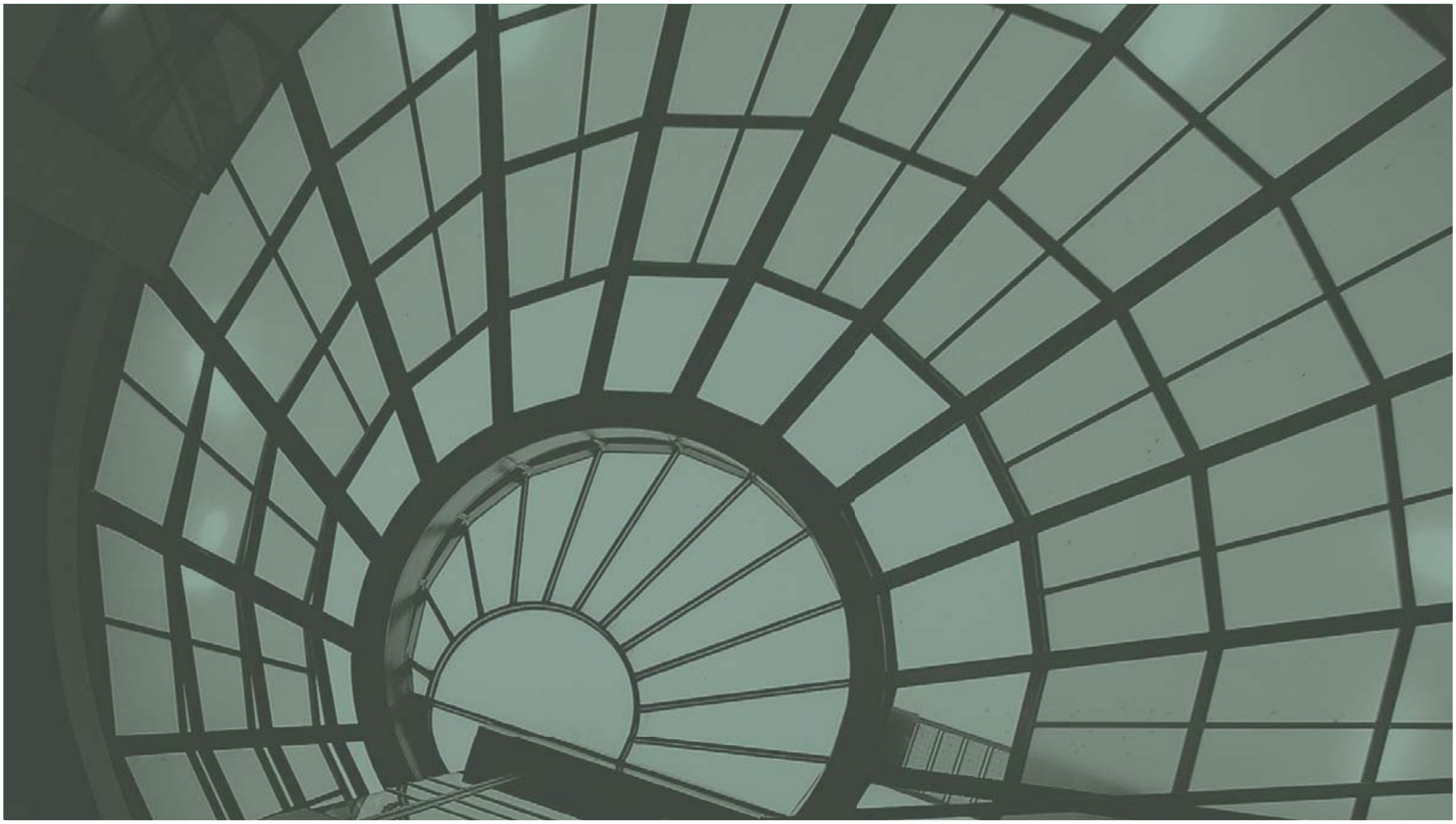

PLANNING DEPARTMENT | **ENVIRONMENTAL PLANNING DIVISION**

SEAL OF THE CITY AND COUNTY OF SAN FRANCISCO

Guide to the
Evaluation of Sensitive Land Uses in San Francisco

SAN FRANCISCO PLANNING DEPARTMENT | February 2013

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Chapter 1. Introduction

1.1. PURPOSE

Environmental review under the California Environmental Quality Act (CEQA) requires that lead agencies analyze the environmental impacts of projects that a public agency proposes to implement, fund, or approve.[1] Pursuant to City and County of San Francisco (San Francisco) Administrative Code Chapter 31, Initial Studies prepared in accordance with the CEQA shall be based on the environmental checklist form found in Appendix G of the CEQA Guidelines[2] and supplemented to account for additional environmental conditions specific to San Francisco's urban environment.[3] In accordance with the CEQA Guidelines and Chapter 31 of the San Francisco Administrative Code, the Planning Department must analyze whether a proposed project would expose sensitive land uses[4] to substantial air pollutant concentrations. This document lays forth the Planning Department's approach to analyzing air quality impacts to sensitive land uses and provides substantial evidence in support of the Department's approach pursuant to CEQA.

The intended audience is environmental consultants well versed in CEQA, project sponsors, decision makers, and members of the public. The purpose of this document is to identify the situations in which a proposed project could result in potentially significant health risk impacts to sensitive land uses and to identify best management practices (BMPs) that can be implemented for projects that either: (1) site new sensitive land uses in areas affected by existing sources of air pollution, (2) would require the use of construction vehicles or equipment whose emissions may substantially affect nearby sensitive land uses, and/or (3) would site stationary diesel engines that emit air pollutants in proximity sensitive land uses that are already substantially affected by existing sources of air pollution. Specifically, this document examines

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[1] California Code of Regulations, Title 14, Division 6, Chapter 3, §15002.

[2] California Code of Regulations, Title 14, Division 6, Chapter 3, §1500-15387.

[3] San Francisco Administrative Code §31.10.

[4] For purposes of this document, sensitive land uses include dwellings or buildings housing or occupied by sensitive receptors (children, adults, and seniors) and include: residential dwellings, schools, daycares, hospitals and senior care facilities. Workers are not considered sensitive receptors. Worker exposures are regulated by the federal Occupation Safety and Health Administration (OSHA). OSHA adopts laws and regulations for ensuring a safe and healthful work environment to prevent injuries and protect the health of workers. All employers must follow OSHA regulations to ensure the health and well- being of their employees.

the sources and health effects of air pollutants in San Francisco, identifies areas within San Francisco that are substantially affected by existing sources of air pollution, termed air pollution "hot spots," discusses guidance and regulations pertaining to (1) the siting of sensitive land uses, (2) construction-related emissions sources, and (3) the siting of stationary sources of air pollutants. For each of these situations, health protective measures, or BMPs, that can be implemented during the environmental review process are identified to ensure that sensitive land uses are not further exposed to substantial air pollutant concentrations. Identified BMPs are intended to reduce the negative health effects from both long-term (i.e., siting of sensitive land uses or stationary sources) and short-term (i.e., construction-related) exposure to air pollutant concentrations within areas of San Francisco that are affected by existing sources of air pollution. This document does not address the evaluation of projects that would result in a substantial amount of operational emissions (i.e., projects resulting in more than 10,000 vehicles per day or unique stationary sources such as power generation facilities).

1.2. BACKGROUND

San Francisco is approximately 49 square miles in size with a population that continues to grow; now surpassing the 1950's population peak, with over 800,000 residents.[5] With a finite supply of land, and a growing population, there is an increased demand for new housing. The demand for new housing in San Francisco is exemplified in the Association of Bay Area Government's 2007-2014 Regional Housing Need Allocation which estimates that San Francisco's fair share of new housing over this period is approximately 31,000 new dwelling units. San Francisco is already densely populated, with the highest housing densities in the Downtown area, at an average density of up to 283 dwelling units per acre, while lower densities (as low as 14 dwelling units per acre) exist in the western and southern areas of the City.[6] Most areas in San Francisco allow residential uses, except for the heavy industrial areas, which historically have been located in the eastern portion of the City.

San Francisco's limited land supply, the existing dense pattern of development, and mix of land uses often results in development of sensitive land uses in close proximity to high volume roadways, a major source of air pollution. Public health research indicates that long-term

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[5] San Francisco Planning Department, *Final Environmental Impact Report for the San Francisco 2004 and 2009 Housing Element*, March 24, 2011.

[6] San Francisco Planning Department, *Final Environmental Impact Report for the San Francisco 2004 and 2009 Housing Element*, March 24, 2011.

exposure to motor vehicle air pollution results in a number of adverse health outcomes including cancer, respiratory disease, and pre-mature mortality. While infill development can reduce regional and global air pollution, the siting of sensitive land uses near high volume roadways increases exposure of those individuals to air pollutants and increases their associated health risk.

In response, the San Francisco Department of Public Health (DPH) published *Assessment and Mitigation of Air Pollutant Health Effects from Intra-Urban Roadways: Guidance for Land Use Planning and Environmental Review*,[7] documenting the health effects associated with locating sensitive land uses near high volume roadways, assessment methodologies, and exposure reduction strategies. In 2008, San Francisco passed legislation requiring the protection of new dwelling units near high volume roadways, which has been codified as Article 38 of the San Francisco Health Code (Article 38). San Francisco's Article 38 has resulted in the unprecedented protection of sensitive land uses in areas adversely affected by mobile source air pollution and remains a model for the region and nationally.

Since the passage of Article 38, a considerable amount of additional information concerning the emissions from other sources, namely stationary sources[8] and area sources,[9] has come to light requiring reassessment of the sources of air pollutants and the methodologies for evaluating exposure to, and health impacts from, air pollutants. One such source of additional information has been the Bay Area Air Quality Management District (BAAQMD), who maintains a database of emissions from permitted stationary sources. As a result, San Francisco has partnered with BAAQMD to inventory and assess air pollution and exposures from mobile, stationary, and area sources within San Francisco. As described further in Chapter 4, using health-based criteria, the City has identified locations in San Francisco where sensitive land uses are most at risk to exposure from known air pollutant sources. This document has been prepared to provide a consistent and meaningful approach for environmental review of projects proposing new sensitive land uses or common stationary sources and/or construction activities in these

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[7] San Francisco Department of Public Health (DPH), *Assessment and Mitigation of Air Pollutant Health Effects from Intra-Urban Roadways: Guidance for Land Use Planning and Environmental Review*, May 2008. Available online at: http://www.sfdph.org/dph/files/EHSdocs/AirQuality/MitigateRoadAQLUConlicts.pdf. Accessed May 1, 2012.

[8] A stationary source is a non-mobile source of air pollution such as a factory, smoke stack, or stationary generator.

[9] Area sources are sources of air pollutants that individually emit relatively small quantities of air pollutants, but that may emit considerable quantities of emissions when aggregated over a large area, such as water heaters, lawn maintenance equipment, and consumer products.

locations through the implementation of BMPs. It is intended that if and when San Francisco updates current regulations that address the protection of sensitive land uses near high volume roadways (Health Code Article 38), the procedures provided therein will supersede those outlined in this document.

1.3. BEST MANAGEMENT PRACTICES IN CEQA

CEQA permits the use of non-quantitative mitigation measures. CEQA Guidelines §15370 defines mitigation to include actions which minimize the "degree or magnitude of the action and its implementation." In considering mitigation measures, CEQA Guidelines §15126.4(a)(1)(B) states that mitigation measures may specify performance standards. This is consistent with CEQA Guidelines §15064.4(a)(2) pertaining to the assessment of greenhouse gas emissions, which specifically states that compliance with performance based standards is appropriate in determining the significance of greenhouse gas emissions. Therefore, mitigation measures may be measured by degrees or magnitudes, rather than specific emissions amounts.

Regional air pollution control districts have a long history of recommending the use of BMPs to mitigate particulate matter (PM)/dust suppression from construction activities. The BAAQMD in their previous 1999 *CEQA Air Quality Guidelines* and their updated 2011 *CEQA Air Quality Guidelines* continue to recommend BMPs to mitigate construction-related fugitive dust impacts. The BAAQMD states that application of BMPs at construction sites have significantly controlled fugitive dust emissions and individual measures have been shown to reduce fugitive dust by anywhere between 30 to 90 percent.[10]

The recommended BMPs identified in this document for siting sensitive land uses and reducing emissions from construction-related vehicles and equipment at construction sites and stationary sources have been assessed for their overall feasibility and effectiveness and meet the requirements of CEQA by minimizing, to the degree feasible, the exposure of air pollutant concentrations to sensitive land uses.

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[10] BAAQMD, *CEQA Draft Justification and Options Report*, October 2009.

1.4. DOCUMENT ORGANIZATION

This document is composed of the following chapters:

Chapter 1. Introduction describes the purpose and background of this document and outlines the document's organization.

Chapter 2. Overview of Air Pollutants identifies the pollutants of concern, the sources of air pollution and the associated health risks to sensitive land uses.

Chapter 3. Assessment of Air Pollution Exposure in San Francisco describes the air dispersion modeling and the health-based criteria used to determine the areas within San Francisco that are adversely affected by a combination of mobile, stationary, and area sources of air pollution.

Chapter 4. Siting Sensitive Land Uses describes existing regulations and guidance pertaining to the siting of sensitive land uses and identifies best management practices to be implemented for projects proposing sensitive land uses in San Francisco. This chapter also evaluates the feasibility and effectiveness of the recommended BMPs.

Chapter 5. Construction Activities describes the regulatory framework concerning construction activities, provides an inventory of emissions from construction-related equipment, and prescribes recommended BMPs for reducing construction-related air pollutant emissions for sensitive land uses that are most affected by existing sources of air pollution. In addition, this chapter discusses the situations in which the recommended construction BMPs should generally be employed and analyzes the feasibility and effectiveness of the recommended BMPs.

Chapter 6. Siting Stationary Diesel Engines provides an overview of federal, state and local regulations pertaining to the most common stationary source proposed in San Francisco, emergency back-up diesel engines. This chapter identifies BMPs that should be employed when siting diesel engines in air pollution hot spots and analyzes the feasibility and effectiveness of the recommended BMPs.

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Chapter 2. Overview of Air Pollutants

This chapter describes the air pollutants that are of greatest concern in San Francisco because of their expected health effects and relative abundance. Air pollutants may be regulated differently and therefore this chapter identifies two broad categories of air pollutants: (1) criteria air pollutants, and (2) toxic air contaminants. This chapter also identifies the primary sources of air pollutants and the health effects to sensitive populations resulting from exposure to those air pollutants.

2.1. CRITERIA AIR POLLUTANTS

As required by the 1970 federal Clean Air Act (CAA), the United States Environmental Protection Agency (USEPA) has identified six air pollutants that are pervasive in urban environments and for which state and federal health-based ambient air quality standards have been established. USEPA calls these pollutants “criteria air pollutants” because the agency has regulated them by developing specific public health- and welfare-based criteria as the basis for setting permissible levels. The federal government and the State of California focus on the following six criteria air pollutants as indicators of ambient air quality: ozone, carbon monoxide (CO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), particulate matter (PM_{10} and $PM_{2.5}$) [11] and lead.

The federal CAA requires that regional planning and air pollution control agencies prepare a regional air quality plan to outline the measures by which both stationary and mobile sources of air pollutants will be controlled in order to achieve all air quality standards by the deadlines specified in the CAA. These standards, the National Ambient Air Quality Standards (NAAQS), specify the concentration of air pollutants (with an adequate margin of safety) to which the public can be exposed without adverse health effects. NAAQS are designed to protect those segments of the public most susceptible to respiratory distress, known as sensitive land uses. Healthy adults can tolerate occasional exposure to air pollution levels that are somewhat above the ambient air quality standards before adverse health effects are observed.

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[11] Particulate matter is a mixture of particles and droplets that vary in size and chemical composition, depending on each particle’s origin. PM_{10} includes the subset of “coarse” particles, those that are 10 microns in diameter or less, and “fine” particles, those 2.5 microns or smaller ($PM_{2.5}$). Common air emission modeling programs, including CalEEMod and URBEMIS, estimate $PM_{2.5}$ to be equivalent to approximately 92 percent of PM_{10}.

Although the federal CAA established NAAQS, individual states retained the option to adopt more stringent standards and to include other pollution sources. California had already established its own air quality standards when federal standards were established, and because of the unique meteorological conditions in California, there are some differences between the California Ambient Air Quality Standards (CAAQS) and the NAAQS. CAAQS tend to be at least as protective as NAAQS and are often more stringent.

The determination of whether a region's air quality is healthful or unhealthful is made by comparing contaminant levels in ambient air samples to the NAAQS or CAAQS. The BAAQMD's air quality monitoring network provides information on ambient concentrations of criteria air pollutants at several monitoring stations within the San Francisco Bay Area Air Basin (SFBAAB). Data from regional monitoring stations is used to establish a region's attainment status for criteria air pollutants. The purpose of these designations is to identify planning areas with air quality problems and thereby initiate planning efforts for improvement. The three basic designation categories are "nonattainment," "attainment," and "unclassified." The "unclassified" designation is used for an area that cannot be classified on the basis of available information as meeting or not meeting the standards.

2.1.1. Criteria Air Pollutant Attainment Status

The current attainment status for the SFBAAB with respect to federal and state standards is summarized in Table 2-1, State and Federal Ambient Air Quality Standards. In general, the SFBAAB experiences low concentrations of most pollutants when compared to federal or state standards. However, the SFBAAB is designated as "nonattainment" for ozone and particulate matter (both PM_{10} and $PM_{2.5}$), for which standards are exceeded periodically.

TABLE 2-1. STATE AND FEDERAL AMBIENT AIR QUALITY STANDARDS

Pollutant	Averaging Time	(State) CAAQS[a]		(Federal) NAAQS[b]	
		Standard	Attainment Status	Standard	Attainment Status
Ozone	1 hour	0.09 ppm	N	NA	See Note c
	8 hour	0.07 ppm	N	0.075 ppm	N/Marginal
Carbon Monoxide (CO)	1 hour	20 ppm	A	35 ppm	A
	8 hour	9 ppm	A	9 ppm	A
Nitrogen Dioxide (NO$_2$)	1 hour	0.18 ppm	A	0.1 ppm[d]	U
	Annual	0.03 ppm	NA	0.053 ppm	A
Sulfur Dioxide (SO$_2$)	1 hour	0.25 ppm	A	0.075 ppm[e]	A
	24 hour	0.04 ppm	A	NA	NA
Particulate Matter (PM$_{10}$)	24 hour	50 µg/m^3	N	150 µg/m^3	U
	Annual	20 µg/m^3	N	NA	NA
Fine Particulate Matter (PM$_{2.5}$)	24 hour	NA	NA	35 µg/m^3	N
	Annual	12 µg/m^3	N	12 µg/m^3	A
Sulfates	24 hour	25 µg/m^3	A	NA	NA
Lead	30 day	1.5 µg/m^3	A	NA	NA
	Cal. Quarter	NA	NA	1.5 µg/m^3	A
Hydrogen Sulfide	1 hour	0.03 ppm	U	NA	NA
Visibility-Reducing Particles	8 hour	See Note f	U	NA	NA

SOURCE*:* Bay Area Air Quality Management District (BAAQMD), "Air Quality Standards and Attainment Status," accessed online March 16, 2011, http://hank.baaqmd.gov/pln/air_quality/ambient_air_quality.htm.

Notes: A = Attainment; N = Nonattainment; U = Unclassified; NA = Not Applicable, no applicable standard; ppm = parts per million; µg/m^3 = micrograms per cubic meter.

a. CAAQS = state ambient air quality standards (California). SAAQS for ozone, carbon monoxide (except Lake Tahoe), sulfur dioxide (1-hour and 24-hour), nitrogen dioxide, particulate matter, and visibility-reducing particles are values that are not to be exceeded. All other state standards shown are values not to be equaled or exceeded.

b. NAAQS = national ambient air quality standards. NAAQS, other than ozone and particulates, and those based on annual averages or annual arithmetic means, are not to be exceeded more than once a year. The 8-hour ozone standard is attained when the three-year average of the fourth highest daily concentration is 0.08 ppm or less. The 24-hour PM$_{10}$ standard is attained when the three-year average of the 99th percentile of monitored concentrations is less than the standard. The 24-hour PM$_{2.5}$ standard is attained when the three-year average of the 98th percentile is less than the standard.

c. The USEPA revoked the national 1-hour ozone standard on June 15, 2005.

d. To attain this standard, the 3-year average of the 98th percentile of the daily maximum 1-hour average at each monitor within the area must not exceed 0.1 ppm (effective January 22, 2010).

e. On June 2, 2010, the U.S. EPA established a new 1-hour SO$_2$ standard, effective August 23, 2010, which is based on the 3-year average of the annual 99th percentile of 1-hour daily maximum concentrations. The EPA also revoked both the existing 24-hour SO$_2$ standard of 0.14 ppm and the annual primary SO$_2$ standard of 0.030 ppm, effective August 23, 2010.

f. Statewide visibility-reducing particle standard (except Lake Tahoe Air Basin): Particles in sufficient amount to produce an extinction coefficient of 0.23 per kilometer when the relative humidity is less than 70 percent. This standard is intended to limit the frequency and severity of visibility impairment due to regional haze and is equivalent to a 10-mile nominal visual range.

2.2. TOXIC AIR CONTAMINANTS

Toxic Air Contaminants (TACs) collectively refer to a diverse group of air pollutants that are capable of causing chronic (i.e., of long duration) and acute (i.e., severe but of short duration) adverse effects on human health, including carcinogenic effects. A TAC is defined in the California Health and Safety Code §39655 as an air pollutant which may cause or contribute to an increase in mortality or serious illness, or which may pose a present or potential hazard to human health. Human health effects of TACs include birth defects, neurological damage, cancer, and death. There are hundreds of different types of TACs with varying degrees of toxicity. Individual TACs vary greatly in the health risk they present; at a given level of exposure, one TAC may pose a hazard that is many times greater than another.

TACs do not have ambient air quality standards, but are regulated by the BAAQMD using a risk-based approach. This approach uses a health risk assessment to determine which sources and pollutants to control as well as the degree of control. A health risk assessment is an analysis in which human health exposure to toxic substances is estimated, and considered together with information regarding the toxic potency of the substances, to provide quantitative estimates of health risks.[12]

In addition to monitoring criteria pollutants, both the BAAQMD and the California Air Resources Board (ARB) operate TAC monitoring networks in the SFBAAB. These stations measure 10 to 15 TACs, depending on the specific station. The TACs selected for monitoring are those that have traditionally been found in the highest concentrations in ambient air, and therefore tend to result in the most substantial health risk. The BAAQMD operates monitoring sites for TACs and PM. Monitoring sites are selected based on population exposure and at locations with the highest expected concentrations and/or proximity near potential sources of air pollutants.[13] The BAAQMD operates an ambient TAC monitoring station at its 16th and Arkansas Streets facility in San Francisco. When TAC measurements at this station are compared to ambient concentrations of various TACs for the Bay Area as a whole, the cancer risk associated with mean (i.e., average) TAC concentrations in San Francisco are similar to

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[12] In general, a health risk assessment is required if the BAAQMD concludes that projected emissions of a specific air toxic compound from a proposed new or modified source suggest a potential public health risk. The applicant is then subject to a health risk assessment for the source in question. Such an assessment generally evaluates chronic, long-term effects, estimating the increased risk of cancer as a result of exposure to one or more TACs.

[13] BAAQMD, "District Air Monitoring Sites," Available at: http://hank.baaqmd.gov/tec/maps/dam_sites.htm#guidelines. Accessed May 2, 2012.

those for the Bay Area as a whole. Therefore, the estimated average lifetime cancer risk resulting from exposure to background TAC concentrations monitored at the San Francisco station does not appear to be any greater than for the Bay Area as a region. Table 2-2 compares statewide TAC emissions with emissions inventories for the SFBAAB and estimated excess cancer risk from exposure to those TACs.

2.2.1. Inventory of Toxic Air Contaminants

Each year, ARB provides historical, current, and projected air quality and emissions data for California in *The California Almanac of Emissions and Air Quality* (*Almanac*). At the time of this report, the most recent published addition was the *2009 Almanac*. The *Almanac* provides an overview of data, as maintained in ARB's emission and air quality databases, for criteria air pollutants and the ten TACs posing the greatest known cancer risk in California (listed in Table 2-2). The information provided in Table 2-2 presents a summary of pertinent data contained in the *2009 Almanac*. However, since publication of the *2009 Almanac*, ARB has updated the methodology for estimating emissions, providing limitations in using this data. As explained further in Chapter 5, these limitations have resulted in an overestimation of emissions from off-road equipment.

It should be noted that the health risk numbers provided are attributable only to health risk from these ten TACs. It has been estimated that the bulk of cancers from known risk factors are associated with lifestyle factors. One such study estimated that of cancers associated with known risk factors, environmental related exposures (which include air pollution) constituted only two percent of the total risk. Ten risk factors had greater risk than environmental related exposures including: 30 percent were related to tobacco, 30 percent were related to diet and obesity, and five percent were related to lack of exercise. [14]

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[14] Harvard Center for Cancer Prevention; Harvard School of Public Health, *Harvard Report on Cancer Prevention, Volume I: Causes of Human Cancer*, 1996.

TABLE 2-2. TOXIC AIR CONTAMINANT EMISSIONS AND HEALTH RISK

Toxic Air Contaminants	**2008 Toxic Air Contaminant Emissions (tons/year)**		**Health Risk Estimates (Excess Cancer Cases per Million)[a, b]**	
	Statewide	SFBAAB	Statewide	SFBAAB
Acetaldehyde	9,103	1,350	5	3
Benzene	10,794	1,634	35	25
1,3-Butadiene	3,754	3,754	34	23
Carbon Tetrachloride	4.04	2.13	25	25
Chromium, Hexavalent	0.61	0.05	10	8
para-Dichlorobenzene	1,508	284	10	10
Formaldehyde	20,951	3,138	19	11
Methylene Chloride	6,436	906	1	<1
Perchloroethylene	4,982	788	1	1
Diesel Particulate Matter	35,884	4,151	540	480
TOTAL	**93,416.65**	**16,007.18**	**680**	**586**

SOURCE: California Air Resources Board, *The California Almanac of Emissions and Air Quality – 2009 Edition*, Chapter 5 and Table C-19.

SFBAAB – San Francisco Bay Area Air Basin

TAC – Toxic Air Contaminant

a. Health Risk represents the number of excess cancer cases per million people based on a lifetime (70-year) exposure to the annual average concentration (not shown in table).

b. The latest year of record for the top ten toxic air contaminants and health risks varies: diesel particulate matter reflects 2000 data (currently, estimates are being reviewed), carbon tetrachloride reflects 2003 data, para-dichlorobenzene reflects 2006 data, and all others reflect 2007 data. Therefore, the 2008 toxic air contaminant emissions may not necessarily correlate with the latest health risk numbers provided here because of different years of record.

2.3. SOURCES OF AIR POLLUTION

As shown in Table 2-2, above, among the 10 TACs that pose the greatest known health risk in California, diesel particulate matter (DPM) poses the greatest excess cancer risk in California (79 percent of total) and in the SFBAAB (82 percent of total).[15] Table 2-3 identifies the primary sources of DPM emissions for California and the SFBAAB. As shown in Table 2-3 other mobile emissions[16] are the largest source of DPM in California (60 percent of total) and the SFBAAB (69

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[15] ARB, *The California Almanac of Emissions and Air Quality – 2009 Edition*, Figure 5-2. The latest year of record for the top ten toxic air contaminants and health risks varies: diesel particulate matter reflects 2000, carbon tetrachloride reflects 2003, para-dichlorobenzene reflects 2006, and all others reflect 2007 data.

