	Wood St / 17th St	Oakland	demo no watering	
236297	Odor	7/13/2018	NONE	W Grand Ave & Linden St	Oakland	sulphur	
237527	Odor	9/26/2018	NONE	Adeline St & 24th St	Oakland	burning	
237672	Dust	10/8/2018	NONE	NONE	Oakland	black dust	
238281	Odor	11/5/2018	NONE	3rd St / Center St	Oakland	chemical burning	
232143	Asbestos	7/19/2017	Old American Steel Factory	1900 Mandela Parkway	Oakland	poss illegal removal	Workers on scene in rear warehouse tearing down walls, no containment, fans blowing dust all around
225769	Odor	4/7/2016	Parking Lot	351 Mandela Pkwy	Oakland	paint solvent	
233942	Dust	1/2/2018	Pipe Spy	1108 26th St	Oakland	soil/ concrete	from excavated soil/concrete
235243	Dust	4/25/2018	Road Construction	Peralta St/9th St	Oakland	dust	
235776	Smoke	6/4/2018	Schnitzer Steel	1101 Embarcadero West	Oakland	black	Black smoke - big fire. Concerned about our health and potential respiratory issues.

Complaint Number	Complaint Type	Date Received	Alleged Site	Address	City	Description	Pertinent Information
1116959	Wood Smoke	8/24/2016	SFD	1425 Myrtle St	Oakland	Heavy - cannot see through smoke	Outside backyard fire or firepit; Fire next door to complainant, ashes left uncleaned, property built in 1940, concerned ab out asbestos and airborne inhalation
234568	Dust	3/7/2018	SFD	1480 8th St	Oakland	construction	lots of dust, odor and debris from a basement renovation of this residence
WSC408951	Wood Smoke	9/3/2018	SFD	1618 12th St	Oakland	White smoke - can partially see through smoke	neighbor burning backyard, wood toxins, garbage
WSC409806	Wood Smoke	11/17/2018	SFD	1131 Wood St	Oakland	White smoke - can partially see through smoke	Backyard fire pit, burning on no burn day
236563	Odor	7/25/2018	Smart Foodservice Warehouse Stores	400 Oak St	Oakland	diesel, gas	generator runs midday, everyday for about 2 hours
232800	Idling Port Truck	9/21/2017	Trapac Terminal	2800 7th St	Oakland	Idling trucks	Trucks are seen lined up and idled for hours at a time
225034	Odor	2/25/2016	Unknown Business	1448 3rd St	Oakland	smoke	Caller from City of Oakland Admin.. reporting loads of smoke coming from businesses yard
224433	Odor	2/2/2016	Warehouse	1448 3rd Street	Oakland	skunk	
227679	Dust	9/7/2016	Warehouse	1919 Market St	Oakland	not watering down	No containment, dust & debris flying all over neighborhood ... tearing down part of the building
229618	Odor	1/23/2017	Warehouse	1448 3rd Street	Oakland	chlorox	

Complaint Number	Complaint Type	Date Received	Alleged Site	Address	City	Description	Pertinent Information
237830	Odor	10/17/2018	West Oakland Bart Station	1451 7th St	Oakland	burning tires	
234990	Odor	4/10/2018	Warehouse	3rd St/Center St	Oakland	bleach	
229843	Odor	2/3/2017	Yang Auto Repair	1101 7th ST	Oakland	Spray paint	sometimes can even smell it til 10pm (smelled it last night and again this morning)

LIST OF NOTICES OF VIOLATIONS ISSUED IN WEST OAKLAND (JANUARY 2016 – DECEMBER 2018)

NOV Number	Regulation	Type	Date Issued	Site	Address	City	Zip	Status
A54387	Rule 11-2-401	Administrative Requirement	2/4/2016	Asbestos Management Group of California	3438 Helen Street	Oakland	94607	Closed
A56003	Rule 11-2-401	Administrative Requirement	7/29/2016	Construction Site	1919 Market St	Oakland	94607	Closed
A56005	Rule 11-2-303	Operational Requirement	9/8/2016	Construction Site	1919 Market St	Oakland	94607	Closed
A56006	Rule 11-2-401	Administrative Requirement	9/8/2016	Construction Site	1919 Market St	Oakland	94607	Closed
A56333	Rule 2-1-302	Administrative Requirement	12/5/2016	Department of Transportation	Toll Operations Bldg, SF-Oakland Ba	Oakland	94608	Closed
A56328	Rule 2-6-307	Operational Requirement	7/1/2016	East Bay Municipal Utility District	2020 Wake Avenue	Oakland	94607	Closed
A56330	Rule 2-6-307	Operational Requirement	9/27/2016	East Bay Municipal Utility District	2020 Wake Avenue	Oakland	94607	Closed
A56331	Rule 2-6-307	Operational Requirement	9/27/2016	East Bay Municipal Utility District	2020 Wake Avenue	Oakland	94607	Closed
A56332	Rule 2-6-307	Operational Requirement	12/2/2016	East Bay Municipal Utility District	2020 Wake Avenue	Oakland	94607	Closed
A56334	Rule 2-6-307	Operational Requirement	2/7/2017	East Bay Municipal Utility District	2020 Wake Avenue	Oakland	94607	Closed
A56391	Rule 2-6-307	Operational Requirement	8/22/2017	East Bay Municipal Utility District	2020 Wake Avenue	Oakland	94607	Pending
A56067	Rule 2-1-307	Operational Requirement	4/26/2018	East Bay Municipal Utility District	2020 Wake Avenue	Oakland	94607	Pending
A58247	Rule 8-7-302	Operational Requirement	7/12/2018	East Bay Municipal Utility District	2020 Wake Avenue	Oakland	94607	Closed
A56070	Rule 2-1-307	Operational Requirement	9/17/2018	East Bay Municipal Utility District	2020 Wake Avenue	Oakland	94607	Pending
A56329	Rule 2-1-301	Administrative Requirement	8/29/2016	Pinnacle Ag Services	2440 W 14th Street	Oakland	94607	Closed
A56686	Rule 2-1-302	Administrative Requirement	11/8/2016	San Pablo Auto Body	2926 San Pablo Ave	Oakland	94608	Pending
A56389	Rule 2-1-307	Operational Requirement	7/24/2017	Schnitzer Steel Products Company	Adeline St, Foot of	Oakland	94607	Closed
A56069	Rule 5-301, Rule 6-4-301 & 501	Administrative & Operational Requirement	8/24/2018	Schnitzer Steel Products Company	Adeline St, Foot of	Oakland	94607	Pending
A58204	Rule 11-2-401	Administrative Requirement	5/3/2018	Silverado Contractors	2855 Mandela Parkway	Oakland	94608	Closed
A58487	Rule 11-2-401	Administrative Requirement	9/4/2018	Silverado Contractors	2855 Mandela Pkwy, 2nd Flr	Oakland	94608	Pending
A57908	Rule 8-7-301	Operational Requirement	1/26/2018	Trapac	2800 7th Street	Oakland	94607	Closed
NTC Number	**Regulation**	**Type**	**Date Issued**	**Site**	**Address**	**City**	**Zip**	**Status**
A46659	Rule 8-7-301	Administrative Requirement	3/9/2018	Mobil SS #63049	3400 San Pablo Ave	Oakland	94608	Violation Resolved

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