[16] The category "other mobile" includes aircraft, trains, ocean going vessels, commercial harbor craft, recreational boats, off-road recreational vehicles, off-road equipment, farm equipment, and fuel storage and handling.

percent of total). On-road mobile emissions are the second largest source of DPM in California (38 percent of total) and the SFBAAB (29 percent of total).[17]

TABLE 2-3. EMISSION SOURCES OF DIESEL PARTICULATE MATTER

Emissions Source	**2008 DPM Emissions (tons/year)**	
	Statewide	SFBAAB
Stationary Sources	531	62
Area-Wide Sources	0	0
On-Road Mobile	13,670	1,222
Other Mobile	21,683	2,867
Natural Sources	0	0
TOTAL	**35,884**	**4,151**

SOURCE: California Air Resources Board, *The California Almanac of Emissions and Air Quality – 2009 Edition*, Tables 5-21 and 5-43.

DPM – Diesel Particulate Matter

SFBAAB – San Francisco Bay Area Air Basin

TAC – Toxic Air Contaminant

Within San Francisco, the primary sources of TACs and PM are mobile sources (high volume roadways, the Caltrain railway, and the Transit Center/Transbay Terminal bus depot). In addition to mobile sources, maritime and port operations, and stationary sources also emit TACs and PM. Stationary sources are permitted by the BAAQMD, who maintains a database of TAC emissions from these sources.

Of the sources most prevalent within San Francisco, PM emissions, either $PM_{2.5}$ or DPM, are associated with roadway-related air pollutants, operation of the Caltrain railway, and maritime and port operations. PM emissions are also associated with permitted stationary diesel engines, crematories, and construction projects.[18]

The BAAQMD identifies three categories of air pollutant sources, each of which are described below along with an assessment of their general prevalence within San Francisco:[19]

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[17] ARB, *The California Almanac of Emissions and Air Quality – 2009 Edition*, Tables 5-21 and 5-43.

[18] Construction projects require the use of on- and off-road vehicles and equipment that emit DPM.

[19] BAAQMD, *Recommended Methods for Screening and Modeling Local Risks and Hazards*. May 2011. Available online at: http://www.baaqmd.gov/Divisions/Planning-and-Research/CEQA-GUIDELINES/Tools-and-Methodology.aspx. Accessed May 2, 2012.

2.3.1. Common Sources

Common Sources are sources of TACs or PM emissions that are significant enough to warrant consideration when siting new sensitive land uses. Common sources include, but are not limited to: freeways and major roadways; gas stations; stationary diesel engines, such as standby back-up generators; dry cleaners; crematories; spray-booths; and construction projects. Many of these common sources can be found within San Francisco.

Common sources generally pose the greatest health risks in the Bay Area.[20] Common stationary sources within San Francisco primarily include diesel engines (i.e., standby back-up generators), gas stations, dry cleaning operations, and paint spray booths. The primary TACs associated with gas stations are evaporative emissions of benzene and ethylbenzene. Based on a review of the BAAQMD's inventory of stationary sources within San Francisco, PM emissions from gas stations are insignificant.[21]

Dry cleaning operations primarily emit evaporative emissions of perchloroethylene and spray booths emit evaporative emissions of volatile organic compounds (VOCs). However, BAAQMD Regulation 11, Rule 16 required that all co-residential (sharing a wall, floor, ceiling or is in the same building as a residential unit) dry cleaners cease use of perchloroethylene on July 1, 2010. Additionally, all other dry cleaners must phase out use of perchloroethylene by Jan. 1, 2023. Therefore, due to current regulations, dry cleaning facilities are not anticipated to result in substantial, long term health risks to sensitive receptors in San Francisco.

The BAAQMD also administers a number of rules and regulations regarding spray booths and new stationary diesel engines. Spray booths must comply with a number of rules relating to VOC limits and new stationary diesel engines are required to comply with Regulation 2, Rule 5 New Source Review for Toxic Air Contaminants. Regulation 2, Rule 5 requires new sources that result in an excess cancer risk greater than one in one million to implement the best available control technology; however, older stationary diesel engines in San Francisco continue to present potential health risks from emissions of DPM.

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[20] BAAQMD, *Recommended Methods for Screening and Modeling Local Risks and Hazards*. May 2011. Available online at: http://www.baaqmd.gov/Divisions/Planning-and-Research/CEQA-GUIDELINES/Tools-and-Methodology.aspx. Accessed May 2, 2012.

[21] The BAAQMD has released a database listing all stationary sources permitted by BAAQMD and provides risk and hazard estimates, along with $PM_{2.5}$ concentrations from those facilities. This database is available online at: http://www.baaqmd.gov/Divisions/Planning-and-Research/CEQA-GUIDELINES/Tools-and-Methodology.aspx. Accessed May 25, 2012. All gas stations within San Francisco have been designated "n/a" for $PM_{2.5}$ emissions, which according to BAAQMD staff means no significant risk.

2.3.2. Complex Sources

Complex Sources are sources that may pose significant health risks but require either specific information or complex modeling analysis. Quantification of emissions from these types of sources is complex and requires comprehensive knowledge of the sources of emissions, number of sources, and the types of pollutants emitted. Examples of complex sources that generate substantial air pollution include: major ports; railyards; distribution centers and truck-related businesses; airports; oil refineries; power plants; metal melting facilities; and cement plants. Port and maritime operations, the Transit Center/Transbay Terminal bus depot, and operation of the Caltrain railway are complex sources within San Francisco that emit DPM. The BAAQMD has determined that there are currently no distribution centers within San Francisco that pose a substantial health risk.[22]

2.3.3. Minor, Low-Impact Sources

Minor, low-impact sources are sources that are unlikely to pose a significant risk. The BAAQMD has determined through extensive modeling, source tests, and evaluation of TAC emissions, that minor, low impact sources do not pose a significant health impact even in combination with other nearby sources and determined that these sources can be omitted from risk and hazard assessments. Minor, low-impact sources include: roads with less than 10,000 total vehicles per day and less than 1,000 trucks per day; non-diesel boilers; soil-vapor extraction wells; and cooking (excluding under-fired char-broilers) and space-heating equipment.[23] The BAAQMD considers sources that are exempt from their stationary source permitting requirements (as listed in Regulation 2, Rule 1) to be insignificant sources.[24] Therefore, exempt sources would not result in substantial, long-term health risks to sensitive populations in San Francisco.

2.4. HEALTH EFFECTS FROM EXPOSURE TO AIR POLLUTANTS

Air pollution does not affect every individual in the population in the same way, and some groups are more sensitive to adverse health effects than others. Population subgroups sensitive to the health effects of air pollutants include the elderly and the young, population subgroups

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[22] Lau, Virginia, BAAQMD. Personal Communication with Jessica Range, San Francisco Planning Department. Email dated November 28, 2011.

[23] BAAQMD, *Recommended Methods for Screening and Modeling Local Risks and Hazards.* May 2011.

[24] BAAQMD, *Recommended Methods for Screening and Modeling Local Risks and Hazards.* May 2011.

with higher rates of respiratory disease such as asthma and chronic obstructive pulmonary disease, and populations with other environmental or occupational health exposures (e.g. indoor air quality) that affect cardiovascular or respiratory diseases. Land uses such as residences, schools, children's day care centers, hospitals, and nursing and convalescent homes are considered to be the most sensitive to poor air quality because the population groups associated with these uses have increased susceptibility to respiratory distress or, as in the case of residential receptors, their exposure time is greater than for other land uses. Parks and playgrounds are considered moderately sensitive to poor air quality because persons engaged in strenuous work or exercise also have increased sensitivity to poor air quality; however, exposure times are generally far shorter in parks and playgrounds than in residential locations and schools, for example, which reduce overall exposure to air pollutants. Residential land uses are considered more sensitive to air pollution compared to commercial and industrial land uses because people generally spend longer periods of time at their residences, with associated greater exposure to ambient air quality conditions. Exposure assessment guidance typically assumes that residences would be exposed to air pollution 24 hours per day, 350 days per year, for 70 years. Therefore, assessments of air pollutant exposure to residents typically result in the greatest adverse health outcomes of all population groups.

As shown in Table 2-3, mobile sources are responsible for a large share of air pollution in California and in the SFBAAB. Engine exhaust, from diesel, gasoline, and other combustion engines, is a complex mixture of particles and gases, with collective and individual toxicological characteristics. Vehicle tailpipe emissions include criteria air pollutants such as PM and CO, and ozone precursor compounds such as nitrogen oxides (NO_x). In addition to criteria pollutants, tailpipe emissions contain other non-criteria TACs, including benzene, 1,3-butadiene, formaldehyde, acetaldehyde, acrolein, naphthalene, and diesel exhaust.[25]

While each constituent pollutant in engine exhaust may have a unique toxicological profile, health effects have been associated with proximity, or exposure, to vehicle-related pollutants *collectively* as a mixture.[26] Individual epidemiological studies have linked roadway proximity, or

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[25] DPH, *Assessment and Mitigation of Air Pollutant Health Effects from Intra-Urban Roadways: Guidance for Land Use Planning and Environmental Review*. May 2008.

[26] Delfino RJ, 2002. Epidemiologic evidence for asthma and exposure to air toxics: linkages between occupational, indoor, and community air pollution research. Environmental Health Perspectives, 110(S4):573-589.

vehicle emissions, to impairments of lung function; [27] asthma symptoms;[28,29,30] medical visits for asthma;[31] asthma prevalence and incidence; [32,33,34,35,36] and ischemic heart disease.[37,38] A Health Effects Institute (HEI) Report in 2008 concluded that "Evidence was 'sufficient' to infer a causal relationship between exposure to traffic-related air pollution and exacerbation of asthma and 'suggestive' to infer a causal relationship with onset of childhood asthma, non-asthma respiratory symptoms, impaired lung function, and cardiovascular mortality."[39]

PM is a complex mixture of extremely small particles and liquid droplets. Fine PM particles ($PM_{2.5}$) are associated with forest fires, or they can form when gases emitted from power plants,

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[27] Brunekreef, B. et al. "Air pollution from truck traffic and lung function in children living near motorways." Epidemiology. 1997; 8:298-303.

[28] Venn AJ, Lewis SA, Cooper M, Hubbard R, and Britton J. 2001. Living near a main road and the risk of wheezing illness in children. American Journal of Respiratory and Critical Care Medicine, 164:2177-2180.

[29] Lin, S. et al. "Childhood asthma hospitalization and residential exposure to state route traffic." Environ Res. 2002;88:73-81.

[30] Kim, J. et al. "Traffic-related air pollution and respiratory health: East Bay Children's Respiratory Health Study." American Journal of Respiratory and Critical Care Medicine 2004; Vol. 170. pp. 520-526

[31] English P., et al. "Examining Associations Between Childhood Asthma and Traffic Flow Using a Geographic Information System." (1999) Environmental Health Perspectives 107(9): 761-767.

[32] McConnell R, Berhane K, Yao L, Jerrett M, Lurmann F, Gilliland F, Kunzli N, Gauderman J, Avol E, Thomas D, and Peter J, 2006. *Traffic, susceptibility, and childhood asthma*. Environmental Health Perspectives, 114:766-772.

[33] Gauderman WJ, Avol E, Lurmann F, Kuenzli N, Gilliland F, Peters J, McConnell R. Childhood asthma and exposure to traffic and nitrogen dioxide. Epidemiology. 2005 Nov;16(6):737-43.

[34] Jerrett M, Shankardass K, Berhane K, Gauderman WJ, Künzli N, Avol E, Gilliland F, Lurmann F, Molitor JN, Molitor JT, Thomas DC, Peters J, McConnell R. *Traffic-related air pollution and asthma onset in children: a prospective cohort study with individual exposure measurement.* Environ Health Perspect. 2008 Oct;116(10):1433-8.

35 Kim JJ, Huen K, Adams S, Smorodinsky S, Hoats A, Malig B, Lipsett M, Ostro B. Residential traffic and children's respiratory health. Environ Health Perspect. 2008 Sep;116(9):1274-9.

[36] McConnell R, Islam T, Shankardass K, Jerrett M, Lurmann F, Gilliland F, Gauderman J, Avol E, Kuenzli N, Yao L, Peters J, Berhane K. Childhood Incident Asthma and Traffic-Related Air Pollution at Home and School. Environ Health Perspect. 2010 Mar 22. [Epub ahead of print]

[37] Hoffmann B, Moebus S, Mohlenkamp S, Stang A, Lehmann N, Dragano N, Schmermund A, Memmesheimer M, Mann K, Erbel R, and Jockel KH, 2007. Residential exposure to traffic is associated with coronary atherosclerosis. Heinz Nixdorf Recall Study Investigative Group. Circulation, 116:489-496.

[38] Hoffmann B, Moebus S, Stang A, Beck EM, Dragano N, Mohlenkamp S, Schmermund A, Memmesheimer M, Mann K, Erbel R, and Jockel KH, 2006. Residence close to high traffic and prevalence of coronary heart disease. Heinz Nixdorf RECALL Study Investigative Group. European Heart Journal, 27:2696-2702.

[39] Health Effects Institute, 2009. "Traffic-Related Air Pollution: A Critical Review of the Literature on Emissions, Exposure, and Health Effects." Special Report #17. Available online at: http://pubs.healtheffects.org/view.php?id=306. Accessed May 25, 2012.

industries and automobiles react in the air.[40] Collectively, exposures to fine particles are strongly associated with mortality, respiratory diseases and impairment of lung development in children, and other endpoints such as hospitalization for cardiopulmonary disease.[41] Based on toxicological and epidemiological research, smaller particles and those associated with traffic appear more closely related to health effects.[42] Therefore, $PM_{2.5}$, or fine particulate matter, is of particular concern. $PM_{2.5}$ is not a designated TAC, but rather a criteria pollutant, as described previously. The SFBAAB is designated nonattainment for either state or federal PM_{10} and $PM_{2.5}$ standards. Evidence suggests that there is no safe level of exposure to particulates and that the effects of PM are linearly related to the concentration one is exposed to.[43]

In addition to $PM_{2.5}$, DPM is also of concern. The ARB identified DPM as a TAC in 1998, primarily based on evidence demonstrating cancer effects in humans.[44] Mobile sources such as trucks and buses are among the primary sources of diesel emissions, and concentrations of DPM are higher near heavily traveled highways. The estimated cancer risk from exposure to diesel exhaust is much higher than the risk associated with any other TAC routinely measured in the region. As shown in Table 2-2, ARB has estimated the average Bay Area cancer risk from DPM, based on a population-weighted average ambient diesel particulate concentration, at about 480 in one million, as of 2000. ARB has estimated that DPM is responsible for about 70 percent of the cancer risk associated with exposure to the total ambient air toxics.[45] However, cancer risk from DPM declined from 750 in one million in 1990 to 570 in one million in 1995; by 2000, ARB estimated the average statewide cancer risk from DPM at 540 in one million.[46,47]

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[40] USEPA, "Particulate Matter." Available online at: http://www.epa.gov/pm. Accessed May 2, 2012.

[41] DPH, *Assessment and Mitigation of Air Pollutant Health Effects from Intra-Urban Roadways: Guidance for Land Use Planning and Environmental Review*. May 2008.

[42] Schlesinger RB, Kunzli N, Hidy GM, Gotschi T, Jerrett M. 2006. The Health Relevance of Ambient Particulate Matter Characteristics: Coherence of Toxicological and Epidemiological Inferences. Inhalational Toxicology. 18:95-125.

[43] World Bank Group. Pollution Prevention and Abatement Handbook, Airborne Particulate Matter. July 1998.

[44] ARB, Fact Sheet, "The Toxic Air Contaminant Identification Process: Toxic Air Contaminant Emissions from Diesel-fueled Engines." October 1998. Available on the internet at: http://www.arb.ca.gov/toxics/dieseltac/factsht1.pdf.

[45] ARB, Health Impacts of Diesel PM: An Update. November 19, 2009. This presentation is available online at: http://www.arb.ca.gov/board/books/2009/111909/09-9-6pres.pdf. Accessed May 2, 2012.

[46] ARB, California Almanac of Emissions and Air Quality - 2009 Edition, Table 5-44 and p. 5-44. Available on the internet at: http://www.arb.ca.gov/aqd/almanac/almanac09/pdf/chap509.pdf. Viewed 26 May 2011.

In 2000, the ARB approved a comprehensive *Diesel Risk Reduction Plan* to reduce diesel emissions from both new and existing diesel-fueled vehicles and engines. As part of meeting the goals of this Plan, in 2008 the ARB approved a new regulation for existing heavy-duty diesel vehicles that will require retrofitting and replacement of vehicles (or their engines) over time such that by 2023, all vehicles must have a 2010 model year engine or equivalent. The regulation is anticipated to result in an 80 percent decrease in statewide diesel health risk in 2020 from the 2000 risk levels.[48] Additional regulations apply to new trucks and to diesel fuel. With new controls and fuel requirements, 60 trucks built in 2007 would have the same soot exhaust emissions as one truck built in 1988.[49]

Despite these reductions, the ARB recommends that proximity to sources of DPM emissions be considered in the siting of new sensitive land uses. The location of transportation facilities determines the spatial patterns of exposure to traffic-related pollutants from vehicle sources in urban areas. In traffic-related studies, the additional non-cancer health risk attributable to roadway proximity was seen within 1,000 feet of the roadway and was strongest within 300 feet. As a result, the ARB recommends that new sensitive land uses not be located within 500 feet of a freeway or urban roads carrying more than 100,000 vehicles per day.[50]

The ARB notes that these recommendations are advisory and should not be interpreted as defined "buffer zones," and that local agencies must balance other considerations, including housing and transportation needs, the benefits of urban infill development, community economic development priorities, and other quality of life issues. With careful evaluation of exposure, health risks, and affirmative steps to reduce risk where necessary, ARB's position is that infill development, mixed-use, higher density, transit-oriented development, and other

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[47] The calculated cancer risk values from ambient air exposure in the Bay Area can be compared against the lifetime probability of being diagnosed with cancer in the United States, from all causes, which is more than 40 percent (based on a sampling of 17 regions nationwide), or greater than 400,000 in one million, according to the National Cancer Institute.

[48] ARB, "Overview of Truck and Bus Regulation Reducing Emissions from Existing Diesel Vehicles," fact sheet, February 25, 2009; and "Facts About Truck and Bus Regulation Emissions Reductions and Health Benefits," fact sheet, February 25, 2009. Available online at: http://www.arb.ca.gov/msprog/onrdiesel/documents.htm. Accessed May 26, 2011.

[49] Pollution Engineering, New Diesel Fuel Rules Start, July 2, 2006. http://www.pollutionengineering.com/articles/85480-new-clean-diesel-fuel-rules-start. Accessed October 30, 2006.

[50] ARB, *Air Quality and Land Use Handbook: A Community Health Perspective.* April 2005. Available online at: http://www.arb.ca.gov/ch/landuse.htm. Accessed May 2, 2012.

concepts that benefit regional air quality can be compatible with protecting the health of individuals at the neighborhood level.[51]

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[51] ARB, *Air Quality and Land Use Handbook: A Community Health Perspective.* April 2005. See footnote 52, p.1. Available online at: http://www.arb.ca.gov/ch/landuse.htm. Accessed May 2, 2012.

Chapter 3. Assessment of Air Pollution Exposure in San Francisco

As discussed in Chapter 1, San Francisco's limited land supply, the existing dense pattern of development, and mix of land uses often results in development of sensitive land uses in close proximity to sources of air pollution. While most of San Francisco is endowed with good air quality, portions of the City that are close to freeways, busy roadways, and other sources of air pollution experience much higher concentrations of air pollutants. These air pollution "hot spots" result in additional health risks for affected populations. This chapter describes the criteria used to determine air pollution hot spots.

3.1. AIR POLLUTANT DISPERSION MODELING

In order to identify air pollution hot spots, San Francisco has partnered with the BAAQMD to inventory and assess air pollution and exposures from mobile, stationary, and area sources within San Francisco. This modeling effort includes dispersion modeling of emissions from the primary sources of air pollutants in San Francisco and therefore, represents a comprehensive assessment of cumulative exposures to air pollution throughout the City. The BAAQMD has conducted dispersion modeling using AERMOD[52] to assess the emissions from the following primary sources: roadways, permitted stationary sources, port and maritime sources, Caltrain and the Transit Center/Transbay Terminal bus depot. PM_{10}, $PM_{2.5}$ and total organic gases (TOG) were modeled on a 20 meter by 20 meter receptor grid covering the entire City. For more information on methodology and assumptions that were included in the model see Appendix A.

3.2. HEALTH-BASED CRITERIA FOR DETERMINING AIR POLLUTION HOT SPOTS

Air pollution hot spots are identified based on two health-protective criteria: (1) excess cancer risk from the contribution of emissions from all modeled sources, and (2) cumulative $PM_{2.5}$ concentrations. In determining the additional health impacts from $PM_{2.5}$, $PM_{2.5}$ concentrations throughout the City were modeled from the primary sources listed above and ambient $PM_{2.5}$

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[52] AERMOD is the USEPAs preferred/recommended steady state air dispersion plume model. For more information on AERMOD and to download the AERMOD Implementation Guide, see: http://www.epa.gov/ttn/scram/dispersion_prefrec.htm#aermod. Accessed May 3, 2012.

concentrations were added to those concentrations to determine total $PM_{2.5}$ exposure concentrations. As explained in Chapter 2, PM is strongly associated with a number of adverse health effects including mortality, respiratory diseases, impairment of lung development in children, and hospitalization for cardiopulmonary disease. Therefore, the following health protective criteria were identified to determine air pollution hot spots:

- Excess cancer risk from all sources > 100 per one million population; and
- $PM_{2.5}$ concentrations from all sources including ambient >10 micrograms per cubic meter ($\mu g/m^3$).

Figure 3-1 shows the geographic locations that exceed the above excess cancer risk and $PM_{2.5}$ concentration. Figure 3-2 combines these locations into one map illustrating the City's air pollution hot spots. Emissions were modeled on a 20 meter receptor grid; therefore, Figures 3-1 and 3-2 reflect a 20 meter boundary around receptor points that exceed the above criteria. The following evidence is provided in support of the criteria identified above.

3.2.1. Excess Cancer Risk

The one-hundred per one million persons (100 excess cancer risk) criteria is based on the USEPA guidance for conducting air toxic analyses and making risk management decisions at the facility and community-scale level.[53] As described by the BAAQMD, the USEPA considers a cancer risk of 100 per million to be within the "acceptable" range of cancer risk. Furthermore, in the 1989 preamble to the benzene National Emissions Standards for Hazardous Air Pollutants (NESHAP) rulemaking,[54] the USEPA states that it "…strives to provide maximum feasible protection against risks to health from hazardous air pollutants by: (1) protecting the greatest number of persons possible to an individual lifetime risk level no higher than approximately one in one million, and (2) limiting to no higher than approximately one in ten thousand [100 in one million] the estimated risk that a person living near a plant would have if he or she were exposed to the maximum pollutant concentrations for 70 years." The 100 per one million excess cancer cases is also consistent with the ambient cancer risk in the most pristine portions of the Bay Area based on BAAQMD regional modeling.[55]

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[53] BAAQMD, *Revised Draft Options and Justification Report, California Environmental Quality Act Thresholds of Significanc*e, October 2009, page 67.

[54] 54 Federal Register 38044, September 14, 1989.

[55] BAAQMD, *Revised Draft Options and Justification Report, California Environmental Quality Act Thresholds of Significance*, October 2009, page 67.

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Figure 3-1: Excess Cancer Risk >/= 100 per one million or Annual Average PM2.5 concentrations >/= 10.0 ug/m^3

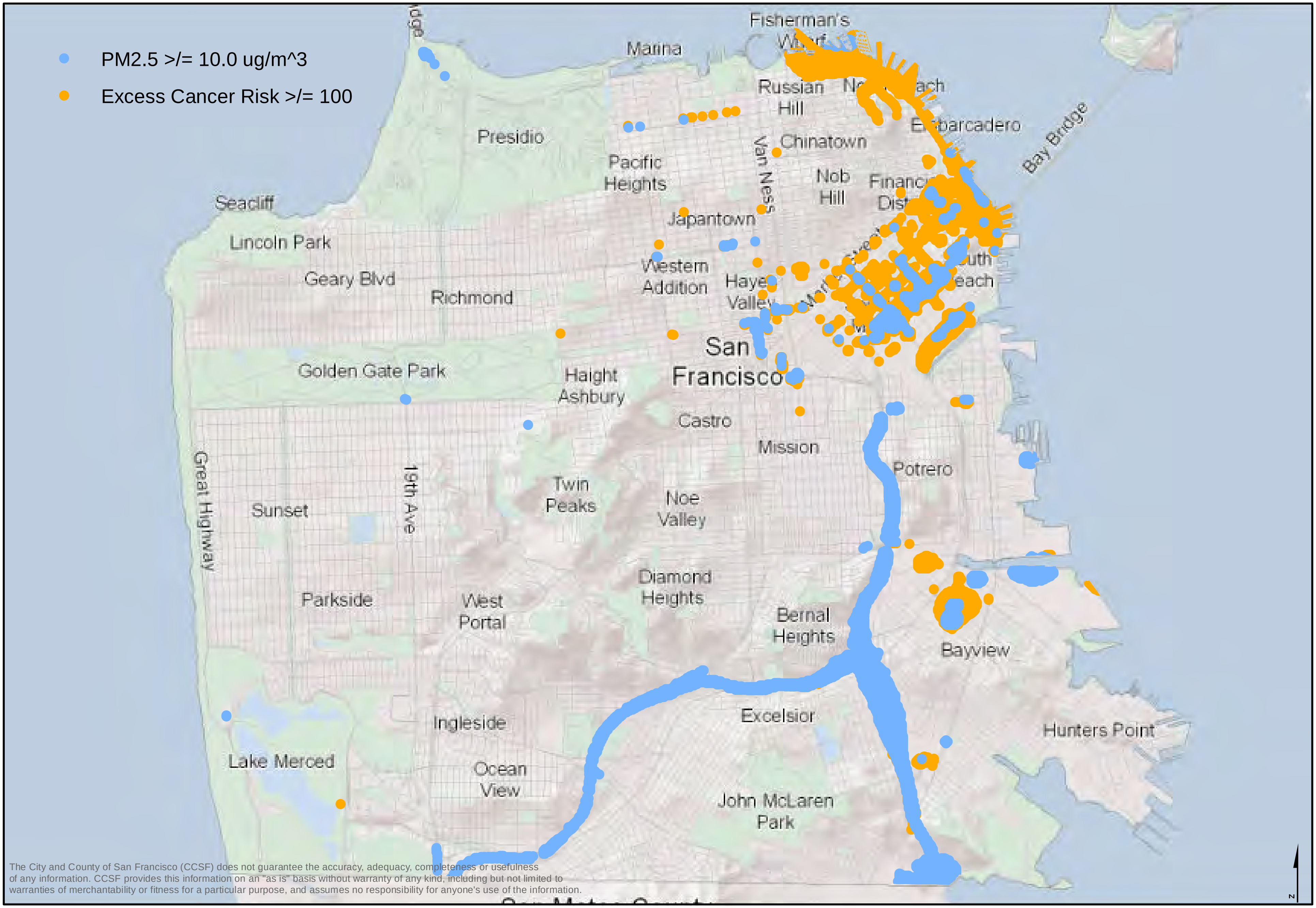

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Figure 3-2: Air Pollution Hot Spots

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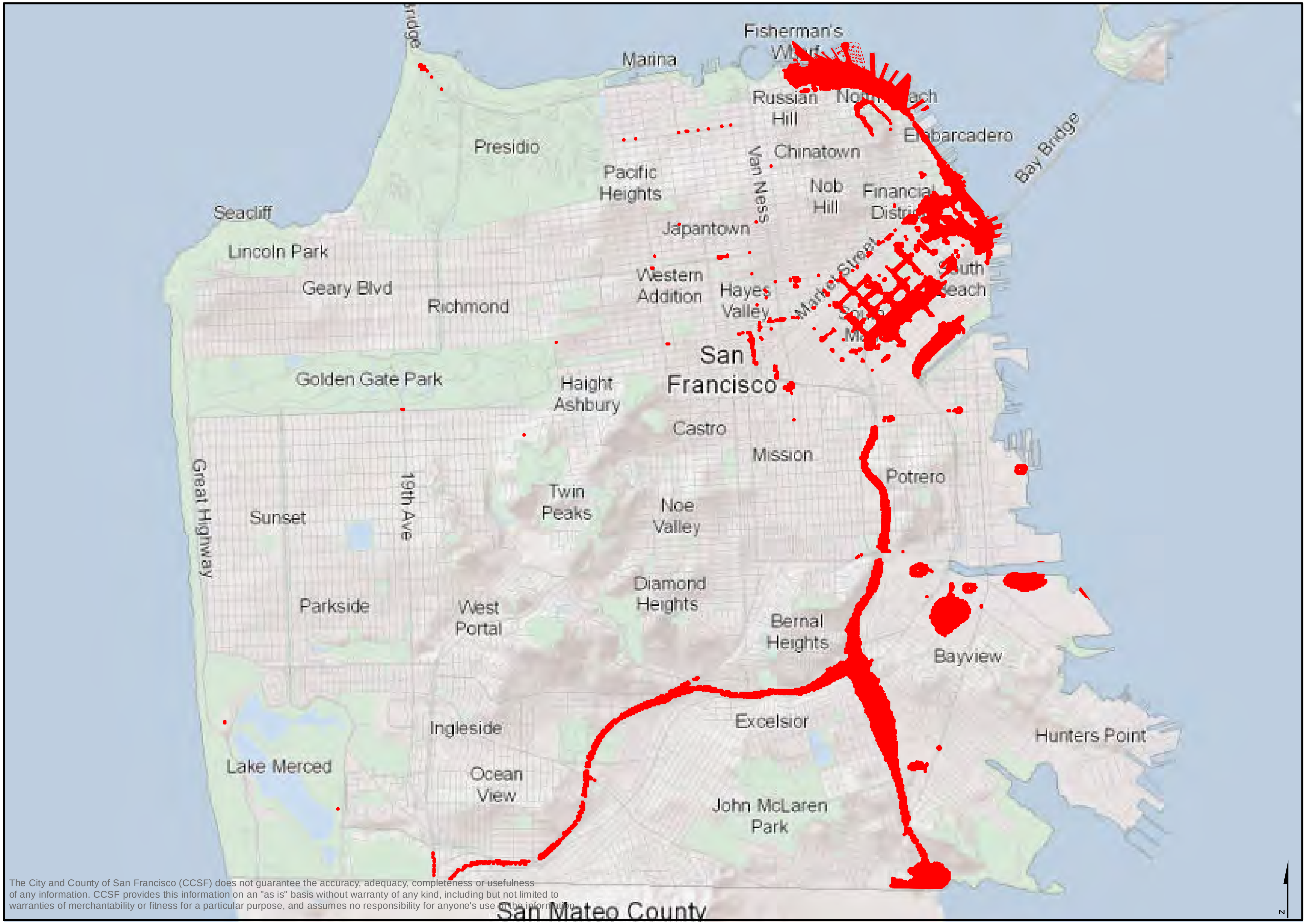

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Therefore, in areas of the City where the combination of sources result in an additional excess cancer risk of 100 per one million, sensitive land uses may be substantially more at risk of developing cancer.

3.2.2. Fine Particulate Matter ($PM_{2.5}$) Concentration

As explained in Chapter 2, federal and state agencies have identified ambient air quality standards for California pursuant to federal and state Clean Air Acts. The USEPA is required to carry out a periodic review and revision, as appropriate, of the air quality criteria and the primary and secondary standards for the six criteria air pollutants regulated by the federal CAA, which include PM. Primary standards set limits to protect public health, including the health of sensitive populations, such as asthmatics, children, and the elderly. Secondary standards set limits to protect public welfare, including protection against decreased visibility, damage to animals, crops, vegetation, and buildings.

In April 2011, the USEPA published *Policy Assessment for the Particulate Matter Review of the National Ambient Air Quality Standards*, "Particulate Matter Policy Assessment." The purpose of the Particulate Matter Policy Assessment is to "bridge the gap" between the scientific information and the judgments required of the USEPA Administrator in determining whether it is appropriate to retain or revise the PM standards. In this document, USEPA staff concludes that the currently available information calls into question the adequacy of the federal standard of 15 $\mu g/m^3$ for $PM_{2.5}$ and that consideration should be given to revising the standards to provide increased public health protection. The USEPA staff further concludes that the current annual $PM_{2.5}$ standard should be revised to a level within the range of 13 to 11 $\mu g/m^3$, with evidence strongly supporting a standard within the range of 12 to 11 $\mu g/m^3$. USEPA staff also concluded that protection from both long- and short-term $PM_{2.5}$ exposures can most effectively and efficiently be provided by relying primarily on the annual standard, with the 24-hour standard providing supplemental protection for days with high peak concentrations.

In preparing the Particulate Matter Policy Assessment, the USEPA requested that the Clean Air Scientific Advisory Committee review various drafts. This independent technical body concurred with the USEPA's findings that the current standard for $PM_{2.5}$ should be revised and that the levels under consideration, 13 to 11 μg/m^3, are supported by epidemiological and toxicological evidence.[56]

Advocates for clean air, including the American Lung Association, Clean Air Task Force, and Earthjustice support an annual standard of 11 μg/m^3 and a daily standard of 25 μg/m^3 and have analyzed the health benefits of reducing the federal $PM_{2.5}$ standards to these levels.[57] Their report *Sick of Soot*, summarizes the findings of *Health Benefits of Alternative* $PM_{2.5}$ *Standards*,[58] which determined that lowering the federal $PM_{2.5}$ standards to 11 μg/m^3 (annual) and 25 μg/m^3 (daily) would result in avoidance of the following adverse health effects:

- 35,700 premature deaths;
- 2,350 heart attacks;
- 23,290 hospital and emergency room visits;
- 29,800 cases of acute bronchitis;
- 1.4 million cases of aggravated asthma; and
- 2.7 million days of missed work or school due to air pollution-caused ailments.

On December 14, 2012, the USEPA finalized revised fine particulate matter standards under the federal CAA, reducing the national ambient air quality standards from 15 μg/m^3 to 12 μg/m^3.[59] These revised annual standards are equivalent to California's fine particulate matter standard of 12 μg/m^3, adopted in 2002.

Air pollution hot spots shown in Figure 3-2, are based on the health protective $PM_{2.5}$ standard of 11 μg/m^3, as supported by the USEPA's Particulate Matter Policy Assessment, although lowered to 10 μg/m^3 to be more health protective and account for error bounds in emissions modeling programs.

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[56] USEPA, "CASAC Review of Policy Assessment for the Review of the PM NAAQS – Second External Review Draft (June 2010)," EPA-CASAC-10-015, September 10, 2010.

[57] American Lung Association, Clean Air Task Force, Earthjustice, *Sick of Soot: How the EPA can Save Lives by Cleaning up Fine Particulate Air Pollution*, November 2011.

[58] McCubbin, Donald, PhD, *Health Benefits of Alternative* $PM_{2.5}$ *Standards*, July 2001, accessed online May 17, 2012, http://earthjustice.org/soot.

[59] "Press Release: USEPA Announces Next Round of Clean Air Standards to Reduce Harmful Soot Pollution." December 14, 2012. Available online at: yosemite.epa.gov/opa/admpress.nsf/d0cf6618525a9efb85257359003fb69d/a7446ca9e228622b85257ad400644d82!OpenDocument. Accessed February 7, 2013.

Sensitive land uses within these locations are more at risk for adverse health effects from exposure to sources of air pollution. Proposed projects that would site new sensitive land uses or result in additional air pollution require special consideration in these locations. Chapters 4, 5, and 6 identify best management practices that should be implemented when siting new sensitive land uses, for projects that would result in construction emissions, or when introducing a new stationary source within air pollution hot spots.

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Chapter 4. Siting Sensitive Land Uses

This chapter identifies existing guidance pertaining to the siting of sensitive land uses and identifies best management practices for development of such uses within air pollution hot spots.

4.1. REGULATIONS AND GUIDANCE PERTAINING TO SITING SENSITIVE LAND USES

Federal, state and local agencies have varying regulatory control over emissions from either mobile or stationary sources of air pollution. (See Chapters 5 and 6 for additional information regarding regulations pertaining to mobile and stationary sources of air pollution.) Land uses, however, are generally regulated at the local level. This section describes existing guidance and regulations pertaining to the siting of new sensitive land uses near sources of air pollution.

1.1.1. California Air Resources Board Guidance on Land Use and Air Quality Conflicts

Although ARB regulates air pollutant emissions from vehicles and does not regulate local land use planning, the mission of ARB is to promote and protect the public health, welfare and ecological resources through effective and efficient reduction of air pollutants.[60] Based on robust evidence relating proximity to roadways and a range of non-cancer and cancer health effects, ARB developed guidance for avoiding air quality conflicts in land use planning in their *Air Quality and Land Use Handbook: A Community Health Perspective*.[61] In this guidance, ARB recommends not locating sensitive land uses, including residential developments, within 500 feet of a highway carrying more than 100,000 vehicles per day. ARB recommendations relevant to transportation-related land use and air quality conflicts are listed in the Table 4-1, below. The ARB recommendations in Table 4-1 are based on studies conducted throughout the State and are not specific to a given region or location. Several factors contribute to the exposure of air pollution at a given site including local meteorological conditions, which can substantially influence air pollution levels. As such, a number of air districts including BAAQMD and the Sacramento Metropolitan Air Quality

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[60] ARB. www.arb.ca.gov./html/mission/htm. Accessed April 28, 2012.

[61] ARB, *Air Quality and Land Use Handbook: A Community Health Perspective.* April 2005. Available online at: www.arb.ca.gov/ch/landuse.htm. Accessed May 2, 2012.

Management District have published protocols for the evaluation of sensitive land uses near sources of air pollution.[62,63]

TABLE 4-1. CALIFORNIA AIR RESOURCES BOARD LAND USE RECOMMENDATIONS

Pollution Source	Recommendations
Freeways and High Volume Roadways	Avoid siting sensitive land uses within 500 feet of a freeway, urban roads with 100,000 vehicles/day, or rural roads with 50,000 vehicles/day.
Distribution Centers	Avoid siting sensitive land uses within 1,000 feet of a distribution center (that accommodates more than 100 trucks per day, more than 40 trucks with operating Transportation Refrigeration Units (TRUs) per day, or where TRU unit operations exceed 300 hours per week). Take into account the configuration of existing distribution centers and avoid locating residences and other sensitive land uses near entry and exit points.
Rail Yards	Avoid siting sensitive land uses within 1,000 feet of a major service and maintenance rail yard. Within one mile of a rail yard, consider possible siting limitations and mitigation approaches.
Ports	Consider limitations on the siting of sensitive land uses immediately downwind of ports in the most heavily impacted zones. Consult with local air districts for the latest available data on health risks associated with port emissions.

SOURCE: California Air Resources Board, *Air Quality and Land Use Handbook: A Community Health Perspective,* April 2005.

4.1.3. Senate Bill 352

Senate Bill 352 (Chapter 668, Statutes of 2003 [SB 352]) became effective in January, 2004, making significant changes to existing rules regarding school site selection where new property is acquired. In particular, SB 352 requires the identification of impacts from facilities emitting hazardous air pollutants or handling hazardous material or wastes within a one-quarter mile (400 meter) radius of a new school site and created new requirements for sites within 500 feet (150 meters) of busy roadways.

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[62] BAAQMD, *Recommended Methods for Screening and Modeling Local Risks and Hazards.* May 2011.

[63] Sacramento Metropolitan Air Quality Management District. *Recommended Protocol for Evaluating the Location of Sensitive Land Uses Adjacent to Major Roadways*. March 2011. Available online at: http://www.airquality.org/ceqa/RoadwayProtocol.shtml. Accessed April 18, 2012.

For proposed school sites within 500 feet of a busy roadway, school districts must determine if air quality at the site poses a significant health risk to pupils. Another important element of SB 352 is the redefinition of "facilities within ¼ [one quarter] mile" to mean "both permitted and non-permitted facilities, including but not limited to freeways, busy traffic corridors, large agricultural operations, and rail yards."

4.1.4. Bay Area Air Quality Management District CEQA Air Quality Guidelines

The BAAQMD is the primary agency responsible for air quality regulation in the nine county SFBAAB. As part of their role in air quality regulation, BAAQMD released updated guidance, the *CEQA Air Quality Guidelines*, in May 2011 to assist lead agencies in evaluating the air quality impacts of projects and plans proposed in the SFBAAB.[64] These guidelines provide procedures for evaluating potential air quality impacts during the environmental review process. In addition to these guidelines, in 2010 and 2011 the BAAQMD adopted updated thresholds of significance for air quality impacts for projects subject to CEQA. However, BAAQMD's adoption of significance thresholds for air quality analysis is the subject of recent judicial actions. In a ruling dated February 14, 2012 Alameda County Superior Court Judge Frank Roesch found that in adopting updated significance thresholds for air quality impacts, the BAAQMD violated CEQA by not first studying the potential environmental impacts of its new rules and required that they be rescinded pending formal CEQA approval.[65] Judge Roesch did not rule on the merits of the thresholds presented by BAAQMD. However, due to current litigation surrounding the updated significance thresholds, as of the time of this report, BAAQMD no longer recommends that local agencies use these thresholds when evaluating air quality impacts.[66]

4.1.5. San Francisco General Plan Policies

San Francisco's Air Quality Element of the General Plan establishes a goal of clean air planning to reduce the level of pollutants in the air, to protect and improve public health, welfare, and the quality of life for citizens of San Francisco and residents of the metropolitan

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[64] BAAQMD, *CEQA Air Quality Guidelines*. Updated May 2011. Available online at: http://www.baaqmd.gov/Divisions/Planning-and-Research/CEQA-GUIDELINES.aspx. Accessed May 2, 2011.

[65] *California Building Industry Association v. Bay Area Air Quality Management District*. 2012. Proposed Statement of Decision. Case No. RG10-548693. Superior Court of the State of California in and for the County of Alameda.

[66] BAAQMD. CEQA Guidelines. Available online at: http://www.baaqmd.gov/Divisions/Planning-and-Research/CEQA-GUIDELINES.aspx. Accessed October 16, 2012.

region. The General Plan also recognizes that the majority of air pollutants are generated on roadways from vehicle emissions. Policy 3.7 calls for the assessment and prevention of air quality hazards through modeling and building design:

> **POLICY 3.7 Exercise air quality modeling in building design for sensitive land uses such as residential developments that are located near the sources of pollution such as freeways and industries.** Project review and approval in the City should consider air quality implications. Certain land uses such as some types of industrial uses and freeways generally emit air pollutants that could be hazardous to human health, particularly that of sensitive receptors such as children, elderly and people with respiratory diseases. When reviewing new housing projects or other land uses to be used by sensitive receptors, location of industrial sites or other sources of air pollution should be considered in the design of the building to orient the air intake of the building away from the sources of pollution. Conversely, future industrial and other air polluting development should consider the existence of sensitive receptors in the vicinity.

In compliance with Policy 3.7 of the Air Quality Element of the General Plan, San Francisco passed Health Code Article 38, described below.

4.1.6. San Francisco Health Code Article 38

In 2008 the San Francisco Department of Public Health published *Assessment and Mitigation of Air Pollutant Health Effects from Intra-Urban Roadways: Guidance for Land Use Planning and Environmental Review*,[67] documenting the health effects associated with locating sensitive land uses near high volume roadways, assessment methodologies, and exposure reduction strategies. The City and County of San Francisco subsequently passed legislation requiring the protection of new residential land uses from high volume roadways, which is codified as Article 38 of the San Francisco Health Code. Article 38 of the Health Code requires that projects proposing ten or more dwelling units near high volume roadways undergo an air quality assessment. Should results of the air quality assessment indicate that roadway-related pollutants (expressed as a concentration of $PM_{2.5}$) exceed established health standards identified by DPH ($0.2 \mu g/m^3$) the project sponsor is required to implement design solutions to reduce exposure of residents to outdoor air pollutants while indoors.

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[67] DPH, *Assessment and Mitigation of Air Pollutant Health Effects from Intra-Urban Roadways: Guidance for Land Use Planning and Environmental Review*. May 2008.

The action level identified by DPH is a 0.2μg/m^3 increase in annual average exposure from roadway-related $PM_{2.5}$ emissions within 150 meters (approximately 500 feet) of the proposed residential development.[68]

Projects that undergo subsequent project specific analysis to find that the project site exceeds the action level identified in Health Code Article 38 are required to redesign their projects to reduce outdoor $PM_{2.5}$ concentrations indoors by a performance standard of 80 percent. The performance standard may be met by establishing a distance buffer between roadway sources, locating the building's air intakes away from roadways, or installing a filtered air supply system capable of removing 80 percent of outdoor $PM_{2.5}$ concentrations. Mechanical ventilation systems meeting the following parameters are expected to remove 80 percent of $PM_{2.5}$ indoors:

- American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) 85 percent supply air filters;
- >= 1 air exchange(s) per hour of fresh outside filtered air;
- >= 4 air exchange(s) / hour recirculation; and
- <= 0.25 air exchange(s) per hour in unfiltered infiltration.[69]

4.2. RECOMMENDED BEST MANAGEMENT PRACTICES

Since the passage of Health Code Article 38, the City with the assistance of the BAAQMD has conducted refined modeling of emissions from a variety of sources of air pollutants, not just traffic related air pollution. Therefore, this section identifies best management practices to be implemented for projects that site new sensitive land uses within air pollution hot spots and assesses the feasibility and effectiveness of those measures.

4.2.1. Applicability

New sensitive land uses proposed within air pollution hot spots identified in Figure 3-2, have the potential to expose sensitive land uses to substantial pollutant concentrations. For

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[68] DPH, *Assessment and Mitigation of Air Pollutant Health Effects from Intra-Urban Roadways: Guidance for Land Use Planning and Environmental Review*. May 2008.

[69] DPH, *Assessment and Mitigation of Air Pollutant Health Effects from Intra-Urban Roadways: Guidance for Land Use Planning and Environmental Review*. May 2008. Original reference: Fisk WJ, Faulker D, Palonen J, Seppanen O. Performance and Costs of Particle Air Filtration Technologies Indoor Air 2002; 12(4):223-234.

purposes of this report, sensitive land uses are defined as buildings that house sensitive receptors, these include:

- Residential dwellings, including apartments, houses, and condominiums;
- Schools, colleges and universities with dormitories;
- Daycares;
- Hospitals; and
- Senior care facilities.[70]

The following best management practices would apply to all new sensitive land uses proposed within the air pollution hot spots shown in Figure 3-2. Projects that are required to install a ventilation and air filtration system for all habitable spaces on a project site pursuant to the performance standard set forth in San Francisco Health Code Article 38, as discussed above, would meet the requirements of this measure through existing regulatory requirements.

4.2.2. Best Management Practices for Siting Sensitive Land Uses

The following best management practices are required for all projects proposing sensitive land uses in areas identified in Figure 3-2.

A. **Air Filtration and Ventilation Requirements for Sensitive Land Uses**. Prior to receipt of any building permit, the project sponsor shall submit a ventilation plan for the proposed building(s). The ventilation plan shall show that the building ventilation system removes at least 80 percent of the outdoor $PM_{2.5}$ concentrations from habitable areas and be designed by an engineer certified by ASHRAE, who shall provide a written report documenting that the system meets the 80 percent performance standard identified in this measure and offers the best available technology to minimize outdoor to indoor infiltration of air pollution.

B. **Maintenance Plan**. Prior to receipt of any building permit, the project sponsor shall present a plan that ensures ongoing maintenance for the ventilation and filtration systems.

C. **Disclosure to buyers and renters.** The project sponsor shall also ensure the disclosure to buyers (and renters) that the building is located in an area with existing sources of air pollution and as such, the building includes an air filtration and ventilation system

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[70] BAAQMD, *Recommended Methods for Screening and Modeling Local Risks and Hazards.* May 2011.

designed to remove 80 percent of outdoor particulate matter and shall inform occupants of the proper use of the installed air filtration system.

4.2.3. Feasibility

Heating, Ventilation and Air Conditioning (HVAC) systems control the air flow in buildings by circulating outside air through and, eventually, out of a building. ASHRAE uses a Minimum Efficiency Reporting Value (MERV) measurement scale to rate the effectiveness of air filters on a scale of 1 to 20. MERV-13 air filtration devices that are installed on an HVAC's air intake system can remove 80 to 90 percent of indoor $PM_{2.5}$. Research on air pollution has calculated infiltration fractions for specific pollutants. The outdoor to indoor infiltration of $PM_{2.5}$ in conventional construction is approximately 70 percent (i.e., 70 percent of outdoor $PM_{2.5}$ makes it indoors).[71] The BMPs for siting sensitive land uses requires that ventilation and filtration systems reduce infiltration of outdoor $PM_{2.5}$ indoors to 20 percent of outdoor concentrations (i.e., 80 percent of outdoor particulates are filtered out and never reach the indoor environment). Testing of ventilation and filtration systems on indoor PM has demonstrated the feasibility of this performance standard using conventional ventilation engineering techniques.[72] DPH's *Assessment and Mitigation of Air Pollutant Health Effects from Intra-Urban Roadways: Guidance for Land Use Planning and Environmental Review*, provides additional details and guidance for meeting an 80 percent reduction in outdoor PM performance standard.

The requirements of this performance standard have been determined feasible because San Francisco Health Code Article 38 already requires projects near roadway sources of air pollution to install a ventilation and air filtration system that removes 80 percent of fine particulates. Ventilation and air filtration systems mandated by Health Code Article 38 have been required of, and implemented for, various projects since 2008. The BMPs identified above would extend the existing ventilation requirements to areas within San Francisco that are affected by other sources of air pollution, not just roadway-related air pollution.

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[71] Zhou Y. Levy JI. The impact of urban street canyons on population exposure to traffic-related primary pollutants. Atmospheric Environment. 2008; 42: 3087-3098.

[72] Fisk WJ, Faulker D, Palonen J, Seppanen O. 2002. Performance and Costs of Particle Air Filtration Technologies Indoor Air. 12(4):223-234

4.2.4. Effectiveness

PM is the primary air pollutant emitted from sources within San Francisco. The ventilation and air filtration system would be required to remove $PM_{2.5}$ and larger PM_{10} particles. Therefore, the ventilation and air filtration systems would effectively reduce indoor infiltration of outdoor PM generated from vehicles (including buses), Caltrain railway, port and maritime sources (ferries), and stationary diesel backup generators. As explained in Chapter 2, spray booths, gas stations, and dry cleaning operations emit other, gaseous TACs. Health risks from these sources of gaseous TACs represent a small contribution to overall health risks within San Francisco. In addition, regulations are in place that will eliminate the risks from dry cleaning operations over the next 11 years and therefore, these sources are not significant contributors to long-term health impacts, which are assessed over a 70 year lifetime. A review of stationary sources within San Francisco indicates that spray booths and gas stations are not substantial sources of health risks, in part because the risks are substantially lower than the risks from stationary diesel engines and in part because gas stations and spray booths are relatively dispersed.[73] As shown in Figure 3-2, air pollution hot spots are located in proximity to major sources of PM emissions, such as freeways and areas dominated by multiple PM-emitting stationary sources (including diesel backup generators). As such, installation of air filtration systems designed to meet an 80 percent performance standard for the reduction of outdoor PM would effectively ameliorate the health risks from the primary sources (mobile, stationary, and area) of PM emissions within San Francisco's identified hot spots.

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[73] A review of the screening level cancer risks from stationary sources as provided by the BAAQMD indicates that gas stations comprise approximately 3.5 percent of the excess cancer risk from stationary sources within San Francisco. As explained in Chapter 2, gas stations are not significant sources of particulate matter.

Chapter 5. Construction Activities

This chapter identifies existing regulations pertaining to emissions from construction-related vehicles and equipment, provides an overview of the inventory of emissions from construction equipment, and identifies BMPs to be implemented for projects proposing construction activities at construction sites within identified air pollution hot spots. Recommended BMPs are also assessed for their overall feasibility and effectiveness.

5.1. REGULATIONS APPLICABLE TO CONSTRUCTION VEHICLES AND EQUIPMENT

As discussed in Chapter 2, construction activities are common sources of air pollution. Construction-related equipment typically generate DPM emissions from the following sources: 1) off-road equipment (e.g., excavators, tractors, cranes), 2) portable diesel engines (e.g., diesel generators), and 3) on-road construction vehicles (e.g., delivery and haul truck trips). This section provides an overview of regulations relating to construction vehicles and equipment. State and federal agencies started regulating emission standards for construction-related equipment in the mid-1990s with more stringent standards being adopted and phased in over the next several years. The effect of these standards is anticipated to significantly reduce emissions and associated health risks from construction-related equipment.

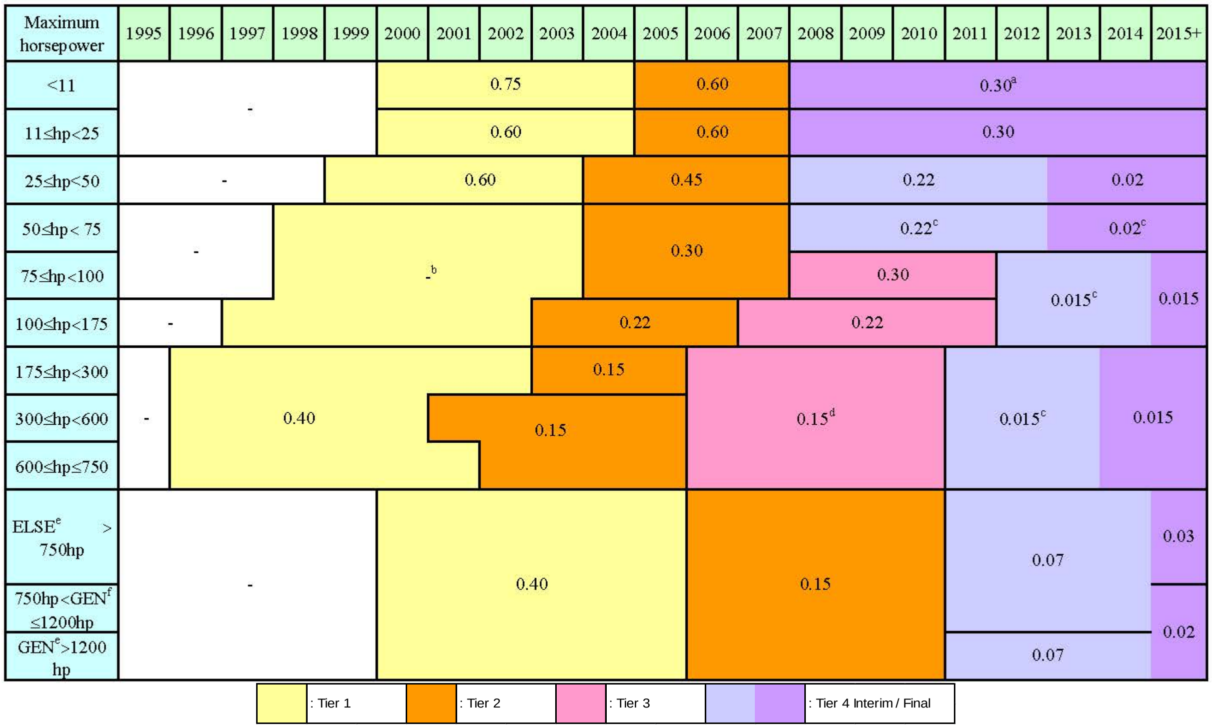
5.1.1. Off-Road Equipment

As described later in Section 5.2, off-road equipment is the primary contributor to air pollutant emissions at construction. Off-road equipment is the sixth largest source of DPM emissions in the State.

5.1.1.1. New Off-Road Equipment Emissions Standards

Since 1994, the USEPA has established emission standards for hydrocarbons, NO_x, CO, and PM to regulate new pieces of off-road (also known as nonroad) equipment. Standards were first adopted in 1994. These emission standards came to be known as Tier 1 emission standards and apply to new engines over 50 horsepower (hp). Tier 1 emission standards were phased in between 1996 and 2000. Additional standards were adopted in 1998 that set Tier 1 emission standards for new engines under 50 hp to phase in between 1999 and 2000, more stringent Tier 2 emission standards for all new engine sizes to phase in between 2001 and 2006, and more stringent Tier 3 emission standards for equipment over 50 hp to phase in between 2006 and 2008. Lastly, further standards were adopted in 2004 that set Tier 4 Interim and Final emission standards for all new engines to phase in between 2008 and 2015. Refer to Table 5-1 for USEPA standards combined with California standards.

TABLE 5-1. CALIFORNIA AIR RESOURCES BOARD AND U.S. ENVIRONMENTAL PROTECTION AGENCY OFF-ROAD COMPRESSION-IGNITION (DIESEL) ENGINE STANDARDS FOR PARTICULATE MATTER



Maximum horsepower	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015+
<11	-					0.75					0.60			0.30[a]							
11≤hp<25						0.60					0.60			0.30							
25≤hp<50	-				0.60					0.45				0.22					0.02		
50≤hp< 75	-			-[b]						0.30				0.22[c]					0.02[c]		
75≤hp<100														0.30				0.015[c]			0.015
100≤hp<175	-								0.22				0.22								
175≤hp<300	-	0.40							0.15			0.15[d]					0.015[c]			0.015	
300≤hp<600							0.15														
600≤hp≤750																					
ELSE[e] > 750hp	-					0.40						0.15					0.07				0.03
750hp<GEN[f] ≤1200hp																					0.02
GEN[e]>1200 hp																	0.07				

🟨 : Tier 1 🟧 : Tier 2 ▨ : Tier 3 ▨ ▨ : Tier 4 Interim / Final

SOURCE: California Air Resources Board, "ARB and USEPA Off-Road Compression-Ignition (Diesel) Engine Standards," accessed online, April 19, 2012, http://www.arb.ca.gov/msprog/ordiesel/documents/Off-Road_Diesel_Stds.xls.

When California Air Resources Board and U.S. Environmental Protection Agency standards differ, the standards shown here represent the more stringent of the two.

Standards given are for particulate matter (PM) grams per brake horsepower per hour (g/bhp-hr)

a) The PM standard for hand-start, air cooled, direct injection engines below 11 horsepower (hp) may be delayed until 2010 and be set at 0.45 g/bhp-hr.

b) No PM standard. Only oxides of nitrogen standard for this tier and hp range.

c) Engine families in this power category may alternately meet Tier 3 PM standards (0.30 g/bhp-hr) from 2008-2011 in exchange for introducing final PM standards in 2012.

d) Certain manufacturers have agreed to comply with these standards by 2005.

e) "ELSE" refers to all mobile machinery subject to the regulation, excluding generator engines.

f) "GEN" refers to generator engines only.

To meet the Tier 4 emission standards, engine manufacturers will be required to produce new engines with advanced emission-control technologies. In addition to emission standards set by the USEPA, because the emission-control devices can be damaged by sulfur, in 2004 the USEPA also adopted a limit to decrease the allowable level of sulfur in off-road diesel fuel from previous (i.e., prior to regulation adoption) sulfur levels of 3,000 parts per million (ppm) to 15 ppm in 2010.[74]

As stated above, these standards apply to new engines. The useful life for typical construction-related equipment is between 13 and 22 years, as shown in Table 5-2.[75] Therefore, the full benefits of the regulations will not be realized for several years. However, the USEPA estimates that by implementing the Tier 4 standards, NO_x and PM emissions will be reduced by more than 90 percent and by 2030 the estimated benefits include yearly prevention of approximately:

- 12,000 premature deaths;
- 8,900 hospitalizations;
- one million work days lost;
- 15,000 heart attacks;
- 6,000 children's asthma-related emergency room visits;
- 280,000 cases of respiratory problems in children;
- 200,000 cases of asthma symptoms in children; and
- 5.8 million days of restricted adult activity due to respiratory symptoms.[76]

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[74] USEPA, “Clean Air Nonroad Diesel Rule: Fact Sheet,” May 2004.

[75] Rod Sutton, “America’s Fleet Remains Strong,” Construction Equipment Magazine, August 2003.

[76] USEPA, “Clean Air Nonroad Diesel Rule: Fact Sheet,” May 2004.

TABLE 5-2. TYPICAL CONSTRUCTION-RELATED EQUIPMENT AVERAGE AGE AND USEFUL LIFE (YEARS)

Equipment Type	Average Age	Useful Life
Asphalt Pavers	7.8	17.5
Backhoe and Loaders	6.3	18
Concrete Pavers, Slab	7.1	17.3
Directional Boring Equipment	4	9.6
Hydraulic Excavator, Crawler	6.1	17
Motor Grader, Articulated	7.5	22
Off-highway haulers, Articulated	5.8	13
Rough Terrain Forklift, Telescopic	6.5	14
Rough Terrain Forklift, Vertical Mast	8.5	17.2
Rubber-Tired Trenchers	6.9	13
Skid-steer Loaders	5.2	13.2
Wheel Loaders	8.7	21

Source: Rod Sutton, “America’s Fleet Remains Strong,” Construction Equipment Magazine, August 2003.

5.1.1.2. California Diesel Risk Reduction Plan

In September 2000, the ARB approved the *Diesel Risk Reduction Plan*, a plan with a goal to reduce DPM emissions and the associated health risk by 75 percent in 2010 and 85 percent or more by 2020. The *Diesel Risk Reduction Plan* identifies the steps required for the ARB to take to develop specific regulations to reduce DPM emissions. Fourteen measures are identified for the ARB to develop over a several year period, including the following measures related to off-road equipment: lower emission standards for new engines and control of emissions from existing engines, public fleets and other off-road fleets.

5.1.1.3. California Emission Standards for New Off-Road Equipment

In late 2004, the ARB adopted their latest off-road emission standards for new equipment which are nearly identical to those of the USEPA. California is preempted by federal statute from adopting emission standards for new off-road equipment with engines less than 175 hp.[77] The combined emission standards for off-road equipment from the ARB and USEPA are provided above in Table 5-1.

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[77] United States Code, Title 42, Chapter 85, §7543(e)(1)(A).

5.1.1.4. California In-Use (Existing) Off-Road Diesel Regulation

The USEPA has adopted federal emission standards for new off-road engines, however, no federal standards have been adopted addressing reductions from in-use (i.e., existing) off-road engines. Under section 209(e)(2) of the federal Clean Air Act, California is the only state allowed to adopt emission requirements for in-use off-road engines, so long as California applies for and receives authorization from the USEPA. In 2007, the ARB originally adopted the In-Use Off-Road Diesel Vehicle Regulation to reduce emissions from existing off-road vehicles (25 hp or greater), including construction-related equipment. The ARB approved additional amendments to the In-Use Off-Road Vehicle Regulation; the latest amendments were approved in December 2010.

The In-Use Off-Road Diesel Vehicle Regulation is intended to significantly reduce emissions of DPM and NO_x from over 150,000 in-use off-road diesel vehicles that operate in California. The In-Use Off-Road Diesel Vehicle Regulation requires fleets to gradually clean up their equipment by getting rid of, or limiting the addition of, older engines (i.e., engines older than and including Tier 1 emission standards), using newer engines (i.e., engines newer than and including Tier 2 emission standards), and installing exhaust retrofits. The In-Use Off-Road Diesel Regulation establishes average annual emission standards based on fleet size.[78] The regulation takes effect earliest for the largest fleets, those with over 5,000 hp of affected vehicles. For these large fleets, the first fleet average compliance dates are in 2014. For medium fleets, those with 2,501 to 5,000 hp, the first fleet average compliance dates are in 2017. The requirements are delayed until 2019 for fleets of 2,500 hp or less (small fleets). Fleet owners, including public agencies, private businesses, and individuals, must maintain or upgrade their existing equipment to comply with the annual emission targets. If an organization is unable to meet the annual targets, it must upgrade or replace its equipment to bring the fleet into compliance.[79] However, the above provisions are currently not enforceable because the ARB, despite applying in 2008, has not received authorization from the USEPA for enforcing them.[80]

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[78] The ARB has provided a calculator for fleet owners to determine compliance: California Air Resources Board, "Fleet Average Calculators." Available online at: http://www.arb.ca.gov/msprog/ordiesel/documents/documents.htm#fleet. Accessed May 23, 2012.

[79] ARB, *Staff Report: Initial Statement of Reasons for Proposed Rulemaking, Proposed Amendments to the Regulation for In-Use Off-Road Diesel-Fueled Fleets and the Off-Road Large Spark-Ignition Fleet Requirements*, October 2010.

[80] ARB, "Regulatory Advisory, Advisory 10-414, Enforcement of the In-Use Off-Road Diesel Regulation," Revised May 2011.

The In-Use Off-Road Diesel Vehicle Regulation also requires reporting and labeling of vehicles and fleets, starting with applicable fleets in 2009. After reporting, fleets are required to label their vehicles with the Equipment Identification Numbers assigned by the ARB. Fleets are required to update the reporting and labeling within 30 days of purchasing new equipment. New fleets are required to report their vehicles within 30 days. The information is maintained in the Diesel Off-road On-line Reporting System (DOORS). In addition, the In-Use Off-Road Diesel Vehicle Regulation requires that idling be limited to no longer than five minutes. The limit does not apply in certain situations, such as queuing, idling to verify that the vehicle is in safe operating condition, for testing, servicing, repairing, or diagnostic purposes, or to accomplish work for which the vehicle was designed.[81] The above reporting, labeling, and idling provisions are currently enforceable by the ARB.[82] As described more in Section 5.2, with implementation of the In-Use Off-Road Diesel Vehicle Regulation, PM emissions are estimated to reduce further beyond those reductions anticipated by the above federal and State regulations related to new off-road equipment.

5.1.1.5. California Assembly Bill 8 2x

In between the original 2007 adoption and December 2010 amendments of the In-Use Off-Road Diesel Vehicle Regulation, the California legislature approved Assembly Bill 8 2x (AB 8 2X), which required the ARB to amend certain sections of the In-Use Off-Road Diesel Vehicle Regulation. As part of the amendments, the ARB gave credit to fleet owners toward early requirements if they provided documentation that indicated reduced operation (e.g., hour meter readings, fuel purchase records, etc.) and/or reduced population of their off-road equipment since 2007. In order to receive credit for reduced usage, fleet owners had to provide equipment-specific activity values (hours/year) for the baseline year (2007) and reduced activity values for the same equipment in 2009. Fleet owners provided such data from late 2009 through April 2010 in accordance with requirements in the reduced activity reporting guide. These data were used to adjust ARB's off-road emissions inventory model activity values to new baseline levels and to derive depressed activity values to reflect the recent economic recession. These data were determined by the ARB staff to be representative of all California fleets because the data was compared with, and found to be similar to, data

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[81] ARB, *Staff Report: Initial Statement of Reasons for Proposed Rulemaking, Proposed Amendments to the Regulation for In-Use Off-Road Diesel-Fueled Fleets and the Off-Road Large Spark-Ignition Fleet Requirements*, October 2010.

[82] ARB, "Regulatory Advisory, Advisory 10-414, Enforcement of the In-Use Off-Road Diesel Regulation," Revised May 2011.

received for the DOORS.[83] This information was used in refining the off-road equipment emission inventory described in Section 5.2.

5.1.1.6. San Francisco Clean Construction Ordinance

In 2007, San Francisco passed the Clean Construction Ordinance (Ordinance No. 70-07), which regulates the type of off-road equipment that can be used on publicly funded construction projects. City-contracted projects subject to the Clean Construction Ordinance include:

- "Major construction projects" defined as those that take 20 or more cumulative work days to complete.
- Projects using "high use" off-road equipment (25 hp or more), meaning equipment used for 20 hours or more during any portion of the project.

Beginning in March 2009, all work performed under a major public works contract must:

- Utilize only off-road equipment and off-road engines fueled by biodiesel fuel grade B20 or higher, and
- Utilize only high use equipment that either (a) meets or exceeds Tier 2 standards for off-road engines or (b) operates with the most effective verified diesel emission control strategy.

5.1.1 Portable Diesel Engines

Portable diesel engines may be moved readily from one location to another. The engines are used to power a variety of equipment used at construction sites (and other uses) including cranes and other equipment. Statewide, portable diesel engines emit approximately 3,000 tons per year of DPM.[84]

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[83] ARB, *Staff Report: Initial Statement of Reasons for Proposed Rulemaking, Proposed Amendments to the Regulation for In-Use Off-Road Diesel-Fueled Fleets and the Off-Road Large Spark-Ignition Fleet Requirements*, October 2010, Appendix D.

[84] ARB, *Staff Report Initial Statement of Reasons for Proposed Amendments to the Regulations Applicable to Portable Diesel Engines and Diesel Engines Used in Off-Road and On-Road Vehicles*, December 10, 2009.

5.1.1.1 Federal and California Emission Standards for New Portable Diesel Engines

New portable diesel engines are subject to the ARB/USEPA standards for newly manufactured off-road engines identified in Table 5-1.[85]

5.1.1.2 California Air Toxic Control Measure for Portable Diesel Engines

Similar to the requirements of the In-Use Off-Road Diesel Regulation, the ARB has adopted an Air Toxic Control Measure (ATCM) for Portable Diesel Engines to further reduce emissions from these in-use sources. The ATCM affects all in-use diesel-fueled portable engines that are 50 hp and larger. The ATCM requires all portable diesel engines to utilize certain fuels and be certified to Tier 1, 2, or 3 USEPA/ARB off-road engine standards by 2010. After 2010, the ATCM requires all fleets of portable engines to meet DPM emission averages that become more stringent in 2013, 2017, and 2020. The owners and operators of these fleets will have flexibility in determining how the fleet emission standards are to be satisfied. Options that are available to satisfy this standard include replacing engines, using add-on control devices, switching to alternative fuels or alternative diesel fuels, and receiving credit for electrification. By 2020, the ATCM requires diesel-fueled portable engines to either:

- Be certified to Tier 4 emission standards for newly manufactured off-road engines; or
- Be equipped with a DPM control technology that has been verified by the ARB under its Verification Procedure for DPM control technologies (Title 13, California Code of Regulations sections 2700-2710) to reduce DPM emissions by 85 percent (Level-3 Verification), or equipped with a combination of verified control technologies that cumulatively achieve 85 percent DPM reduction.[86]

The ATCM was estimated to reduce DPM emissions by 500 tons for activity year 2010.[87]

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[85] ARB, *Updated Informative Digest, Adoption of Air Toxic Control Measure for Portable Diesel Engines*, October 31, 2009.

[86] ARB, *Updated Informative Digest, Adoption of Air Toxic Control Measure for Portable Diesel Engines*, October 31, 2009.

[87] ARB, *Staff Report Initial Statement of Reasons for Proposed Amendments to the Regulations Applicable to Portable Diesel Engines and Diesel Engines Used in Off-Road and On-Road Vehicles*, December 10, 2009.

5.1.2. On-Road Heavy Duty Vehicles

Regulations pertaining to on-road heavy duty vehicles are similar to those mentioned above for off-road and portable diesel equipment. For example, the USEPA has adopted emission standards to reduce emissions from new vehicles ("2007 Highway Rule"), the ARB has adopted an On-Road Heavy Duty In-Use Regulation to reduce emissions from existing vehicles, and the ARB has adopted an ATCM to restrict idling to five minutes from all vehicles. In general, the implementation dates for the on-road heavy duty vehicle regulations are earlier than the implementation dates for off-road equipment.[88] The regulations are anticipated to substantially reduce PM emissions from these vehicles. For example, the USEPA estimates that once the 2007 Highway Rule is fully implemented, PM emissions will be reduced by 110,000 tons per year and estimated benefits would include yearly prevention of approximately:

- 8,300 premature deaths,
- 7,100 hospitalizations,
- 1.5 million work days lost, and
- 2,400 asthma-related emergency room visits.[89]

5.1.3. Other

In addition to the regulations above related to off-road engines, portable diesel engines, and on-road vehicles, San Francisco has adopted a regulation to control fugitive dust emissions from construction sites.

5.1.3.1. San Francisco Dust Control Ordinance

In 2008, San Francisco approved a series of amendments and Health Codes generally referred hereto as the Construction Dust Control Ordinance (Ordinance 176-08) to manage fugitive dust from construction projects in San Francisco by implementing BMPs. For projects over one half acre, project sponsors are also required to prepare and obtain approval

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[88] For example, the On-Road Heavy Duty In-Use Regulation requires nearly all trucks and buses to have 2010 model year engines or equivalent by 2023. The In-Use Off-Road Diesel Vehicle Regulation requires all construction fleet vehicles to be Tier 2 (engine model year between 2001 and 2010) or higher by 2029. In addition, as stated above, this portion of the In-Use Off-Road Diesel Vehicle Regulation is currently not enforceable by the ARB.

[89] USEPA, "Heavy Duty Highway Diesel Program," August 2009. Available online at: http://www.epa.gov/otaq/highway-diesel/index.htm. Accessed May 16, 2012.

of a dust control plan from the Director of Public Health. The Construction Dust Control Ordinance includes, but is not limited to, the following regulations and procedures:

- Paving, applying water three times daily, or applying non-toxic soil stabilizers on all unpaved access roads, parking areas and staging areas at the construction site;
- Loading hauling trucks carrying excavated material and other non-excavated material so that the material does not extend above the walls or back of the truck bed. Tight cover with tarpaulins or other effective covers for all trucks hauling soil, sand, and other loose materials before the trucks leave the loading area. Wet prior to covering if needed.
- During excavation and dirt-moving activities, wet sweep or vacuum the streets, sidewalks, paths, and intersections where work is in progress at the end of the workday;
- Establishing speed limits so that vehicles entering or exiting construction areas travel at a speed that minimizes dust emissions. This speed shall be no more than 15 miles per hour;
- Cover any inactive (no disturbance for more than seven days) stockpiles greater than ten cubic yards or 500 square feet of excavated materials, backfill material, import material, gravel, sand, road base, and soil with a 10 mil (0.01 inch) polyethylene plastic or equivalent tarp and brace it down or use other equivalent soil stabilization techniques;
- Use dust enclosures, curtains, and dust collectors as necessary to control dust in the excavation area; and
- Establish a hotline for surrounding community members to call and report visible dust problems so that the applicant can promptly fix those problems; posting signs around the site with the hotline number and making sure that the number is given to adjacent residents, schools, and businesses.

5.2. INVENTORY OF CONSTRUCTION-RELATED EQUIPMENT EMISSIONS

As described previously in Chapter 2, of all TACs, DPM emissions pose the greatest cancer risk in California. This section provides estimates of DPM emissions from categories of construction-related equipment and compares construction-related DPM emissions, using

PM emissions as a proxy, to other sources of DPM emissions. In summary, off-road (which includes construction-related) equipment was once estimated to be the second largest source of ambient DPM emissions in California by previous emission inventories. Refined, newer emission inventories have substantially lowered the estimates of DPM emissions from off-road equipment such that off-road equipment is now considered the sixth largest source of DPM emissions in California. Therefore, construction-related equipment contributes to a smaller percentage of the overall DPM emissions and associated cancer risk than previously estimated.

5.2.1. Categories of Construction-Related Equipment

As described in above in Section 5.1, construction-related equipment includes off-road equipment, portable diesel engines, and on-road heavy duty vehicles, with off-road equipment contributing the most emissions at construction sites. Off-road equipment is included in the estimates for other mobile sources in the ARB *Almanac*. As shown in Chapter 2, other mobile sources are the largest source of DPM emissions in California (60 percent of total) and the SFBAAB (69 percent of total). The category of other mobile sources in the ARB *Almanac* includes aircraft, trains, ocean going vessels, commercial harbor craft, recreational boats, off-road recreational vehicles, off-road equipment, farm equipment, and fuel storage and handling. The subcategory of off-road equipment in the ARB *Almanac* includes passenger trains, transport refrigeration units, light commercial equipment, industrial equipment, construction and mining equipment, logging equipment, airport ground support equipment, dredging, oil drilling and workover, military tactical support equipment, entertainment, port operations, rail operations, lawn and garden (commercial, residential, and other), commercial (commercial, residential, other) and other. The emissions from off-road equipment and construction and mining equipment categories are described further below. Appendix B includes the emissions inventory for the relevant construction and mining subcategory.[90]

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[90] The construction and mining equipment subcategory presented in Tables 5-3 and 5-4 and Figure 5-1 has been refined to match the equipment types included in the In-Use Off-Road Equipment Model. Therefore, the estimates provided do not include emissions from the following equipment types, which are included in the *Almanac* for the construction and mining equipment subcategory: Daytime, Asphalt Pavers, Cement and Mortar Mixers, Concrete/Industrial Saws, Crushing/Proc. Equipment, Dumpers/Tenders, Plate Compactors, Signal Boards, and Tampers/Rammers. The *Almanac* results for construction and mining equipment provided in Tables 5-3 and 5-4 and Figure 5-1 would be approximately 20 – 40 tons/year higher if these equipment types were included.

The ARB has estimated DPM emissions from portable diesel engines to be approximately 3,000 tons per year, which would represent approximately eight percent of statewide total DPM emissions (35,884 tons). Portable diesel engines include pumps (e.g., agricultural irrigation pumps and other water pumps), ground support equipment at airports, cranes, oil-well drilling and workover rigs, power generators, dredging equipment, rock crushing and screening equipment, welding equipment, woodchippers, and compressors.[91]

Heavy-duty vehicles are included in the estimates for on-road mobile sources in the ARB *Almanac*. As shown in Chapter 2, on-road mobile sources are the second largest source of DPM emissions in California (38 percent of total) and the SFBAAB (29 percent of total). However, emissions at construction sites from on-road heavy duty vehicles are typically negligible when compared to off-road equipment as evident from a review of construction health risks assessments conducted for various projects within the City and County of San Francisco.[92]

Because DPM emissions pose the greatest cancer risk among the top ten TACs routinely measured in the SFBAAB and because other mobile emissions are the largest estimated source of DPM in the SFBAAB, the rest of this section focuses on DPM emissions from the category of other mobile sources, which includes construction-related equipment.

5.2.2. Inventories of PM_{10} and DPM

Unlike the other TACs presented in the *Almanac*, the ARB does not monitor outdoor DPM because there is no routine method for monitoring ambient concentrations of this TAC. However, the ARB, in preparing estimates of DPM concentrations for the State's 15 air basins and for the State as a whole in the *Almanac,* used a PM-based exposure method because visible emissions in diesel exhaust are composed of PM, a criteria air pollutant, and DPM is a major component of total PM. The PM-based exposure method is based on the ARB emission

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[91] ARB, *Staff Report Initial Statement of Reasons for Proposed Amendments to the Regulations Applicable to Portable Diesel Engines and Diesel Engines Used in Off-Road and On-Road Vehicles*, December 10, 2009.

[92] A number of construction health risk assessments have been prepared for projects within San Francisco, some including on-road haul trucks and others determining their emissions impact to be negligible. For example, Case No. 2011.11489E, 155 5th Street, determined that health risks from on-road haul trips were negligible and therefore were not analyzed. On the other hand, Case No. 2008.2724E, Chinese Hospital, included on-road haul truck trips in the project-level health risk assessment, but determined that mitigation measures were unnecessary for on-road haul trucks because their contribution to overall construction emissions were negligible. The health risk assessments conducted for these projects are on file and available for public review at the San Francisco Planning Department, 1650 Mission Street, Suite 400, San Francisco, CA 94103.

inventory for PM_{10}, ambient PM_{10} monitoring data, and the results from several studies with chemical speciation of ambient PM data. The *Almanac* uses this data, along with receptor modeling techniques, to estimate statewide outdoor concentrations of DPM.[93]

Data is readily available to estimate the amount of PM_{10} from off-road equipment. Therefore, the following presents data on PM_{10} inventories in the SFBAAB.

As stated above, off-road equipment is a subcategory of other mobile sources and construction and mining equipment is a subcategory within the off-road equipment category. Table 5-3 shows the estimated PM_{10} emissions in the SFBAAB for these three subcategories as compared to emissions from all sources included in the *Almanac* in five-year increments from 1975 to 2020 (projected). Figure 5-1 displays the three subcategories graphically, along with 2008 DPM emissions for other mobile and all sources in the SFBAAB.

As shown in Table 5-3, PM_{10} emissions from other mobile sources, off-road equipment, and construction and mining equipment were highest in 1990. Between 1990 and 2008, PM_{10} emissions from construction and mining equipment declined approximately 30 percent. Between 2008 and 2020, PM_{10} emissions from construction and mining equipment are estimated to decline approximately 60 percent further.[94] Reasons for this decline include implementation of some of the regulations (e.g., off-road emission standards) presented in Section 5.1. As shown in Figure 5-1 and Table 5-3, DPM is a fraction of total PM_{10} for all sources and other mobile source categories. If one were to conservatively assume all 2008 PM_{10} emissions from construction and mining equipment were DPM emissions, construction and mining equipment would account for approximately 50 percent of the other mobile 2008 DPM emissions in the SFBAAB (1,423 tons/2,867 tons) and approximately 34 percent of the total 2008 DPM emissions in the SFBAAB (1,423 tons/4,151 tons).

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[93] ARB, *The California Almanac of Emissions and Air Quality – 2009 Edition*, Page 5-44.

[94] ARB, *The California Almanac of Emissions and Air Quality – 2009 Edition*, Page 5-44.

TABLE 5-3. SAN FRANCISCO BAY AREA AIR BASIN PM10 EMISSIONS (TONS/YEAR)

Emissions Source[a]	**1975**	**1980**	**1985**	**1990**	**1995**	**2000**	**2005**	**2008**	**2010**	**2015**	**2020**
Total All Sources	66,790	67,117	72,022	71,926	70,942	80,425	77,322	79,273	80,583	84,047	87,701
Other Mobile	4,274	4,367	4,856	5,667	4,760	4,373	4,089	3,720	3,567	3,021	2,651
Off-Road Equipment	2,380	2,352	2,665	3,317	2,862	2,743	2,560	2,272	2,105	1,526	1,039
C&M Equipment	1,253	1,258	1,491	2,045	1,797	1,758	1,634	1,423	1,312	913	565

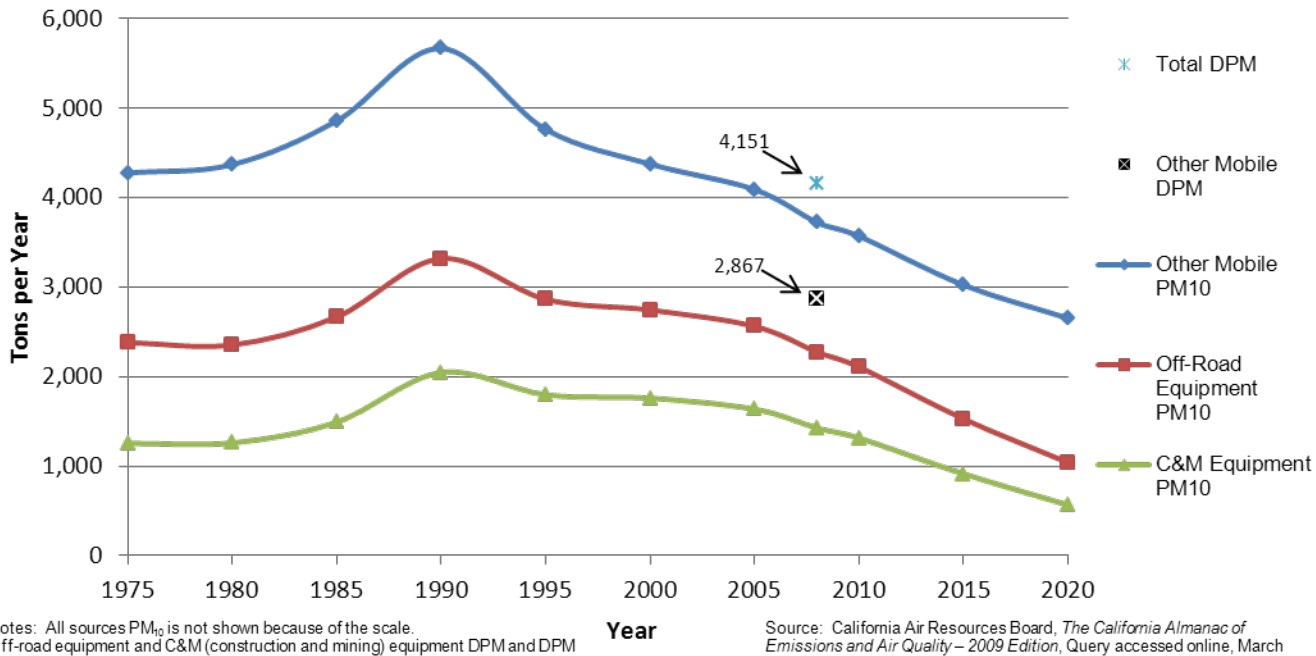
SOURCE: California Air Resources Board, *The California Almanac of Emissions and Air Quality – 2009 Edition*, Query accessed online, March 29, 2012, http://www.arb.ca.gov/app/emsinv/emssumcat.php.

C&M – Construction and Mining

PM_{10} – particulate matter less than 10 microns in size

a. Total all sources reflects all categories in the ARB *Almanac*; other mobile is a subcategory of all sources; off-road equipment is a subcategory of other mobile sources; C&M equipment is a subcategory of off-road equipment.

FIGURE 5-1. SAN FRANCISCO BAY AREA AIR BASIN PM10 AND DPM EMISSIONS 1975-2020



Notes: All sources PM_{10} is not shown because of the scale.
Off-road equipment and C&M (construction and mining) equipment DPM and DPM for other years is not shown because data was not readily available.

Source: California Air Resources Board, *The California Almanac of Emissions and Air Quality – 2009 Edition*, Query accessed online, March 29, 2012, http://www.arb.ca.gov/app/emsinv/emssumcat.php.

5.2.3. Revisions to Almanac Emissions Inventories

In estimating the emissions for the *Almanac,* ARB staff utilized ARB's off-road emissions inventory model, OFFROAD. The OFFROAD model is based on a wide range of industry reports and studies as well as ARB surveys. In estimating off-road equipment emissions for the *Almanac*, the inventory does not take into account the In-Use Off-Road Diesel Vehicle Regulation, discussed previously in Section 5.1.

Subsequent to the modeling done for the OFFROAD inventory, conditions in the construction industry changed dramatically due to the economic recession. ARB staff estimates that between 2005 and 2010 construction emissions dropped by more than 50 percent because of reduced construction activity caused by the recession. A 2009 study by Rob Harley at UC Berkeley, which used a fuel-based method to assess construction-related equipment emissions, found the ARB's inventory to be overestimated by more than a factor of three. Industry stakeholders pointed to that study as well as a similar study done in 2000, which found comparable results. As a result, the ARB staff updated the methodology used in calculating emissions from off-road equipment sources and created a new model, the In-Use Off-Road Equipment Model. Other factors for updating the methodology included updated growth forecasts, load factor corrections and estimates using the equipment population reported to ARB in compliance with the In-Use Off-Road Diesel Vehicle Regulation and Assembly Bill 8 2x.[95]

ARB's revised emissions of off-road equipment subject to the In-Use Off-Road Diesel Vehicle Regulation (which includes construction-related equipment) are substantially lower than previously estimated in the OFFROAD inventory. Approximately half of the reduction can be attributed to the economic recession and approximately half can be attributed to updated assumptions independent of the economic recession. For the years where information is provided, 2009, 2014, and 2023, ARB staff reduced their *Almanac* estimates of $PM_{2.5}$ emissions by approximately 80 percent, 73 percent, and 57 percent, respectively using the In-Use Off-Road Equipment Model for the State. $PM_{2.5}$ emissions from construction activities typically represent approximately 92 percent of PM_{10} emissions from construction-related equipment; therefore a similar reduction in overall PM emissions is expected. ARB staff now estimates that off-road equipment subject to the In-Use Off-Road Diesel Vehicle Regulation is the sixth

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[95] ARB, *Staff Report: Initial Statement of Reasons for Proposed Rulemaking, Proposed Amendments to the Regulation for In-Use Off-Road Diesel-Fueled Fleets and the Off-Road Large Spark-Ignition Fleet Requirements*, October 2010, Pages D-1 and D-2.

largest source of DPM in California, representing approximately seven percent of total DPM.[96] This estimate is down from the estimate based on the OFFROAD inventory which estimated the same equipment was the second largest source of DPM in California, representing approximately 23 percent of total DPM.[97]

Similar reductions between State estimates in the ARB *Almanac* and the In-Use Off-Road Equipment Model can be shown in the SFBAAB. The In-Use Off-Road Equipment Model also provides a scenario for modeling emission reductions from implementation of the In-Use Off-Road Diesel Vehicle Regulation. Table 5-4 shows the estimated PM_{10} emissions using the ARB *Almanac* and the In-Use Off-Road Equipment Model (with and without In-Use Off-Road Diesel Vehicle Regulation) for the years 2010,[98] 2015, and 2020 in the SFBAAB. The 2010 emissions presented in Table 5-4 are examined more in detail in Appendix C.

As shown in Table 5-4, for the years 2010, 2015, and 2020, the ARB staff has reduced their *Almanac* estimates of PM_{10} emissions from construction and mining equipment[99] by approximately 83, 80, and 82 percent, respectively, using the In-Use Off-Road Equipment Model for the SFBAAB. Additionally, PM_{10} emissions are projected to drop four percent further in the SFBAAB by 2015 and 16 percent further by 2020 with implementation of the In-Use Off-Road Regulation.[100] Revised estimates of PM_{10} emissions are substantially lower for the SFBAAB than those estimated in the *Almanac*. Therefore it can be inferred that emissions of DPM and associated cancer risk, particularly from other mobile (which includes construction and mining equipment), are substantially lower than previous estimates discussed in Chapter 2 and described earlier above.

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[96] ARB, *Staff Report: Initial Statement of Reasons for Proposed Rulemaking, Proposed Amendments to the Regulation for In-Use Off-Road Diesel-Fueled Fleets and the Off-Road Large Spark-Ignition Fleet Requirements*, October 2010, Pages D-1 and D-2.

[97] ARB, *Technical Support Document: Proposed Regulation for In-Use Off-Road Diesel Vehicles*, April 2007, Pages 64 and 65.

[98] Most of the data described above from the *Almanac* uses data from the year 2008. The In-Use Off-Road Equipment, 2011 Inventory Model only queries between 2009 and 2029, therefore the year 2010 was used as a comparison to previous data.

[99] Excludes sweepers and scrubbers for construction and mining equipment category in the In-Use Off-Road Equipment Model because these equipment types were not included in the ARB *Almanac*.

[100] ARB, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category.

TABLE 5-4. SAN FRANCISCO BAY AREA AIR BASIN PM10 EMISSIONS (TONS/YEAR)

Emissions Source	**2010**			**2015**			**2020**		
	Almanac	Model w/o Reg	Model w/Reg	Almanac	Model w/o Reg	Model w/Reg	Almanac	Model w/o Reg	Model w/Reg
C&M Equipment	1,312	219	219	913	184	177	565	99	83

Almanac - California Air Resources Board, *The California Almanac of Emissions and Air Quality – 2009 Edition*, Query accessed online, March 29, 2012, http://www.arb.ca.gov/app/emsinv/emssumcat.php.

C&M – Construction and Mining

Model – California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category.

PM_{10} – particulate matter less than 10 microns in size

w/o Reg – assumes the entire In-Use Off-Road Diesel Vehicle Regulation is not adopted and implemented.

w/Reg – assumes the amended In-Use Off-Road Diesel Vehicle Regulation is adopted and implemented.

5.3. BEST MANAGEMENT PRACTICES FOR CONSTRUCTION

As discussed in Chapter 1, CEQA has long allowed for implementation of BMPs in connection with management of PM and dust suppression from construction activities at construction sites. This section recommends BMPs for reducing exposure of sensitive populations to DPM emissions from construction-related equipment at construction sites. Recommended BMPs identified below are based on the need to reduce emissions and associated health risks from construction-related equipment at construction sites for populations within the City that are most at risk from existing sources of air pollution. The recommended BMPs take into consideration existing federal and state regulations that are anticipated to substantially reduce emissions from construction-related equipment at construction sites and the relative contribution of DPM emissions from construction-related equipment at construction sites. In addition, the recommended BMPs are based on a review of BMPs used by industries, other local governments, or private developments (Appendix F). The feasibility and effectiveness of implementing the recommended BMPs are also presented.

5.3.1. Applicability

In considering whether BMPs should be employed for specific projects, three primary factors must be considered: 1) existing state and federal regulations that are anticipated to substantially reduce emissions from construction-related equipment, 2) health effects attributable to emissions from construction-related equipment at construction sites, and 3) the degree to which existing environmental conditions warrant protective measures. Each of these considerations is discussed further.

As discussed in Sections 5.1 and 5.2, both federal and state agencies have passed regulations to reduce emissions from the primary sources of construction-related air pollution. These regulations are anticipated to substantially reduce emissions from construction equipment throughout the state.

In considering the applicability of BMPs for construction activities at construction sites, it is also important to consider the extent to which construction-related equipment contributes to ambient DPM concentrations. Section 5.2 of this document discusses the State and SFBAAB inventory of emissions from construction-related equipment. As explained in that section, emissions from construction-related equipment were previously substantially overestimated. Revised PM emission estimates for the year 2010 have decreased by 83 percent from previous estimates for the SFBAAB. Approximately half of the reduction can be attributed to the economic recession and approximately half can be attributed to updated assumptions independent of the economic recession (e.g., updated methodologies used to better assess construction emissions). Revisions to the emissions inventory for off-road equipment have resulted in off-road equipment being downgraded from the second largest source of DPM emissions in the State to the sixth largest source and therefore off-road equipment, which includes construction, mining, agricultural, and other pieces of equipment, is not as significant a source of DPM emissions as previously estimated.

Nevertheless, construction activities at construction sites emit DPM and several environmental studies have focused on the impacts of DPM and resulting health effects. Both long-term and short-term exposure to DPM has been linked to adverse health effects. The USEPA has identified DPM as a probable carcinogen due to the link between long-term exposure and increased lung cancer.[101] However, construction activities at construction sites do not lend themselves to analysis of long-term health risks because of their temporary and variable nature. As explained in the BAAQMD's *CEQA Air Quality Guidelines*:

> "Due to the variable nature of construction activity, the generation of TAC emissions in most cases would be temporary, especially considering the short amount of time such equipment is typically within an influential distance that would result in the

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[101] USEPA, *Public Health and Environmental Benefits of EPA's Proposed Program for Low-Emissions Nonroad Diesel Engines and Fuel*, EPA-420-F-03-010, April 2003.

> exposure of sensitive receptors to substantial concentrations. Concentrations of mobile-source diesel PM emissions are typically reduced by 70 percent at a distance of approximately 500 feet (ARB 2005). In addition, current models and methodologies for conducting health risk assessments are associated with longer-term exposure periods of 9, 40, and 70 years, which do not correlate well with the temporary and highly variable nature of construction activities. This results in difficulties with producing accurate estimates of health risk."[102]

Project-level analyses of construction activities at construction sites have a tendency to produce overestimated and inaccurate assessments of long-term health risks. However, in certain areas of San Francisco, sensitive populations are already at a higher risk for adverse long-term health risks from existing sources of air pollution.

As discussed in Chapter 3, San Francisco has partnered with the BAAQMD to inventory and assess air pollution exposures from known sources of mobile, stationary, and area source emissions within San Francisco. Figure 3-2 identifies the City's hot spots, those areas of the City that are already adversely affected by existing air pollution.

These hot spot areas require additional consideration when projects or activities have the potential to emit TACs, including DPM emissions from temporary and variable construction activities at construction sites . Therefore, the following BMPs have been identified to reduce the negative health impacts from short-term exposures to construction-related equipment exhaust at construction sites within San Francisco where sensitive populations are most at risk to exposure from air pollution. These BMPs may also be employed for projects that require a substantial amount of construction equipment for multiple years or multiple phases at construction sites that are not within identified air pollution hot spots.

Projects subject to CEQA that require the use of off-road equipment and are located within identified hot spots as shown in Figure 3-2 would reduce impacts to nearby sensitive land uses by implementing the BMPs described below.[103]

The recommended BMPs identified below would result in an 89 to 94 percent decrease in PM emissions.

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[102] BAAQMD, *CEQA Air Quality Guidelines*, May 2011, page 8-6.

[103] Projects that require a limited amount of off-road construction equipment for a limited duration, such as interior renovations and minor additions to existing buildings typically do not generate a substantial amount of DPM emissions and are not expected affect nearby receptors even within identified air pollution hot spots.

5.3.2. Best Management Practices

The following BMPs are required for all projects subject to CEQA located in areas identified in Figure 3-2, except for the specific exemptions listed below. As discussed, exceptions to these BMPs may be granted under specified circumstances. Appendix D includes definitions pertaining to the following BMPs.

A. **Construction Emissions Minimization Plan.** Prior to issuance of a construction permit, the project sponsor shall submit a Construction Emissions Minimization Plan (Plan) to the Environmental Review Officer (ERO) for review and approval by an Environmental Planning Air Quality Specialist. The Plan shall detail project compliance with the following requirements:

    1. All off-road equipment greater than 25 hp and operating for more than 20 total hours over the entire duration of construction activities shall meet the following requirements:

        a) Where access to alternative sources of power are available, portable diesel engines shall be prohibited;

        b) All off-road equipment shall have:

            i. Engines that meet or exceed either USEPA or ARB Tier 2 off-road emission standards, *and*

            ii. Engines that are retrofitted with an ARB Level 3 Verified Diesel Emissions Control Strategy (VDECS).[104]

        c) Exceptions:

            i. Exceptions to A(1)(a) *may* be granted if the project sponsor has submitted information providing evidence to the satisfaction of the ERO that an alternative source of power is limited or infeasible at the project site and that the requirements of this exception provision apply. Under this circumstance, the sponsor shall submit documentation of compliance with A(1)(b) for onsite power generation.

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[104] Equipment with engines meeting Tier 4 Interim or Tier 4 Final emission standards automatically meet this requirement, therefore a VDECS would not be required.

ii. Exceptions to A(1)(b)(ii) *may* be granted if the project sponsor has submitted information providing evidence to the satisfaction of the ERO that a particular piece of off-road equipment with an ARB Level 3 VDECS is: (1) technically not feasible, (2) would not produce desired emissions reductions due to expected operating modes, (3) installing the control device would create a safety hazard or impaired visibility for the operator, or (4) there is a compelling emergency need to use off-road equipment that are not retrofitted with an ARB Level 3 VDECS and the sponsor has submitted documentation to the ERO that the requirements of this exception provision apply. If granted an exception to A(1)(b)(ii), the project sponsor must comply with the requirements of A(1)(c)(iii).

iii. If an exception is granted pursuant to A(1)(c)(ii), the project sponsor shall provide the next cleanest piece of off-road equipment as provided by the step down schedules in Table A1 below.

TABLE A1
OFF-ROAD EQUIPMENT COMPLIANCE STEP DOWN SCHEDULE*****

Compliance Alternative	**Engine Emission Standard**	**Emissions Control**
1	Tier 2	ARB Level 2 VDECS
2	Tier 2	ARB Level 1 VDECS
3	Tier 2	Alternative Fuel**

*How to use the table. If the requirements of (A)(1)(b) cannot be met, then the project sponsor would need to meet Compliance Alternative 1. Should the project sponsor not be able to supply off-road equipment meeting Compliance Alternative 1, then Compliance Alternative 2 would need to be met. Should the project sponsor not be able to supply off-road equipment meeting Compliance Alternative 2, then Compliance Alternative 3 would need to be met.

**Alternative fuels are not a VDECS

2. The project sponsor shall require the idling time for off-road and on-road equipment be limited to no more than *two* minutes, except as provided in exceptions to the applicable state regulations regarding idling for off-road and on-road equipment. Legible and visible signs shall be posted in multiple languages (English, Spanish, Chinese) in designated queuing areas and at the construction site to remind operators of the two minute idling limit.

3. The project sponsor shall require that construction operators properly maintain and tune equipment in accordance with manufacturer specifications.

4. The Plan shall include estimates of the construction timeline by phase with a description of each piece of off-road equipment required for every construction phase. Off-road equipment descriptions and information may include, but is not limited to: equipment type, equipment manufacturer, equipment identification number, engine model year, engine certification (Tier rating), horsepower, engine serial number, and expected fuel usage and hours of operation. For VDECS installed: technology type, serial number, make, model, manufacturer, ARB verification number level, and installation date and hour meter reading on installation date. For off-road equipment using alternative fuels, reporting shall indicate the type of alternative fuel being used.

5. The Plan shall be kept on-site and available for review by any persons requesting it and a legible sign shall be posted at the perimeter of the construction site indicating to the public the basic requirements of the Plan and a way to request a copy of the Plan. The project sponsor shall provide copies of Plan to members of the public as requested.

B. Reporting. Quarterly reports shall be submitted to the ERO indicating the construction phase and off-road equipment information used during each phase including the information required in A(4). In addition, for off-road equipment using alternative fuels, reporting shall include the actual amount of alternative fuel used.

Within six months of the completion of construction activities, the project sponsor shall submit to the ERO a final report summarizing construction activities. The final report shall indicate the start and end dates and duration of each construction phase. For each phase, the report shall include detailed information required in A(4). In addition, for off-road equipment using alternative fuels, reporting shall include the actual amount of alternative fuel used.

C. Certification Statement and On-site Requirements. Prior to the commencement of construction activities, the project sponsor must certify (1) compliance with the Plan, and (2) all applicable requirements of the Plan have been incorporated into contract specifications. Refer to Appendix E for the Certification Statement.

D. **Exemptions.** Projects shall be exempt from the above requirements if the project sponsor submits documentation to the ERO that the following Exemptions apply:

1. Project site boundaries are not located within 1,000 feet of a sensitive land use.
2. Construction of the project would require a limited amount of off-road construction equipment for a limited duration, such as interior renovations and additions to existing buildings. These types of construction equipment typically do not generate a substantial amount of DPM emissions and are not expected to substantially affect nearby sensitive land uses, even within identified air pollution hot spots.

E. Penalties. Should it be determined that the project sponsor or the project sponsor's contractors have not complied with any provision described above, the project will be determined to be out of compliance with the conditions of project approval. Construction activities must cease until the ERO and the construction contractor have agreed upon actions to meet the above requirements. Additional enforcement actions may apply.

5.2.1. Feasibility

The recommended BMPs, with the exception of Requirement A(1), are deemed feasible because of their wide application in other communities. Refer to Appendix F for more information about BMPs applied in other jurisdictions or private industry. With respect to requirement A(1)(a), it may be the case that on-site electrical power is not available at a given project site. If on-site power is not available, portable diesel engines used to meet on-site power needs would be required to meet the same standards as other off-road equipment as detailed in requirement (A)(1)(b), which allows for use of Tier 2 portable diesel engines equipped with an ARB Level 3 VDECS. Exceptions provided in requirement (A)(1)(c)(i), allow for alternative paths of compliance should it be determined that Tier 2 portable diesel engines with a Level 3 VDECS is infeasible. Manufacturers of smaller portable diesel engines (50 to 75 hp) have been required to meet Tier 4 Interim emission standards since 2008. As of 2012, manufacturers of all other size engines must meet Tier 4 Interim emission standards. Therefore, while Tier 4 portable diesel engines are technically available, this equipment may not be widely available. As such, requirement A(1)(a) allows portable diesel engines to meet Tier 2 emission standards with an ARB Level 3 VDECS. Exceptions as listed in requirement A(1)(c) would similarly apply to portable diesel engines should retrofitting the generator with a Level 3 VDECS be determined infeasible. Therefore, given the multiple options for compliance, it is reasonably feasible that projects within identified hot spots could meet the requirements for on-site power generation.

In order to assess the feasibility of requirement A(1) for all other off-road equipment, an analysis was conducted of the current equipment inventory of construction fleets in the SFBAAB. The following summarizes the results, showing engines meeting or exceeding either USEPA or ARB Tier 2 off-road emission standards (Tier 2 and higher engines) accounted for 47 percent of the overall construction and mining equipment available in 2010. Refer to Appendix C for additional data analyzed in this feasibility analysis.

As described in Section 5.1, reporting and labeling of all vehicles subject to the In-Use Off-Road Diesel Vehicle Regulation, which includes construction and mining equipment, is required. This reporting and labeling requirement has allowed the ARB to more accurately understand the amount of, and emissions associated with, off-road equipment in California. This information is input into the In-Use Off-Road Equipment Model and is publically available. It is important to note that the In-Use Off-Road Equipment Model spatially allocates the entire statewide population of equipment to separate air basins because the precise location of every piece of equipment is unknown. For construction and mining equipment, the equipment is allocated based on the regional rate of population growth.[105] Therefore, the following information about construction and mining equipment is not precise but provides a reasonable approximation of the types of equipment available within the SFBAAB.

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[105] ARB, "In-Use Off-Road Equipment, 2011 Inventory Model, Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category and California Air Resources Board, *Staff Report: Initial Statement of Reasons for Proposed Rulemaking, Proposed Amendments to the Regulation for In-Use Off-Road Diesel-Fueled Fleets and the Off-Road Large Spark-Ignition Fleet Requirements*, October 2010, Appendix D.

The In-Use Off-Road Equipment Model was used to estimate the number and type of construction and mining equipment and activity hours by fleet size and tier in 2010 for the SFBAAB. The fleet size is the total hp calculated by summing all hps of individual vehicles within a fleet. Fleets are categorized as small, medium, and large. Small fleets are composed of total hp less than 1,500; a medium fleet includes equipment with total hp greater than 1,500 and less than 5,000; and a large fleet includes equipment with total hp greater than 5,000 and includes all state and federal fleets.[106]

As shown in Figure 5-2, equipment with Tier 2 and higher engines accounted for 47 percent of the overall equipment available in 2010. As shown in Figures 5-3, 5-4, and 5-5, smaller fleet sizes have a smaller percentage of Tier 2 and higher engines. For the small, medium, and large fleet sizes, equipment with Tier 2 and higher engines were estimated to account for 38 percent, 39 percent, and 57 percent of the total fleet, respectively. In other words, larger fleets have a greater percentage of equipment meeting Tier 2 and higher engine emission standards. However, even among small fleets, Tier 2 and higher engines account for a sizable portion of the overall fleet. Therefore, equipment with Tier 2 and higher engines is available among all fleet sizes.

As shown in Figure 5-6, activity hours for equipment with Tier 2 and higher engines accounted for 59 percent of the overall activity hours. As shown in Figures 5-7, 5-8, and 5-9, based on activity hours by equipment type, smaller fleets have a lower percentage of activity hours for Tier 2 and higher engines. For the small, medium, and large fleet size, activity hours for equipment with Tier 2 and higher engines are estimated at 51 percent, 52 percent, and 66 percent of the total activity hours in the fleet size, respectively. In other words, among all fleet sizes, Tier 2 and higher engines account for over 50 percent of the total activity hours. Equipment with Tier 2 and higher engines appear to be used more often, regardless of fleet size, and therefore may be in higher demand, perhaps resulting in a quicker turnover of older, Tier 1 and Tier 0 engines.[107]

The In-Use Off-Road Equipment Model also includes information on the pieces of construction and mining equipment and activity hours by equipment type (e.g., bore/drill

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[106] The definitions shown here for small and medium fleet are slightly different than those in the In-Use Off-Road Diesel Regulation. Refer to Section 5.1.

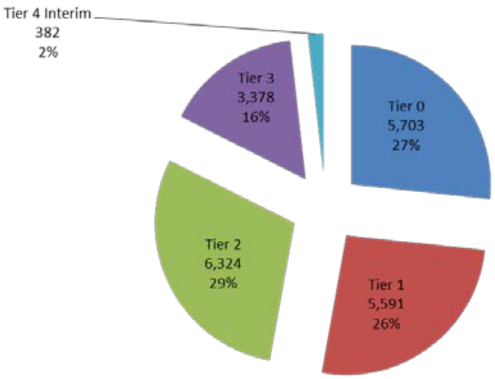
[107] Engines manufactured prior to Tier 1 emission standards do not have emission standards; these engines are referred to as Tier 0 in this report.

rigs, cranes, etc.) and tier in 2010 for the SFBAAB. As shown in Table 5-5, equipment with Tier 2 and higher engines were estimated to account for between 20 percent (rubber tired dozers) and 69 percent (skid steer loaders) of the total pieces of equipment for that equipment type. Equipment with Tier 2 and higher engines were estimated to account for between 29 percent (rubber tired dozers) and 79 percent (bore/drill rigs) of total activity hours for that equipment type.

Appendix C includes additional information on Tier 2 or higher engines based on hp across all fleet sizes. In summary, the 120 hp bin (i.e., equipment with engine hps between 51 hp and 120 hp) was estimated to have the most pieces of equipment (45 percent of total) and accounted for the most activity hours (41 percent of total). Within the 120 hp bin, equipment with Tier 2 and higher engines accounted for 52 percent of the overall equipment available and 64 percent of the overall activity hours in 2010.

In conclusion, requiring construction contractors to utilize equipment with Tier 2 and higher engines (or equivalent emission standards) is considered feasible because of the estimated availability of this equipment across all fleet sizes, equipment types, and hp bins.

FIGURE 5-2. SFBAAB ALL FLEET SIZES (PIECES OF EQUIPMENT) - 2010



Notes:
Total Pieces of Equipment - 21,377

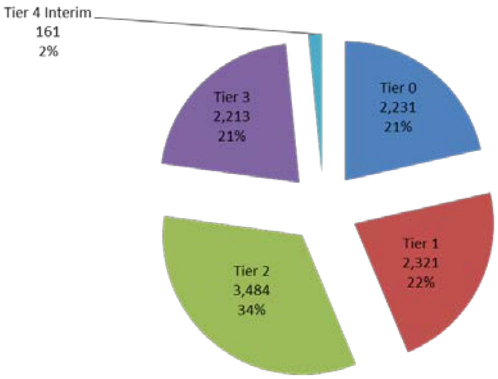
-First number shown in each pie is total pieces of equipment in that tier.

-Second number shown in each pie is the percent of total pieces of equipment in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

FIGURE 5-3. SFBAAB LARGE FLEET SIZE (PIECES OF EQUIPMENT) - 2010



Notes:
Total Pieces of Equipment - 10,411

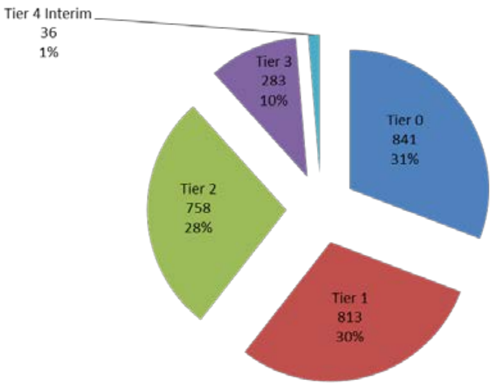
-First number shown in each pie is total pieces of equipment in that tier.

-Second number shown in each pie is the percent of total pieces of equipment in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

FIGURE 5-4. SFBAAB MEDIUM FLEET SIZE (PIECES OF EQUIPMENT)-2010



Notes:
Total Pieces of Equipment - 2,731

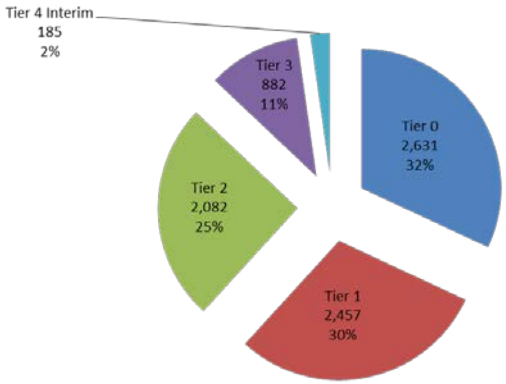
-First number shown in each pie is total pieces of equipment in that tier.

-Second number shown in each pie is the percent of total pieces of equipment in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

FIGURE 5-5. SFBAAB SMALL FLEET SIZE (PIECES OF EQUIPMENT)- 2010



Notes:
Total Pieces of Equipment - 8,236

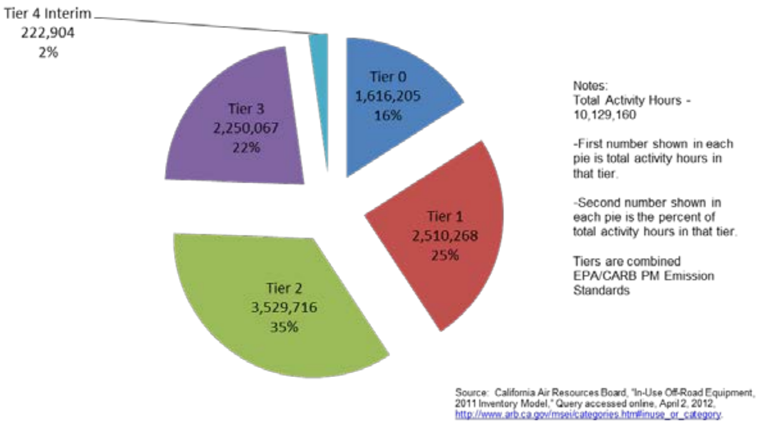
-First number shown in each pie is total pieces of equipment in that tier.

-Second number shown in each pie is the percent of total pieces of equipment in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

FIGURE 5-6. SFBAAB ALL FLEET SIZES (ACTIVITY HOURS) - 2010



Notes:
Total Activity Hours - 10,129,160

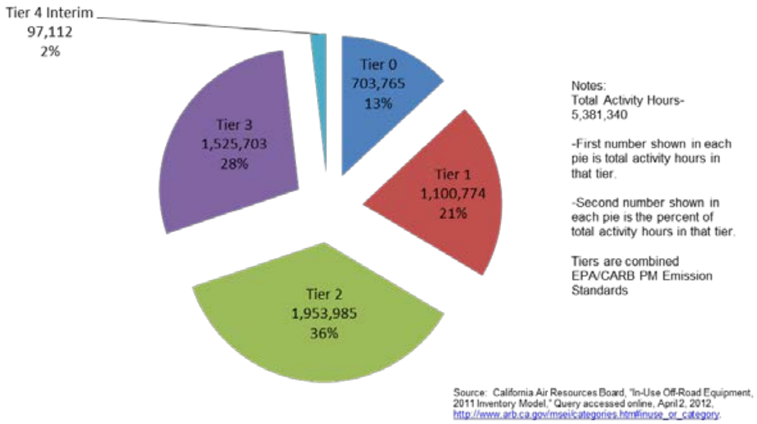
-First number shown in each pie is total activity hours in that tier.

-Second number shown in each pie is the percent of total activity hours in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category.

FIGURE 5-7. SFBAAB LARGE FLEET SIZE (ACTIVITY HOURS) - 2010



Notes:
Total Activity Hours- 5,381,340

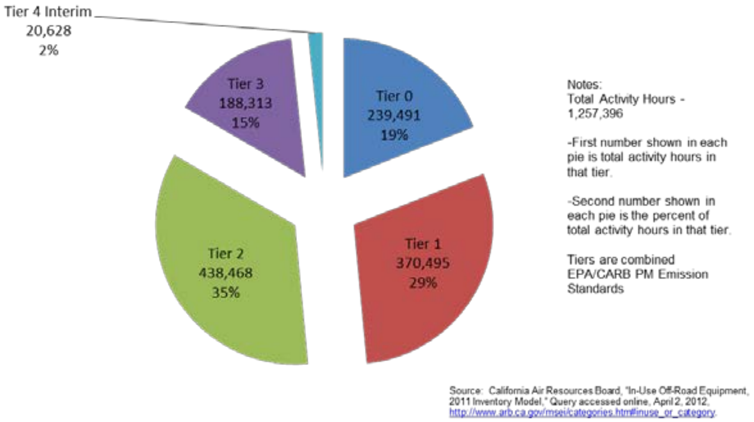
-First number shown in each pie is total activity hours in that tier.

-Second number shown in each pie is the percent of total activity hours in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category.

FIGURE 5-8. SFBAAB MEDIUM FLEET SIZE (ACTIVITY HOURS) - 2010



Notes:
Total Activity Hours - 1,257,396

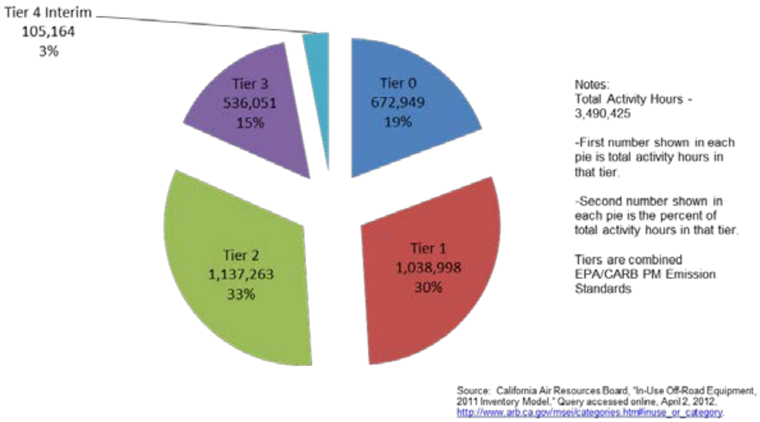
-First number shown in each pie is total activity hours in that tier.

-Second number shown in each pie is the percent of total activity hours in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category.

FIGURE 5-9. SFBAAB SMALL FLEET SIZE (ACTIVITY HOURS) - 2010



Notes:
Total Activity Hours - 3,490,425

-First number shown in each pie is total activity hours in that tier.

-Second number shown in each pie is the percent of total activity hours in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category.

TABLE 5-5. SAN FRANCISCO BAY AREA AIR BASIN ALL FLEET SIZES (PIECES OF EQUIPMENT, ACTIVITY HOURS AND TIER LEVEL BY EQUIPMENT TYPE) – 2010

Equipment Type	Pieces of Equipment	Activity Hours	Percent of Equipment Tier 2 or Higher[a]	Percent of Activity Hours Tier 2 or Higher[a]
Tractors/Loaders/Backhoes	5,724	2,880,678	47	65
Excavators	2,279	1,237,021	58	70
Skid Steer Loaders	1,898	555,975	69	78
Rubber Tired Loaders	1,897	1,565,292	40	55
Rough Terrain Forklifts	1,464	347,490	65	70
Rollers	1,452	419,915	42	48
Crawler Tractors	1,172	456,477	33	49
Scrapers	1,065	419,812	35	47
Other Construction Equipment	785	294,772	40	54
Graders	737	365,480	27	45
Cranes	636	252,685	28	32
Off-Highway Trucks	543	616,782	43	56
Off-Highway Tractors	518	289,772	44	52
Trenchers	344	104,917	39	48
Pavers	279	92,668	41	48
Bore/Drill Rigs	211	64,043	51	79
Paving Equipment	158	61,849	47	54
Rubber Tired Dozers	129	83,816	20	29

Equipment Type	Pieces of Equipment	Activity Hours	Percent of Equipment Tier 2 or Higher[a]	Percent of Activity Hours Tier 2 or Higher[a]
Surfacing Equipment	87	19,717	49	59
TOTAL	**21,377**[b]	**10,129,160**[b]	**--**	**--**

SOURCE: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category.

PM_{10} – particulate matter less than 10 microns in size

a. This was determined by matching the engine model year shown in the In-Use Off-Road Equipment, 2011 Inventory Model for an individual piece of equipment with the horsepower bin for the USEPA/CARB PM Emission Standard (Table C-1, Appendix C).

b. Number may not match the sum of the column due to rounding. However, the number does reflect the actual total from the Model.

As shown above, equipment with Tier 2 and higher engines is available. However, overall, equipment with Tier 3 (16 percent) and Tier 4 Interim (2 percent) engines are currently not as readily available. As shown in Figure 5-10, estimated equipment sales for the SFBAAB peaked in 2005 and 2006, followed by a sharp drop. This is most likely due to the economic recession as ARB has shown a strong correlation between construction equipment sales and construction gross domestic product in California.[108] The estimated median engine model year for all equipment is between 2001 and 2002. Equipment with Tier 3 and Tier 4 Interim engines are not as readily available as equipment with Tier 2 engines, therefore requiring construction contractors to utilize equipment with Tier 3 or Tier 4 engines may not be entirely feasible at this time.

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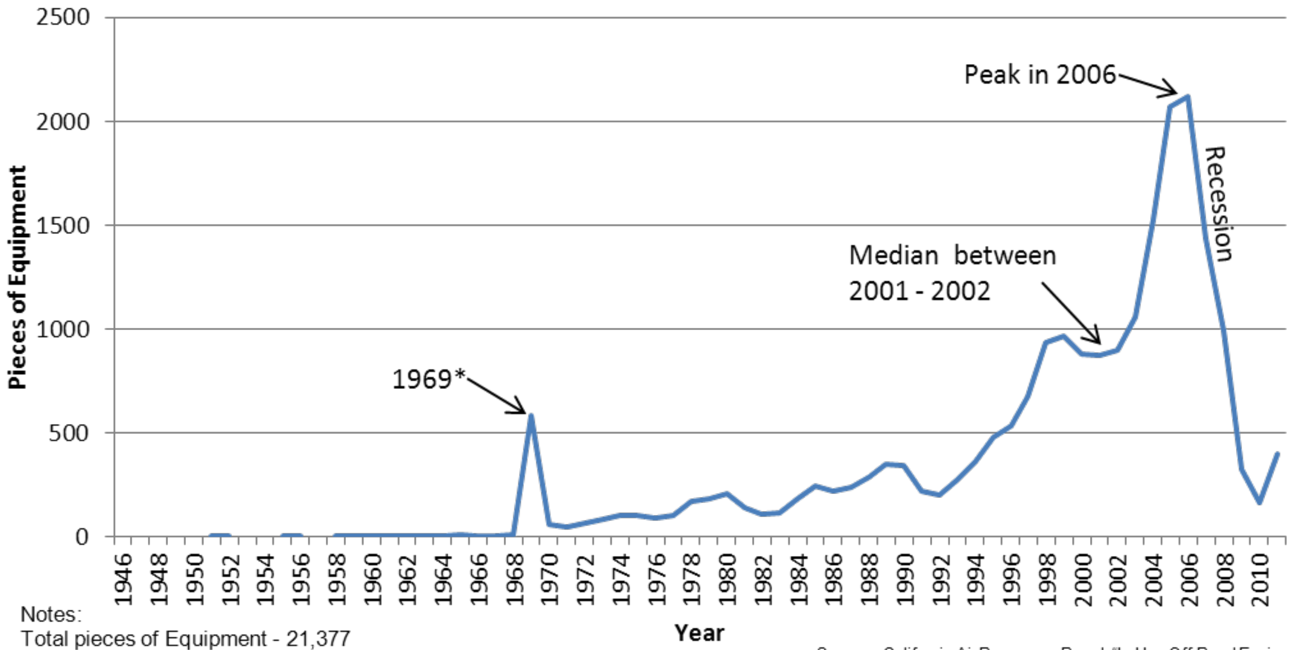
[108] ARB, *Staff Report: Initial Statement of Reasons for Proposed Rulemaking, Proposed Amendments to the Regulation for In-Use Off-Road Diesel-Fueled Fleets and the Off-Road Large Spark-Ignition Fleet Requirements*, October 2010, Appendix D.

FIGURE 5-10. SAN FRANCISCO BAY AREA AIR BASIN ENGINE MODEL YEAR- 2010



Notes:
Total pieces of Equipment - 21,377
*All engines with unknown model years were registered as model year 1969

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category.

Instead of requiring equipment with Tier 3 or Tier 4 engines, as outlined in requirement A(1)(b)(ii) of the construction BMPs, in addition to requiring equipment with Tier 2 engines, ARB Level 3 VDECSs are required. Level 3 VDECSs are designed to reduce PM by an additional 85 percent.[109] VDECS have been verified by the ARB pursuant to the "Verification Procedures, Warranty and In-Use Strategies to Control Emission from Diesel Engines," Title 13, California Code of Regulations, sections 2700-2710. Level 1 (at least 25 percent PM reduction), Level 2 (at least 50 percent PM reduction), and Level 3 VDECS's are available for a wide variety of construction-related equipment. VDECS's are specific to certain types of equipment, therefore, it cannot be determined with certainty that VDECS's are available for all types of equipment that may be used on a construction site or that based on the expected operating mode of a specific piece of equipment, such a device would produce the desired emissions reductions. However, this construction BMP allows for a variety of exceptions to the use of aftermarket VDECS's if the project sponsor can demonstrate that an exception shall apply. Should it be determined that exceptions to the requirements of aftermarket

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[109] A list of current VDECS can be found here: ARB, "Verification Procedure – Currently Verified," http://www.arb.ca.gov/diesel/verdev/vt/cvt.htm.

VDECS's shall apply to a specific piece of equipment, the construction BMP requires that alternative fuels be used. Biodiesel or compressed natural gas is an example of alternative fuels that may be used onsite. Therefore, given the various options for compliance, it is reasonably feasible that projects within identified hot spots could meet the requirements listed in requirement A(1)(b)(iii).

5.2.2. Effectiveness

The recommended BMPs, with the exception of requirement A(1)(b) are difficult to predict and quantify.[110] However, educating workers and the public, minimizing idling time, and properly maintaining equipment is anticipated to minimize potential impacts by limiting emissions from construction activities and ensuring construction contractors are aware of the requirements of the construction BMPs. Requirements for vehicles and equipment to meet specific Tiers and use of VDECS's do allow for a quantitative analysis of emissions reductions.

One can estimate PM emissions benefits of requiring equipment with Tier 2 and higher engines by comparing Tier 2 emission standards with Tier 1 and 0 emission standards. Refer to Table 5-1 in Section 5.1. Tier 0 engines do not have emission standards, but the USEPA has estimated equipment with these engines (Tier 0) between 50 hp and 100 hp to have a PM emission factor of 0.72 g/bhp-hr and equipment with Tier 0 engines greater than 100 hp to have a PM emission factor of 0.40 g/bhp-hr.[111] Therefore, requiring a minimum of Tier 2 engines would result in between a 25 percent and 63 percent reduction in PM emissions, as compared to equipment with Tier 0 or Tier 1 engines, respectively.[112] In addition to meeting equipment with Tier 2 engines, ARB Level 3 VDECSs are required. Level 3 VDECSs are

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[110] A study prepared for the USEPA, *Cleaner Diesel: Low Cost Ways to Reduce Emissions from Construction Equipment*, March 2007, attempts to quantify the emission reductions from minimizing idling and properly maintaining equipment. However, the USEPA acknowledges a lack of available data for off-road equipment and uses broad-based assumptions in quantifying reductions (pages 4 – 10). The BAAQMD in their guidance document, *California Environmental Quality Act, Air Quality Guidelines*, updated May 2011, states a user can assume a five percent reduction in oxides of nitrogen and PM emissions by reducing idling times to five minutes and properly maintaining equipment. However, the BAAQMD does not provide evidence or assumptions as to how they arrived at the five percent reduction (page B-11).

[111] USEPA, *Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling – Compression-Ignition*, July 2010, Table C-1. Refers to engines manufactured between 1988 and 1995.

[112] The 25 percent reduction comes from comparing the PM emission standards for engines between 25 hp and 50 hp for Tier 2 (0.45 g/bhp-hr) and Tier 1 (0.60 g/bhp-hr). The 63 percent reduction comes from comparing the PM emission standards for engines greater than 175 hp for Tier 2 (0.15 g/bhp-hr) and Tier 0 or Tier 1 (0.40 g/bhp-hr).

designed to reduce PM by an additional 85 percent. Therefore, Requirement A(1)(b), assuming no exceptions are met, would result in between an 89 percent and 94 percent reduction in PM emissions, as compared to equipment with Tier 0 or Tier 1 engines, respectively.[113] Emissions reductions from the combination of Tier 2 equipment with level 3 VDECS is almost equivalent to requiring only equipment with Tier 4 Final engines, which is not yet available for engine sizes subject to the recommended BMPs.

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[113] Equipment with Tier 2 engines between 25 hp and 50 hp would be reduced to 0.0675 g/bhp-hr and equipment with Tier 2 engines greater than 175 hp would be reduced to 0.0225 g/bhp-hr.

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Chapter 6. Siting Stationary Diesel Engines

As described in Chapter 2, in addition to high volume roadways common stationary sources of TACs such as diesel engines (i.e., standby back-up generators), gas stations, dry cleaning operations, and paint spray booths generally pose the greatest health risks in the San Francisco Bay Area compared to minor sources[114] and complex sources.[115] This section addresses the requirements for projects that propose new stationary diesel engines, such as standby back-up generators, as this is the most common stationary source proposed by typical urban land use projects. This chapter identifies existing guidance pertaining to the siting of diesel generators and identifies BMPs to be implemented for projects proposing new diesel engines within identified air pollution hot spots.

This document is not intended to address the air quality analysis that would be required for the environmental review of projects introducing other types of new sources to a project site such as gas stations, spray booths or dry cleaners; nor is it intended to address the scope of air quality analysis for complex and multi-phase projects.

6.1. REGULATIONS AND GUIDANCE PERTAINING TO STATIONARY DIESEL ENGINES

This section identifies federal, state and local regulations and guidance pertaining to the siting of stationary diesel engines. Federal agencies refer to the pollutants that result in an increase in mortality, a serious illness, or that pose a present or potential hazard to human health as hazardous air pollutants (HAPs). The USEPA and ARB regulate HAPs and TACs

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[114] Minor, low-impact sources are sources that are unlikely to pose a significant risk. The BAAQMD has determined through extensive modeling, source tests, and evaluation of TAC emissions, that minor, low impact sources do not pose a significant health impact even in combination with other nearby sources and determined that these sources can be omitted from risk and hazard assessments. Minor, low-impact sources include: roads with less than 10,000 total vehicles per day and less than 1,000 trucks per day; non-diesel boilers; soil-vapor extraction wells; and cooking (excluding under-fired char-broilers) and space-heating equipment.

[115] Complex Sources are sources that may pose significant health risks but require either specific information or complex modeling analysis. Examples of complex sources that generate substantial air pollution include: major ports; railyards; distribution centers and truck-related businesses; airports; oil refineries; power plants; metal melting facilities; and cement plants.

through statutes and regulations, and these generally require the use of the maximum or best available control technology (MACT or BACT respectively) in order to limit emissions.

BAAQMD is the regional agency responsible for permitting stationary sources such as diesel engines (i.e., standby back-up generators), gas stations, dry cleaning operations, and paint spray booths within the SFBAAB. The federal and state statutes and regulations in conjunction with additional regulation and rules promulgated by the BAAQMD provide the regulatory framework for addressing new stationary sources of TACs.

6.1.1. Federal Hazardous Air Pollutant Program

In addition to the federal Clean Air Act requirements for the USEPA to promulgate vehicle and fuel standards, the USEPA is required to promulgate national emission standards for HAPs. The national emissions standards may differ for major sources[116] and for area sources. These emissions standards were promulgated in two phases. In the first phase, between 1992 and 2000, the USEPA developed technology-based emissions standards designed to produce the maximum emissions reduction possible, or as commonly referred to the Maximum Achievable Control Technology (MACT) standards. The standards may differ for area sources depending on generally available control technology. The second phase, between 2001 and 2008, required the USEPA to promulgate health risk-based emissions standards, where necessary, to address risks that remained after implementation of technology-based emissions standards.

In 1996, the USEPA introduced new emission standards aimed at non-road mobile diesel engines such as construction and agriculture equipment. To be phased in over a four-year period beginning January 2007, these regulations require new stationary diesel engines, including engine generators, to comply with a tiered timing structure of emission allowances. Based on the system’s engine horsepower rating, generators are rated from Tier 1 to 4, with most non-emergency diesel engine generators required to achieve Tier 4 emissions standards, the most stringent requirements, by 2012. Emergency standby engine generators[117] typically operate for a low number of hours. Therefore, the USEPA exempts emergency diesel engine generator sets from meeting Tier 4

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[116] Major sources are defined as stationary sources with the potential to emit more than 10 tons per year of any HAP or TAC or more than 25 tons per year of any combination of HAPs or TACs.

[117] A back-up or emergency standby generator is an engine generator that only operates when normal power is lost.

emissions standards and requires Tier 2 and 3 compliance accordingly. However, if the engine generator is used to support the load when normal power is present, it would be required to comply with Tier 4 emissions standards. Examples include applications such as peak shaving and operating during storm conditions. Additionally, many state and local municipalities have adopted more stringent regulations.

6.1.2. State Toxic Air Contaminant Programs

California regulates TACs through the Tanner Air Toxics Act (AB1807) and the Air Toxics Hot Spot Information and Assessment Act of 1987 (AB2588). ARB designates substances as TACs through the procedures articulated in the Tanner Act. Once a substance is designated as a TAC, the ARB then adopts an Airborne Toxics Control Measure (ATCM) for any sources that emit this TAC.

The ARB identified DPM emissions as a TAC in August 1998. Following the identification process, the ARB was required by law to determine if there was a need for further emissions control. The process to make a determination regarding further emissions control is called the risk management phase of the program. For the risk management phase, the ARB directed staff to form a Diesel Advisory Committee to assist in the development of a risk management guidance document and a risk reduction plan. The Diesel Advisory Committee and subcommittees consisted of staff from the ARB, USEPA, State and local agencies, industry, environmental groups, and interested public. In addition to formal committee and subcommittee meetings, ARB staff also met with individual stakeholders.

With the assistance of the Advisory Committee and its subcommittees, the ARB developed the *Risk Reduction Plan to Reduce Particulate Matter Emissions from Diesel-Fueled Engines and Vehicles*[118] and *the Risk Management Guidance for the Permitting of New Stationary Diesel-Fueled Engines*.[119] The ARB approved these documents on September 28, 2000, paving the way for the next step in the regulatory process, the control measure phase. During the control

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[118] California Air Resources Board. 2000. *Risk Reduction Plan to Reduce Particulate Matter Emissions from Diesel-Fueled Engines and Vehicles*. Available online at http://www.arb.ca.gov/diesel/documents/rrpfinal.pdf. Accessed September 17, 2012.

[119] California Air Resources Board. 2000 and updated 2008. *Risk Management Guidance for the Permitting of New Stationary Diesel-Fueled Engines*. Available online at: http://www.arb.ca.gov/db/search/search_result.htm?q=Risk+Management+Guidance+for+the+Permitting+of+New+Stationary+Diesel-fueled+Engines&which=arb_google&cx=006180681887686055858%3Abew1c4wl8hc&srch_words=&cof=FORID%3A11. Accessed September 17, 2012.

measure phase, specific statewide regulations designed to further reduce DPM emissions from diesel-fueled engines and vehicles were evaluated and developed. The goal of these regulations is to make diesel engines as clean as possible by establishing state-of-the-art technology requirements or emission standards to reduce diesel PM emissions.

6.1.3. Bay Area Air Quality Management District Air Quality Regulations

At the local level, air quality management districts may adopt and enforce ARB's control measures. The BAAQMD has regulated TACs since the 1980s. All non-exempt sources that have the potential to emit TACs are required to obtain permits from the BAAQMD and the USEPA in compliance with requirements for New Source Review. BAAQMD's New Source Review rules Regulations 2-1 (General Permit Requirements), 2-2 (New Source Review) and 2-5 (New Source Review of Toxic Air Contaminants) implement federal and state new source permit requirements. These regulations specify the conditions under which sources that emit TACs may be constructed and operate, including the applicability of new source review standards and air toxics control measures. The BAAQMD limits public exposure to TACs through a number of programs and prioritizes TAC-emitting stationary sources based upon the quantity and toxicity of the TACs as well as the proximity of the facilities to sensitive receptors.

6.1.3.1. Regulations 2-1 General Permit Requirements and 2-2 New Source Review

BAAQMD Regulation 2, General Permit Requirements Rule 1, and New Source Review Rule 2 specify the procedures for the review of new sources of air pollution, the modification and operation of existing sources, and of associated air pollution control devices, through the issuance of authorities to construct and permits to operate. The general requirements with respect to permits are provided in Rule 1.[120] These requirements specify that a new or modified source of TACs that emits one or more TACs in quantities that exceed the trigger levels listed in Table 2-5-1 of Regulation 2-5, and that is not exempt, is subject to requirements in Regulation 2 Rule 5, New Source Review of Toxic Air Contaminants, including compliance with the best available control technology for toxics (TBACT) and project risk limits, as applicable. In addition, Regulation 2 Rule 2 provides requirements for

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[120] BAAQMD. Regulation 2, Permits, Rule 1 General Requirements (Adopted January 1, 1980 and amended April 18, 2012). Available online at: http://www.baaqmd.gov/~/media/Files/Planning%20and%20Research/Rules%20and%20Regs/rg0201.ashx?la=en. Accessed September 5, 2012.

Best Available Control Technology and emission offsets. Rule 2 implements federal New Source Review and Prevention of Significant Deterioration requirements. Rule 2 implements Section 40919 (a)(2) of the Health and Safety Code, requiring a no net increase for air pollutants for which the air basin is designated as non-attainment. The New Source Review provisions of 40 CFR 51.165 and the Prevention of Significant Deterioration provisions of 40 CFR 51.166 are hereby incorporated by reference.[121]

6.1.3.2. Regulation 2-5 New Source Review of Toxic Air Contaminants

Regulation 2, Rule 5 replaced the BAAQMD's Risk Management guidelines on July 1, 2005. This rule provides pre-construction review for potential health impacts from new and modified sources of TACs. Toxic emissions are estimated for all sources within a proposed project; if emissions from a proposed project exceed the trigger levels in Table 2-5-1 of Regulation 2-5, a Health Risk Screening Analysis (HRSA) is required to determine project risk and risk from each source. Rule 5 requires TBACT for any new or modified source of TACs where the source results in a cancer risk greater than 1.0 in one million (10 E-6), and/or a chronic hazard index greater than 0.20. With respect to project risk: the BAAQMD's Air Pollution Control Officer (APCO) shall deny an Authority to Construct or Permit to Operate for any new or modified source of TACs if the project risk exceeds any of the following project risk limits: A cancer risk of 10.0 in one million (10 E-6); or a chronic hazard index of 1.0; or an acute hazard index of 1.0.

6.1.4. San Francisco General Plan Policies

San Francisco's Air Quality Element of the General Plan establishes a goal of clean air planning to reduce the level of pollutants in the air, to protect and improve public health, welfare, and the quality of life for citizens of San Francisco and residents of the metropolitan region. One objective calls for the City to adhere to state and federal air quality standards and regional programs. In furtherance of this objective, Policy 1.3 calls for the City to support and encourage stationary control measures established by the State:

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[121] BAAQMD. 2005. Regulation 2, Permits, Rule 2 New Source Review (Readopted and Renumbered July 17, 1991). Available online at: http://www.baaqmd.gov/~/media/Files/Planning%20and%20Research/Rules%20and%20Regs/reg%2002/rg0202.ashx?la=en. Accessed September 17, 2012.

> **POLICY 1.3 Support and encourage implementation of stationary control measures established by the State.** Stationary sources refer to industrial or commercial activities that emit air pollutants into the atmosphere through fixed vents or stacks. The Air District [BAAQMD] is the State agency responsible for implementation of stationary control measures in the Bay Area. To encourage and ensure implementation of stationary sources control measures there needs to be better coordination between the City and State agencies to make sure that development of new stationary sources of pollution are reviewed and permitted for air quality impacts evaluation by the Air District.[122]

To this end, San Francisco passed Health Code Article 30 in 2002, requiring that owners of existing back up diesel engines register those engines with DPH. Additionally, owners of new diesel engines are required to submit an application to DPH within 90 days of installation of the engine specifying, among other things, the emissions specifications of the engine. Consistent with the regulations required by the BAAQMD, Article 30: (1) limits the operating hours of a Diesel Backup Generator for Non-Emergency Use to 50 hours each year, (2) requires the engine to install the best available control technologies, as determined by the ARB or BAAQMD, to reduce air emissions, (3) requires periodic maintenance of the diesel back-up generator as recommended by the engine manufacturer, and (4) requires the generator to be equipped with a non-resettable totalizing meter that measures the hours of operation or fuel usage.[123]

6.2. BEST MANAGEMENT PRACTICES FOR DIESEL ENGINES

This section recommends BMPs for reducing emissions from the siting of a new back-up diesel generator within air pollution hot spots. The recommended BMPs identified below are based on the need to reduce emissions and associated health risks from new stationary sources in areas of the City that are most at risk from existing sources of air pollution. The recommended BMPs take into consideration existing federal and state regulations that are anticipated to substantially reduce emissions from new stationary sources and the relative

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[122] San Francisco. San Francisco General Plan Air Quality Element. Available online at: http://www.sf-planning.org/ftp/General_Plan/I10_Air_Quality.htm. Accessed September 13, 2012.

[123] San Francisco Health Code Article 30. Available online at: http://www.amlegal.com/nxt/gateway.dll/California/planning/planningcode?f=templates$fn=default.htm$3.0$vid=amlegal:sanfrancisco_ca$sync=1. Accessed October 16, 2012.

contribution of emissions from diesel-powered back-up generators. The feasibility and effectiveness of implementing recommended BMPs are also presented.

6.2.1. Applicability

In considering whether BMPs should be employed for specific projects, three primary factors must be considered: 1) existing local, state and federal regulations that are anticipated to substantially reduce emissions from new stationary sources, 2) health effects attributable to emissions from stationary sources, and 3) the degree to which existing environmental conditions warrant protective measures. Each of these is discussed further.

As discussed in Section 6.1, both federal and state agencies have passed regulations to reduce emissions from new stationary sources of air pollution including the federal New Source Performance standards and the State *Diesel Risk Reduction Plan*. The key elements of the Plan include reducing emissions through engine retrofit emission control devices, to adopt stringent standards for new diesel engines, and to lower the sulfur content of diesel fuel to protect new, and very effective, advanced technology emission control devices on diesel engines. These regulations are anticipated to substantially reduce emissions from new stationary sources throughout the state.

Chapter 2 of this document discusses the State and SFBAAB inventory of TAC emissions. The majority of the DPM emissions within the SFBAAB result from mobile sources with stationary sources contributing about one percent of emissions.[124] The emissions standards, new source performance standards, and new source review procedures implemented in the SFBAAB require measures to limit emissions of TACs for new stationary sources. However, projects within the air pollution hot spots identified in Figure 3-2, and which propose the installation of a new stationary source such as a back-up diesel generator, have the potential to increase the health risk to nearby sensitive land uses by adding additional emissions in an already adversely affected area. Therefore, the following BMP is appropriate for back-up emergency generators proposed within an air pollution hot spot.

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[124] California Air Resources Board. 2009. *The California Almanac of Emissions and Air Quality - 2009 Edition*. Available online at: http://www.arb.ca.gov/aqd/almanac/almanac09/pdf/chap509.pdf. Accessed September 17, 2012.

6.2.2. Best Management Practices

The following BMP would be required for all projects within San Francisco subject to CEQA and located in areas identified in Figure 3-2 that propose the installation of an emergency back-up generator.

A. Best Available Control Technology for Diesel Generators

All diesel generators shall:

(1) Meet Tier 4 or interim Tier 4 emissions standards; or
(2) Meet Tier 2 emissions standards and be equipped with an ARB Level 3 Verified Diesel Emissions Control Strategy (VDECS).

Exceptions to the above requirements shall be granted in instances where the project sponsor demonstrates that sensitive land uses do not exist within 1,000 feet of the project site boundaries.

6.2.3. Feasibility

USEPA certifies (formally verifies) that engines sold in the United States meet federal emissions standards. Each year, newly manufactured engines must be certified, and engines certified in previous years must be recertified as meeting emission standards, Tier 1 to Tier 4. As discussed above, emergency standby generators typically operate for a low number of hours. Therefore, the USEPA exempts emergency diesel engine generator sets from Tier 4 emissions regulations and requires Tier 2 and 3 compliance accordingly. In 2011 the ARB amended the Airborne Toxics Control Measure (ATCM) for Stationary Compression Ignition Engines in order to align the ATCM with the federal New Source Performance Standards (NSPS) approach of not requiring after treatment based standards for new emergency standby engines.

The amendments retain the 0.15 g/bhp-hr PM emissions limit for new emergency standby engines, align the other pollutant emission standards with the NSPS requirements, and, consistent with the NSPS requirements, require any new emergency standby engine to be 2007 model year or newer. The ATCM also prevents the installation of any new emergency standby engine that does not meet the 2007 model year or newer emissions limits in the Off-Road Standards for all pollutants.

The ARB Staff report regarding 2011 amendments to the ATCM included an analysis of the technical feasibility and costs of after treatment control on new emergency standby generators.[125] ARB staff concluded that Tier 4 engines for emergency standby applications will not be available 'off-the-shelf' due to the fact that manufacturers will not likely develop and maintain a Tier 4 emergency standby platform for California. In addition, the analysis found that it is not cost-effective to routinely apply after-treatment technologies on back-up emergency generators due to the high cost of applying these technologies to back-up diesel generators and that a typical back-up emergency generator is operated for a low number of hours per year. For these reasons, the ARB determined it was more appropriate to more closely align the ATCM with the federal NSPS emission standards.[126]

However, the analysis also found that application of DPF on back-up emergency generators is technically feasible, and ATCM does not limit the ability of districts to impose more stringent conditions on a site-specific basis where additional controls are warranted.[127] Therefore, given the options for compliance, it is reasonably feasible that proposed projects within identified air pollution hot spots would be able to install back-up emergency generators that meet the specified requirements.

In conclusion, requiring project sponsors to install standby or emergency generators with Tier 2 engines equipped with an ARB Level 3 Verified Diesel Emissions Control Strategy (VDECS) or higher engines (or equivalent emission standards) is considered feasible because of the estimated availability of these engines.

6.2.4. Effectiveness

The requirement for standby or emergency back-up generators to meet specific tier emission standards and use of VDECS allows for a quantitative analysis of emissions reductions.

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[125] ARB. 2011. Appendix B: *Analysis of the Technical Feasibility and Costs of After-Treatment Controls on New Emergency Standby Engines.* Available online at:

http://www.arb.ca.gov/regact/2010/atcm2010/atcmappb.pdf. Accessed September 17, 2012.

[126] ARB. 2010. *Final Statement of Reasons for Rulemaking Including Summary of Comments and Agency Responses regarding Proposed Amendments to the Airborne Toxic Control Measure for Stationary Compression Ignition Engines (Stationary Diesel Engine ATCM).* Available online at http://www.arb.ca.gov/regact/2010/atcm2010/atcmfsor.pdf. Accessed September 17, 2012.

[127] ARB. 2010. Final Statement of Reasons for Rulemaking Including Summary of Comments and Agency Responses regarding Proposed Amendments to the Airborne Toxic Control Measure for Stationary Compression Ignition Engines (Stationary Diesel Engine ATCM), Appendix B. Available online at: http://www.arb.ca.gov/regact/2010/atcm2010/atcmfsor.pdf. Accessed September 17, 2012.

USEPA requirements phased in Tier 2 emission standards from 2001 to 2006 for all engine sizes and added more stringent Tier 3 standards for engines between 37 and 560 kW (50 and 750 hp) from 2006 to 2008. These standards reduce nonroad diesel engine emissions by 60 percent for NOx and 40 percent for PM from Tier 1 emission levels.[128] In addition to meeting the requirement with Tier 2 engines, ARB Level 3 VDECSs are required. Level 3 VDECSs are designed to reduce PM by an additional 85 percent. Therefore, the requirement to provide Tier 4 or Tier 2 with level 3 VDECs would result in between an 89 percent and 94 percent reduction in PM emissions, as compared to equipment with Tier 0 or Tier 1 engines.[129] Emissions reductions from the combination of Tier 2 equipment with level 3 VDECS is almost equivalent to requiring a Tier 4 Final engine, which is not yet available for engine sizes subject to the recommended BMP.

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[128] USEPA. 2003. Program Update; Reducing Air Pollution from Nonroad Engines. Available online at: http://www.epa.gov/otaq/cleaner-nonroad/f03011.pdf. Accessed September 13, 2012.

[129] Equipment with Tier 2 engines between 25 hp and 50 hp would be reduced to 0.0675 g/bhp-hr and equipment with Tier 2 engines greater than 175 hp would be reduced to 0.0225 g/bhp-hr.

Chapter 7. Acknowledgements

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Appendix A – The San Francisco Community Risk Reduction Plan: Technical Support Documentation

The San Francisco Community Risk Reduction Plan:
Technical Support Documentation

December 2012

Bay Area Air Quality Management District
San Francisco Department of Public Health
San Francisco Planning Department

TABLE OF CONTENTS

1. Introduction

This document describes technical work performed to support San Francisco's Community Risk Reduction Plan (CRRP). The objective of the technical work was to identify and map regions of the city where current residents are exposed to higher levels of air pollution and where future residents, in new developments projects, may also be exposed. To identify areas with elevated air pollutant concentrations and higher population exposures, *air pollution dispersion modeling* played a central role. Dispersion modeling applies a time-averaged, simplified representation of turbulent, atmospheric transport to approximate how pollutants are carried, mixed, and diluted by the local winds. Critical inputs to the dispersion models are estimates of emissions from major air pollution sources and source characteristics. The technical support documentation therefore highlights how emissions of major source categories were inventoried, as well as which dispersion models were used and how they were applied.

Air pollutants considered in the dispersion modeling analysis were emissions of *primary* particulate matter (PM) from many major source categories and emissions of *primary* toxic air contaminants (TAC) with documented cancer toxicities. The qualifier "primary" signifies that only compounds emitted directly were considered. Furthermore these compounds were assumed to be nonreactive. Compounds formed in the atmosphere from emissions of other pollutants, so-called *secondary* pollutants, were not included in this analysis. Secondary air pollutants were not considered in part because their formation involves complex chemical reactions that are not accounted for in the dispersion models applied in this analysis and in part because near-source exposures tend to be driven by emissions of primary pollutants; whereas, secondary pollutants form downwind of sources and tend to be more regionally distributed.

The emissions estimates and modeling analyses were developed for three years: a base year (2010), a project development year (2014), and a future year (2025). The base year is used to establish baseline concentrations for which air pollution measurements are available. The project development year is the estimated earliest date that residents would occupy a new development project if an application is submitted this year (2012). The development and future year modeling show anticipated reductions in hotspot areas relative to the base year, but also identify areas where hotspots are anticipated to persist without additional emission reductions.

The development of the technical foundation that supports the CRRP, like the development of the CRRP itself, was a collaborative effort. Modeling systems and inputs developed by the San Francisco Department of Public Health (SFDPH) for on-road cars and trucks provided an initial blueprint for this effort, which built on analyses supporting San Francisco's Article 38, a City ordinance that recognizes the health and financial benefits of requiring particulate matter filtration for new developments near busy roadways. The Bay Area Air Quality Management District (BAAQMD) built upon this initial effort by including additional stationary and mobile sources of air pollution and by significantly increasing the number of receptor points included for evaluation in the modeling analysis. Contractor Sonoma Technology, Inc., (STI) assisted the BAAQMD in developing portions of the CRRP emissions inventory (STI 2011; STI 2012a). The San Francisco Planning Department (SFPLAN) provided careful review of modeling inputs and results and helpful suggestions for improvements. Members of the Air District's Community Air Risk Evaluation (CARE) Task Force helped to guide early stages of the CRRP technical work, in addition to generating discussions that led to the concept of a community risk reduction planning tool.

The subsections below, which comprise the technical support documentation, describe the development of the emissions inventory (Section 2), discuss other air dispersion modeling inputs and system configuration (Section 3), outline methods used to generate concentrations and cancer risk estimates from modeling output (Section 4), present modeling results and findings (Section 5), and discuss sources of uncertainty in the methods applied (Section 6).

2. Emissions Inventory

This section presents a summary of the emissions inventory developed for the CRRP. Each subsection presents the methodology for generating estimates of annual emissions for the source categories modeled, including

- On-road mobile sources—cars and trucks—on freeways and surface streets with traffic volumes of more than 1,000 vehicles per day (Section 2.1),
- Permitted, stationary sources, including gasoline dispensing stations, prime and standby diesel generators, wastewater treatment plants, recycling facilities, dry cleaners, large boilers, and other industrial facilities (Section 2.2),
- Caltrain passenger diesel locomotives (Section 2.3),
- Ships and harbor craft, including cruise ships, excursion boats, and tug boats (Section 2.4),
- The Transit Center bus depot, including diesel emissions from local transit buses (Section 2.5), and
- Major construction projects in 2010 and 2025 (Section 2.6).

Source categories of emissions not included in the CRRP analysis are

- Residential wood burning from fireplaces and wood stoves,
- Commercial and residential cooking,
- Ferry boats,
- Indirect sources that generate vehicle trips such as distribution centers, retail centers, and postal service stations.

These categories are potentially important sources of PM on a citywide scale, but are either difficult to analyze, such as in the case of wood burning and cooking (widely distributed and poorly known locations), or were judged to be less important than similar sources that are included, such as the case of indirect sources (whose contribution is small compared to freeway and street traffic) and ferry boats (small contribution compared to ocean-going vessels).

Annual emissions estimates were developed for three years: a base year 2010, a project development year 2014, and a future year 2025. The project and future year modeling included the following changes from the base year:

- Reductions in emissions for on-road trucks based on the California Air Resources Board's (CARB) on-road diesel regulation and assuming San Francisco Transit Authority's growth projections for 2020,
- Phase out of perchloroethlyene from dry cleaners by 2023,
- Shutdown of the Potrero Generating Station in 2011,
- Assumed electrification of Caltrain in 2025,
- Reduction in hoteling emissions associated with docking of cruise ships in 2025 based on available shore power, as required by CARB's ocean going vessel regulation, and
- Phase-specific emissions based on construction schedule of large multi-year construction projects. Year specific emissions (2010 and 2025) were developed to evaluate the one-year impact of major construction projects relative to other sources.

Emissions estimates were generated for the following directly emitted pollutants that have been identified in previous studies (Cohen and Pope 1995, Krewski et al. 2009, HEI 2010) as having significant health impacts:

- Fine particulate matter with ($PM_{2.5}$, particles with diameter less than 2.5 micrometers),
- Diesel particulate matter (diesel PM),
- Other carcinogenic air contaminants, including exhaust and evaporative emissions from gas-powered vehicles, such as benzene and 1,3-butadiene; perchloroethlyene from dry cleaners; and polycyclic aromatic hydrocarbons (PAHs) from industrial sources.

2.1 Roadways

State highways and surface streets in San Francisco are a significant source of fine PM and TAC air pollution. Emissions from cars and trucks in the urban environments occur in close proximity to sensitive receptors and have been shown to have a high ratio of inhaled to emitted pollutants (*intake fraction*; Marshall et al. 2005). The CRRP analysis applied dispersion modeling for all roadways with 1,000 annual average daily traffic (AADT) counts or more, including all motor vehicle types.

Activity Data:
For estimating emissions from on-road mobile sources, roadway activity data were generated using the San Francisco County Chained Activity Modeling Process (SF-CHAMP), developed for the San Francisco County Transportation Authority to provide detailed forecasts of travel demand for planning studies and city projects (Outwater and Charlton 2006). SF-CHAMP, the official travel forecasting tool for San Francisco, is an activity-based model that predicts future travel patterns for the city. Traffic for year 2010 was used to model emissions for 2010, while predicted traffic volumes for year 2020 were used to estimate emissions for 2025. Between years 2010 and 2020,

traffic volumes were linearly interpolated. For years beyond 2020, traffic volumes were assumed to remain constant[1].

In addition to the total traffic volume, an estimate of heavy-duty truck volumes was also developed for each roadway link. Several sources were relied upon to estimate truck volumes. For California freeways (Highways 1, 35, 101, 280, and 80), the California Department of Transportation's (Caltrans) 2009 truck fractions were used and assigned by spatially joining the Caltrans GIS representation of State freeways with the SF-CHAMP network. Average truck fractions for surface streets were estimated using ortho-photo analysis, whereby truck counts were derived in neighborhoods and street segments based on aero-photographs taken at specific times of the day. Truck-restricted streets were assumed to have no truck activity.

Average speeds for each roadway link modeled and roadway lengths were also provided by SF-CHAMP. Average speed was used in the selection of emission factors, as described below. The product of roadway length and vehicle counts was used to calculate the total vehicle miles travelled (VMT).

Hourly traffic activity for San Francisco County was set to an hourly (weekday) profile for San Francisco County derived from CARB's Emission FACtors (EMFAC) model. The diurnal profile sets hourly fractions (relative to peak traffic) representing hourly changes in traffic over the course of a day. Diurnal profiles (Figure 1) were specified for all vehicles and for heavy-duty trucks. While AADT for total vehicles and for heavy-duty trucks were roadway link specific, the diurnal profile was constant across all roadways.

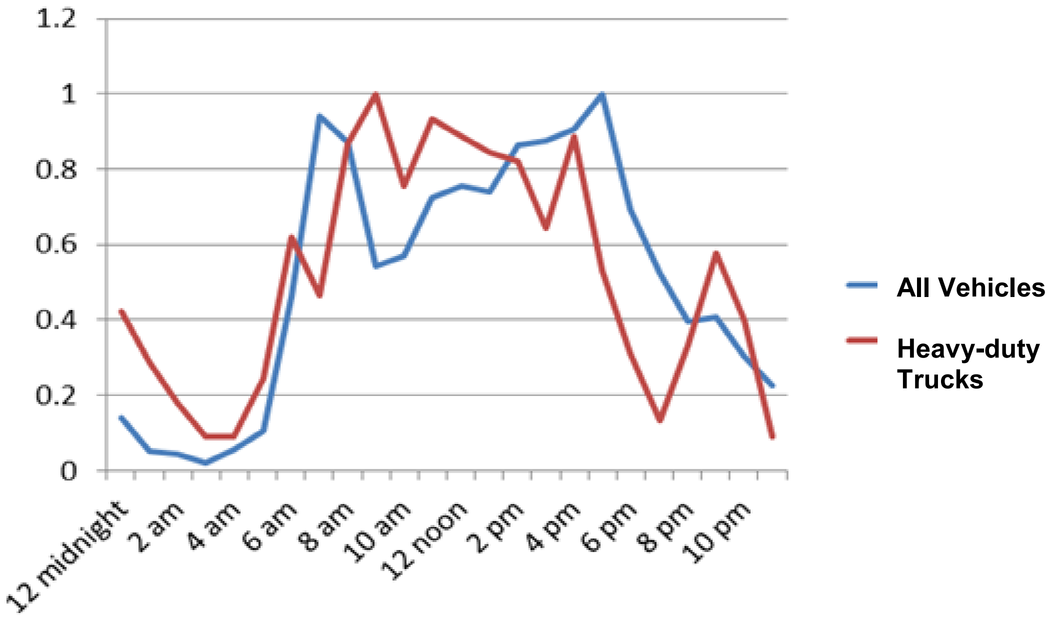

Figure 1. Normalized activity patterns of on-road traffic for all vehicles (blue line) and heavy-duty trucks (red line). Values are normalized to peak-hour traffic.

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[1] Should extended activity forecasts become available for years beyond 2020, dispersion modeling and analyses could be updated.

Emission Factors and Emissions:

Activity-based emission factors were applied for $PM_{2.5}$, diesel PM, and total organic gases from non-diesel, on-road mobile sources. Emission factors were derived using the latest version of EMFAC (EMFAC2011, CARB 2011) for all vehicle classes at all speeds for EMFAC2007 vehicle categories. Emissions of $PM_{2.5}$ on each roadway link were estimated by summing $PM_{2.5}$ exhaust and brake and tire wear emissions across all vehicle categories, using emission factors for the average roadway speed:

$$E_{PM2.5} = \sum_{i}^{\substack{all\,fuel \\ types}} \sum_{k}^{\substack{all\,vehicle \\ types}} e_{PM2.5,i,k}\ L\,N_k\ ,$$

where $E_{PM2.5}$ represents the emissions (g/day) of $PM_{2.5}$ on a roadway,

$e_{PM2.5,\,k,\,i}$ is the emission factor (g/day per vehicle mile travelled) of $PM_{2.5}$ (including running exhaust, brake wear, and tire wear) for the average link speed for vehicle type k and fuel type i,

L is the roadway link length (mi), and

N_k is the count for vehicle type k.

Diesel PM (DPM) was derived similarly by summing PM10 exhaust emissions including brake and tire wear for only the diesel fuel type:

$$E_{DPM} = \sum_{k}^{\substack{all\,vehicle \\ types}} e_{PM10,k}\ L\,N_k\ ,$$

where E_{DPM} represents the emissions (g/day) of diesel particulate matter,

$e_{PM10,\,k}$ is the emission factor (g/day per vehicle mile travelled) of PM10 (running exhaust only) for the average link speed for vehicle type k and diesel fuel only,

L is the roadway link length (mi), and

N_k is the count for vehicle type k.

Emissions of total organic gases (TOG) from tailpipe and evaporative losses were summed for non-diesel (gasoline) fueled vehicles:

$$E_{non-diesel\,TOG} = \sum_{k}^{\substack{all\,vehicle \\ types}} e_{TOG,exhaust}\ L\,N_k + \sum_{k}^{\substack{all\,vehicle \\ types}} e_{TOG,loss}\ T\,N_k\ ,$$

where $E_{non\text{-}diesel\ TOG}$ represents the emissions (g/day) of non-diesel TOG,

$e_{TOG,\,exhaust,\,k}$ is the emission factor (g/day per vehicle mile travelled) of TOG (running exhaust) for the average link speed for vehicle type k and gasoline fuel only,

$e_{TOG,\ loss,\ k}$ is the emission factor (g/day per hr) of TOG (running loss) for the average link speed for vehicle type k and gasoline fuel only,

T is the roadway link length (mi) divided by the average speed (mi/hr), and

N_k is the count for vehicle type k.

Total traffic counts and heavy-duty truck traffic counts for roadway links were used to determine the number of vehicles for each vehicle category for which EMFAC provides emission factors, N_k in the equations above. Using EMFAC2007 heavy-duty classifications, LHD1, LHD2, T6, T7, SBUS, OBUS, and UBUS were used to represent heavy-duty truck counts. Remaining categories were classified as light duty. Relative fractions of traffic volumes within each category were taken to match EMFAC2011 estimates.

Emission factors (per VMT) from running exhaust were derived from EMFAC2011 for years from 2010 to 2035 for all EMFAC2007 vehicle categories. Emission factors for years beyond 2035 were assumed to remain constant.

2.2 Permitted Stationary Sources

Stationary sources of air pollution—including larger facilities such as refineries, power plants, and chemical manufacturers as well as smaller facilities such as diesel generators, gasoline dispensing facilities (GDFs or gas stations), and drycleaners—are regulated and subject to permit conditions established by the BAAQMD. BAAQMD maintains a database of the permitted sources and their associated emissions. Emissions are determined by measurement (source testing) or engineering calculation based on process throughput. Emissions are reported annually to CARB via the California Emissions Inventory Development and Reporting System (CEIDARS, CARB 2008) and, subsequently, reported to EPA to supplement the National Emissions Inventory database (NEI, EPA 2012).

The starting point for the CRRP permitted source emissions inventory development was the 2008 and 2009 CEIDARS point source submittals to CARB. These data submittals were supplemented and improved to develop a stationary source modeling database for the CRRP. One important improvement was the addition of GDFs to the point-source dataset. Historically, emissions from GDFs have been reported as part of county-level area sources in CEIDARS. Adding GDFs as point sources instead provided information on emissions from individual GDFs. Gas station information included street addresses, geocoded coordinates, and emissions of total organic gases and toxic air contaminants.

Another key improvement to the database was correcting and reporting *release parameters*. Release parameters—such as stack locations, stack heights, and stack diameters, and exhaust gas flow rates and temperatures—are auxiliary data needed to determine plume rise and pollutant transport in dispersion models. The BAAQMD's CEIDARS submittals contain placeholders for release parameters; but, because these parameters are not required, much information is incomplete or inaccurate. Significant effort was directed toward collecting and manually entering data to replace missing or inaccurate data fields (STI 2012a).

Data Sources:

Data collection and data quality assurance efforts focused on the following types of sources within the Bay Area:

- Top 1,000 highest emitting prime and standby generators,
- Top 1,000 of the highest emitting gas stations,
- Dry cleaners that use perchloroethylene,
- Top 100 permitted stationary sources of toxic air contaminants (TAC), with rankings based on cancer risk weighted emissions (year 2008) and excluding generators, gas stations, dry cleaners, and refineries, and
- Top 100 permitted stationary sources of $PM_{2.5}$ (year 2009) emissions.

These sources were targeted because they emit compounds that have high toxicities and because they have relatively high intake potential, that is, the sources tend to be near receptors so their emissions have a high likelihood of leading to exposures. A variety of data sets were used to assemble emissions data, release parameters and risk information for permitted stationary sources:

- **California Emissions Inventory Development and Reporting System (CEIDARS) database** – The CEIDARS data include emissions inventory data for all point sources in BAAQMD's jurisdiction were incorporated as comma separated value (CSV) files that contain facility information, annual criteria and TAC emissions, stack parameters, and process-level activity data (e.g., throughput and operating cycles). Initially 2008 CEIDARS data were used; these data were later augmented with a 2009 inventory.

- **2008 GDF emissions inventory** – This inventory was incorporated from an Excel spreadsheet format that included facility information (e.g., address and location coordinates) and total organic gas (TOG) and air toxics emissions data for all GDFs in the BAAQMD, which are not included in the District's CEIDARS data.

- **2011 District survey** – Results of a survey of owners and operators of GDFs and stationary diesel engines provided some missing data for GDFs and diesel generators. For GDFs, survey results provided information on the number of dispensers and dispenser dimensions at each facility, as well as the facility's annual throughput (gallons of gasoline). For diesel engines, the survey results provided information on engine make and model, outlet location, and stack configuration.

- **District permit applications** – applications dating back to the year 2000 that include information on dispersion modeling conducted as part of a health risk assessment (HRA) or prevention of significant deterioration (PSD) analysis.[2] For permits that include such an analysis, information was available in one of three formats:

  1. Electronic model inputs files developed by the engineer assigned to conduct that analysis;

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[2] PSD requirements apply to new point sources or existing point sources where major modifications have been made. The requirements include the use of air quality modeling to demonstrate that emissions from the facility will not cause or contribute to a violation of applicable air quality standards.

2. Permit applications scanned into the District's online document storage system (Peelle Tech.); or
3. Hard copies of permit applications that were scanned and converted into PDF format.

Contractor STI reviewed each of these data sets, extracted pertinent information, and assembled that information into a stationary source modeling database.

Database Design:

STI worked with the BAAQMD to identify the types of data that were to be included in the stationary source database and to develop a database structure that would incorporate these data. The final database design includes 5 tables with a total of 146 data fields (STI 2012a). The contents of each table are summarized below:

- **Plant Table** – contains facility-level data such as address, contact information, location coordinates, and industry type, e.g., Standard Industrial Classification (SIC) code.
- **Source Table** – contains data on individual emissions sources within a facility, including activity data (e.g., hours of operation per year), engine characteristics (e.g., make, model, horsepower), and controls information.
- **Emissions Table** – contains annual emissions by pollutant for each emissions source at a facility. Two different emissions fields are provided for each pollutant: one for emissions from the District's CEIDARS database, and one for an alternative data source (e.g., emissions recorded in a permit application).
- **Release Table** – contains information on emissions release points within a facility, including stack parameters and definitions for area and volume sources.[3] Note that multiple emission sources can be routed to a single stack, and the Source Table includes stack assignments for each emissions source.
- **Applications Table** – contains health risk information (e.g., modeled $PM_{2.5}$ concentrations and associated cancer risk) from permit applications for which HRAs were conducted. The risk information may be connected to individual or multiple emissions sources at a facility.

Because the data fields in the tables listed above were populated with data from the District's CEIDARS database where possible, additional data fields were included that cross-referenced data fields in the CEIDARS database with corresponding fields in the stationary source database. The CEIDARS data, in some cases, contained emissions for total PM or for PM10, and not $PM_{2.5}$ directly, $PM_{2.5}$ emissions were estimated outside the database using source-specific ratios ($PM_{2.5}$/PM or $PM_{2.5}$/PM10). Compound specific cancer toxicities were applied to TAC emissions estimates to calculate toxicity-weighted emissions.

Table 1 presents a summary of the permitted sources in the Bay Area identified for inclusion in the stationary source database, as well as the fraction of sources and emissions captured for each

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[3] In dispersion modeling, an area source is a two-dimensional emissions source that is represented by polygon vertices, while a volume source is a three-dimensional emissions source that is represented by a location, release height, and initial lateral and vertical plume sizes.

source category. These results show that the selected diesel engines, GDFs and dry cleaners emit 78% to 100% of the total $PM_{2.5}$ and risk-weighted emissions associated with those source categories. While the "Other Sources" of $PM_{2.5}$ and TACs selected represent only a small number of the total remaining sources in the CEIDARS database, they emit 36% of the $PM_{2.5}$ and 45% of the cancer-risk-weighted emissions associated with such sources.

Table 1. Summary of sources and emissions included in the stationary source database.

Source Category	Number of Sources Selected	Total Number of Sources	Percentage of Total Emissions Captured for Each Source Category[a]	
			$PM_{2.5}$	Cancer Risk-Weighted
Stationary Diesel Engines	1,000	5,152	93%	84%
Gas Stations	1,001[b]	2,580	--	85%
Perchloroethylene Dry Cleaners	605	605	--	100%
Other $PM_{2.5}$ Sources	100	6,679	36%	--
Other TAC Sources	100	4,525	--	45%

[a] Percentage of emissions captured, based on emissions reported in the District's 2008 CEIDARS database.

[b] Gas station sources ranked 1,000 and 1,001 had the same emission levels.

CEIDARS contains data by individual sources that are associated with each facility. If at least one source was selected for inclusion in the database, then all of the associated sources within the facility were exported to the database. STI entered available emissions, health risk data, stack parameters, and other source characteristics for the sources of interest, augmenting or replacing existing CEIDARS data as appropriate. Survey responses were included for 423 gas stations of the 441 surveys sent out and 345 individual diesel engines out of 310 surveys (some of which had multiple engines). Much of the data was gathered from permit applications, including information from HRA and PSD analyses performed as part of the permitting process. Because detailed modeling data was available through the HRA, all facilities that had at least one HRA completed for a source was included in the database.

Quality Assurance:

Throughout the data entry process, STI performed regular quality assurance checks and also provided interim copies of the stationary source database to the District for review. Internal quality assurance checks performed by STI included:

- **Range checks** – sorting variables such as annual emissions, stack heights, and cancer risk values to check for outliers (i.e., values that fall outside the expected range for the parameter of interest).
- **Completeness checks** – pairing data fields to check for incomplete information. For example, if stack height information is entered for a given source, the stack diameter field

should also be filled. Similarly, if health risk information is entered, pollutant concentrations should also be available.

- **Spot checks** – periodically, staff members not directly involved in data entry were asked to review entries for random sources to check for accuracy and completeness of information.

Application to San Francisco:

To date, the stationary source database developed includes information on 17,593 individual sources at 5,079 unique facilities for many of the larger cities across the Bay Area. This database was the starting point for the San Francisco CRRP. Efforts to quality assure and to supplement the database initially targeted the large sources of PM and sources with relatively high risk associated with the emissions. However, to ensure the adequacy of the CRRP, all permitted sources in San Francisco were added to the modeling database regardless of whether release information was available. In San Francisco, 1,582 unique sets of permitted source processes with emissions (Table 2) of $PM_{2.5}$ or toxic air contaminants were identified. Often more than one process with emissions is vented to a single release point—such as a stack or vent—which is why there are more processes than release points. In San Francisco, 705 release points were identified and modeled. More than half (64%) of these release points had known release heights; however, only 32% had complete release information.[4]

Table 2. Summary of data completeness for permitted stationary sources in San Francisco.

Data Record	Number of Records	% of Release Points
Permitted processes with emissions of $PM_{2.5}$ or toxic air contaminants	1582	224%
Release points	705	100%
Release points with release height	458	64%
Release points with complete release information	223	32%

Figure 2 plots permitted sources in San Francisco by facility type. The majority of permitted stationary sources in San Francisco are located in the eastern side of the city. Dry cleaners and gas stations are the most evenly distributed. Back-up diesel generators are clustered in the downtown areas, reflecting the fact that many multi-story buildings, such as hotels or offices, have emergency generators. Other sources in Figure 2 are associated with industrial activities and tend to be located on the historically industrial parts of the city on the Bay side.

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[4] Complete release information is defined as (1) a full set of stack parameters (height, diameter, exit temperature, and exit flow rate or velocity); (2) complete volume source characteristics (release height and initial lateral and vertical plume sizes); or (3) complete area source characteristics (release height and polygon dimensions).

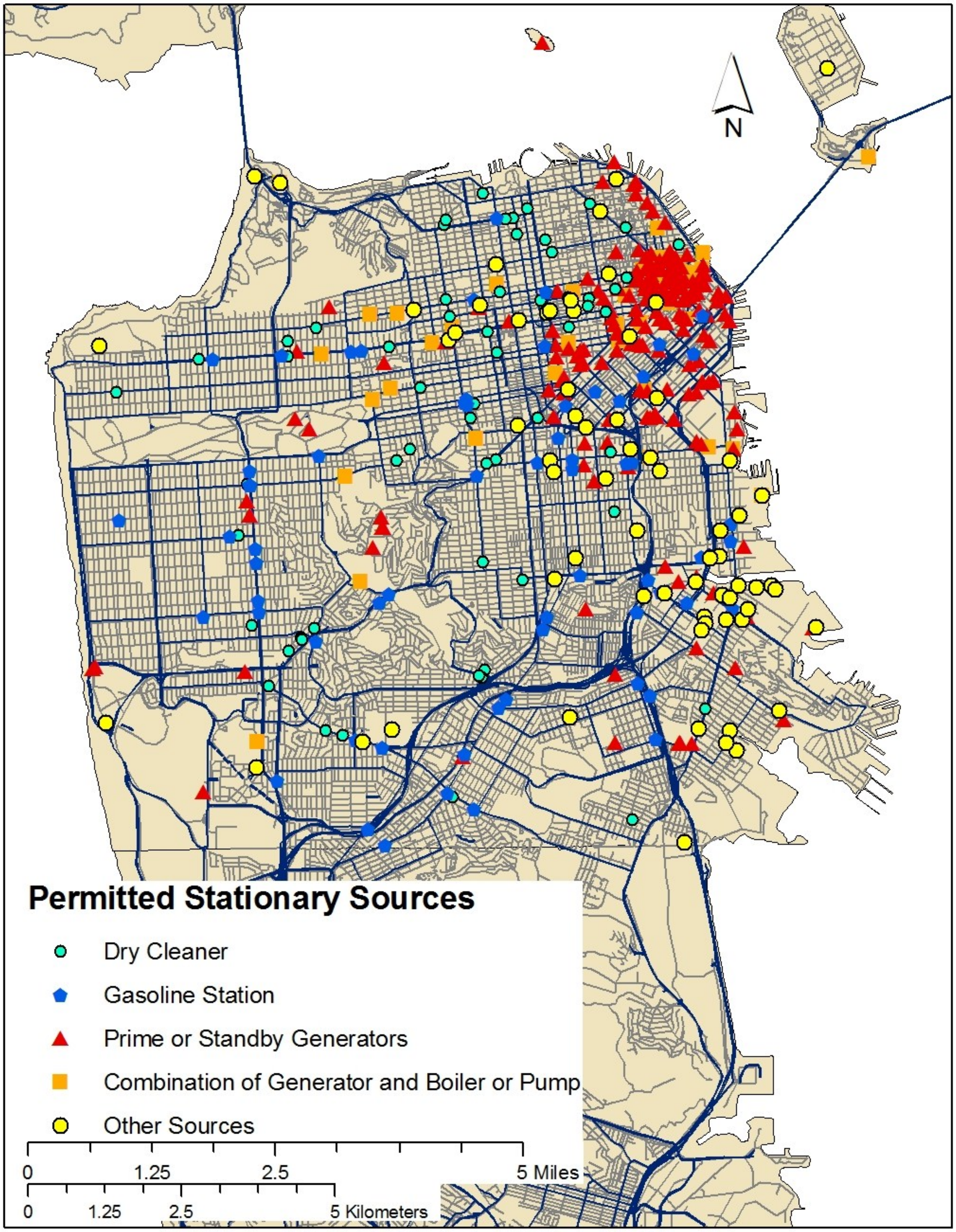

Figure 2. Permitted stationary sources in San Francisco are mapped by source category: dry cleaners (light blue circle), gas stations (blue pentagon), diesel engines or generators (red triangle), generators with a boiler or pump (orange square), and other sources (yellow circle).

Future year emission changes:
No changes in emissions were assumed from 2010 to 2025 except for dry cleaners and two stationary sources. CARB amended its Airborne Toxic Control Measure (ATCM) for emissions of perchloroethylene (PERC) from dry cleaning operations by requiring all PERC machines to be removed from service by January 1, 2023. The ATCM requires machines older than 15 years and co-residential machines to be phased out by July 1, 2010. Dry cleaners that operated PERC machines applicable to the July 1, 2010 deadline were removed from the inventory. The remaining facilities were included in the base year 2010 modeling and assumed to be operational until 2023. For the 2025 inventory, all of the facilities were assumed to comply with the ATCM and emissions from PERC dry cleaners were excluded from the modeling.

Adjustments were made to the emissions from two facilities, Potrero Power Plant and Bay View Management Company. Although Potrero Power Plant was one of the highest sources of emissions in 2010, by 2011, a new underground cable was installed to meet the electrical demand that was previously supplied by the power plant. The plant was closed in 2011 and contribution from the plant was not included in subsequent modeling.

Bay View composts San Francisco's green waste. The operations relied on multiple portable diesel engines to supply electrical power to process green waste collected from curbside recycling. However, they have agreed to replace these historic generators in favor of newer engines by 2012 that meets the District's permitting requirements. The emissions from this facility were adjusted in the model to account for the anticipated use of newer technology starting in 2012.

2.3 Caltrain

Caltrain is a diesel-powered locomotive passenger rail service, owned and operated by the Peninsula Corridor Joint Powers Board. In San Francisco, Caltrain travels along the eastern portion of the city, with stations at Bayshore (Tunnel Avenue near Blanken Avenue), 22nd Street (at Pennsylvania Avenue), and Downtown San Francisco (4th & Townsend Streets). Trains travel daily between San Clara, San Mateo, and San Francisco counties with 86 weekday, 36 Saturday, and 32 Sunday runs.

Activity:
Caltrain operates three levels of service that vary by train speed and frequency of stops. The Baby Bullet express service travels at the fastest speed and has few station stops; the Limited service operates at a slower speed and has more stops; the Local service is slowest and stops at the most stations.

Locomotives operate under a series of load modes called "notches" that, combined with idling, determine operating mode. For each train service, the throttle notch was assumed based on the load expected at each station as well as the average speed. The train service along with average speed and throttle notch is summarized in Table 3. Locomotives emissions depend on average speed, distance traveled, and throttle notches. The weighted average speed of a locomotive is estimated from the distance traveled over time. Distances from city boundaries to the stations were obtained from city maps and distances between the stations were obtained from mile posts between each station (Caltrain Table, July 2011). The time required to travel between stops were extrapolated from the Caltrain Table. Based on this information, the estimated average speed of the Baby bullet train through San Francisco was estimated to be 54 mi/hr. For the Limited, average speed was 38 mi/hr; for the Local, average speed was 36 mi/hr.

Emissions calculations were based on average speed along the rail lines, but also on idling activity at the stations. The Caltrain schedule suggests that trains idle for about 90 second at each station. When trains stop at Downtown San Francisco terminus, idle time was extended to 20 minutes to account for locomotive power down.

Table 3. Average train speed and operating notch for Caltrain locomotives in San Francisco.

Train Service	Average Train Speed (mi/hr)	Average Throttle Notch
Baby Bullet	54	5
Limited	38	3
Local	36	3

Weighted hourly average emissions were calculated based on the number of trains travelling within each hour of the day, engine mode emission rates, and the average time in each mode profile. Weighted emissions vary for weekday versus weekend activities based on the number of commuter trains running per day. Figure 3 shows normalized hourly activity for Caltrain in San Francisco on weekdays, Saturday, and Sunday. Since activity patterns on Saturday and Sunday were similar, emissions for weekend days were merged for the purposes of modeling.

Emission Factors & Emissions:

Locomotive diesel PM emissions were estimated from the locomotives using emission factors for PM derived from the Port of Oakland 2005 Maritime Air Emissions Inventory (ENVIRON 2007), adjusted for fuel sulfur content of 15 ppm by weight in compliance with CARB's Marine and Locomotive Diesel Fuel regulation (adopted November 2004). Locomotives used by Caltrain were assumed to have a fleet mix similar to GP4x and Dash 9 with respective certification levels of pre-controlled and Tier 1. Table 4 presents the locomotive model group, certification tier, and emission factors for San Francisco.

Table 4. PM Emission Factors for Caltrain locomotives, adjusted for reduced fuel sulfur content (15 ppmw).

Locomotive Model Group	Cert Tier	Emission Factors (g/hr) by Throttle Notch		
		Idle	3	5
GP-4x[1]	Pre-control	47.9	210.9	286.2
Dash 9[2]	1	16.9	256.2	377.2

[1] USEPA, 1997.
[2] Fritz, 1995.

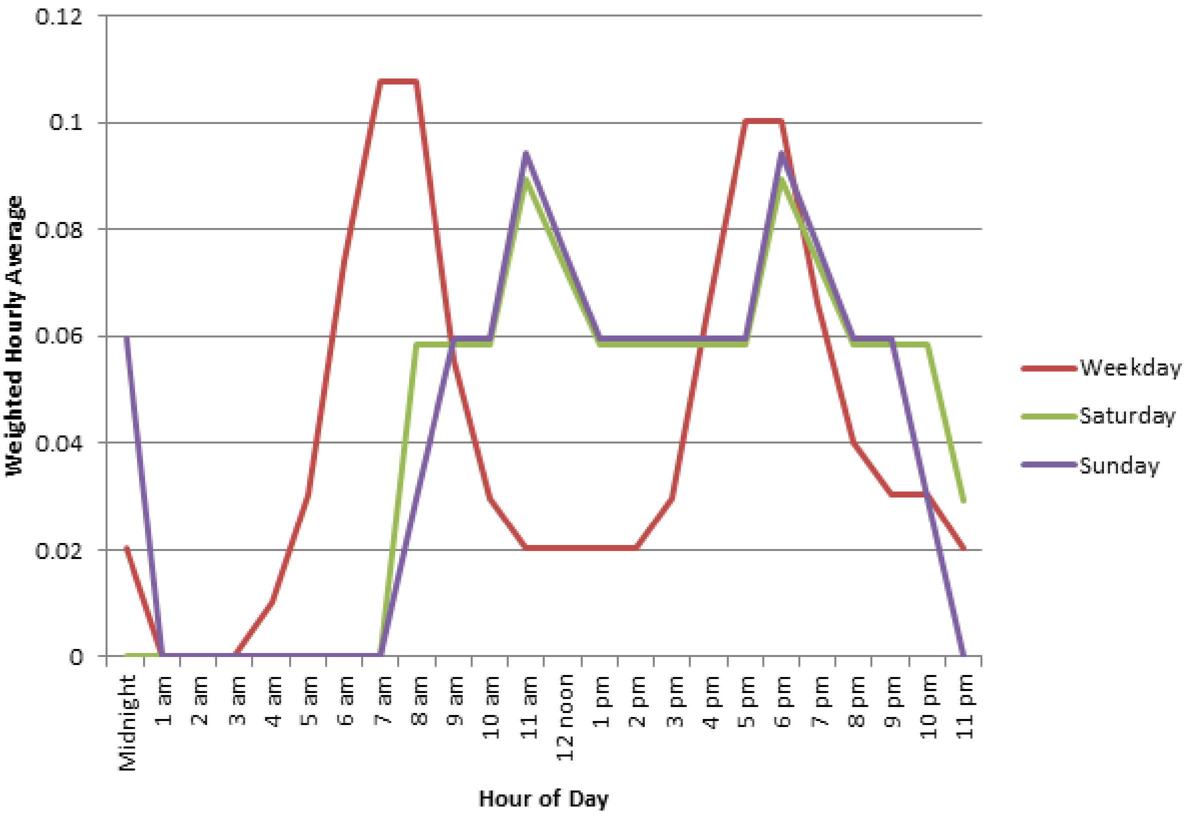

Figure 3. Normalized hourly activity for weekdays, Saturday, and Sunday for Caltrain in San Francisco.

The emission rate by engine mode, multiplied by the hours operated, gives the estimated emissions. Table 5 summarizes the total daily emissions (weekdays and weekends) associated with Caltrain locomotive activities for the City of San Francisco. Running emissions were distributed equally along the rail line; idling emissions were focused near the Downtown San Francisco rail station, where most idling occurs.

The emissions in Table 5 were applied to years 2010 and 2014. Although Caltrain is expected to electrify by 2019 under a financing agreement between the Peninsula Corridor Joints Power Agency, the Metropolitan Transportation Commission and the California High Speed Rail Authority, Caltrains was assumed to operate diesel locomotives until 2025 to account for delays and other contingencies.

Table 5. Estimated weekday, Saturday, and Sunday Caltrain PM emissions (in tons per year) for San Francisco, from all services.

Service	Weekday PM Emissions (ton/yr)	Saturday PM Emissions (ton/yr)	Sunday PM Emissions (ton/yr)
Baby Bullet, Limited, and Local services combined	1.15	0.50	0.44

2.4 Ocean Going Vessels, Tug Boats, and Harbor Craft

Maritime emissions developed for the San Francisco CRRP were based largely on a report of 2005 emissions at publically operated ports in the Bay Area "SF Bay Area Seaports Air Emissions Inventory: Port of San Francisco 2005 Emissions Inventory" (Moffatt and Nichol and ENVIRON 2010). The report, a collaborative effort between BAAQMD and consultants Moffatt and Nichol and ENVIRON Corp., inventoried emissions from the largest sources of air emissions from maritime operations, including emissions from ocean-going marine vessels (OGVs), harbor craft, cargo handling equipment, heavy duty on-road vehicles, transportation refrigeration units, and rail locomotives. Emissions from tug boats were integrated with each maritime activity. Privately owned terminals, non-maritime activity on Port property, and ferry boat activities were not quantified in the Port inventory report. For the CRRP, emissions associated with cargo handling activity, heavy duty on-road vehicles, transportation refrigeration units, and rail locomotives were excluded since these sources combined contributed less than 3% of the total PM emissions from all port activities. The CRRP analysis focused solely on the emissions from two categories of ships: ocean-going vessels and harbor craft.

Activity:
The Port of San Francisco manages about 7.5 mi of coastline, from the Hyde Street Pier in the north to the Ferry Building, to the base of the Bay Bridge, then south through the waterfront industrial areas up through the Islais Creek area, and ending at Berth 96. The Port has over 500 tenants, though most are not engaged in maritime activities.

Emissions were estimated for 13 areas along the shoreline of San Francisco with either OGV or harbor craft activity. The Port currently operates an extensive cruise ship terminal at Berth 35; however, the Port intends to permanently relocate the terminal to Berth 27 in 2014 after the America's Cup event. The industrial area south of the ball park includes several cargo terminals, some lay berthing of large military supply vessels (US Maritime Administration – MARAD), and a large ship dry dock (BAE Systems) and repair yard. The types of activity are bulk and break bulk,[5] and mostly imports. One terminal exports tallow. The San Francisco Bar Pilots jointly lease a terminal with several excursion vessel companies. There is commercial fishing fleet and a charter boat fishing fleet and two tug companies berthed in San Francisco. In addition, there are some historic vessels (Jeremiah O'Brien at Pier 45) which have occasional outings in the Bay. Figures 4 and 5 outline areas with ship activity and list their affiliation based on the Port inventory report. Areas outlined in Figures 4 and 5 include areas where ships berth but do not include onshore property.

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[5] Break bulk is loose material that must be loaded individually, and not in containers nor in bulk, as with oil or grain.

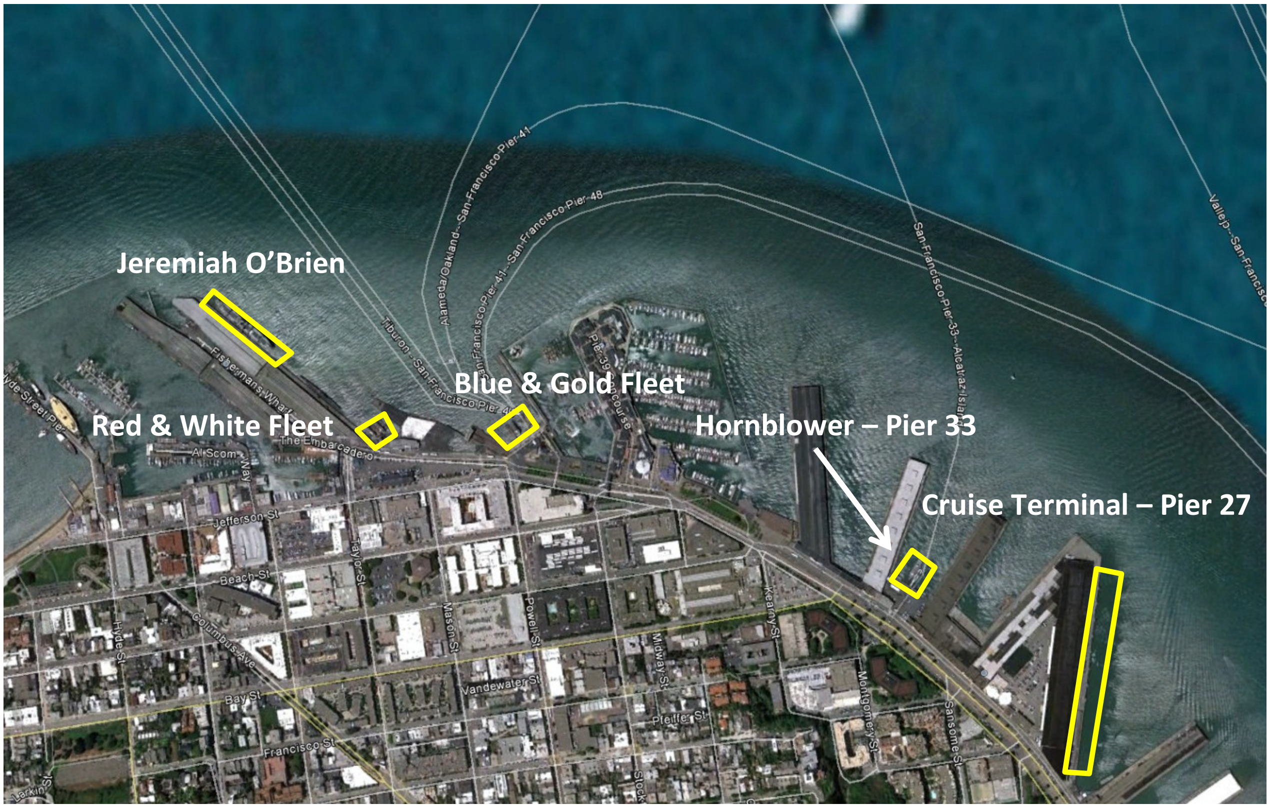

Figure 4. Sources of ship emissions in northern San Francisco.

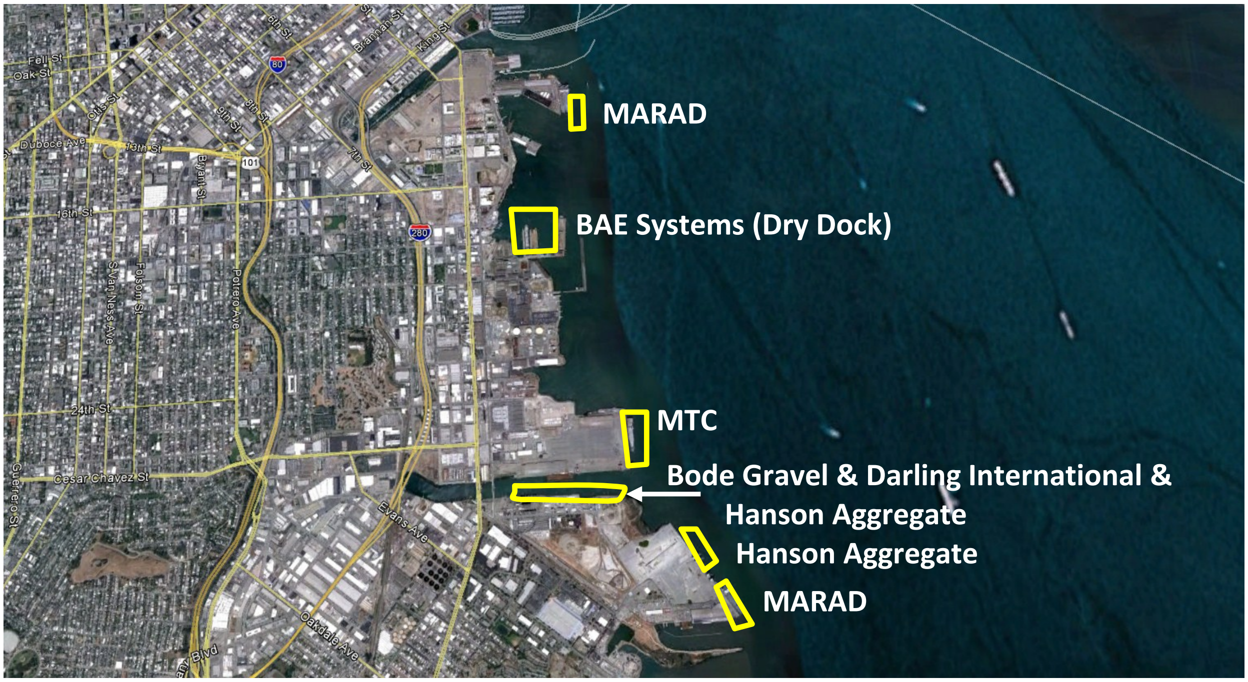

Figure 5. Sources of ship emissions in eastern San Francisco.

The two main types of OGVs are cruise ships and bulk carriers (or general cargo ships and small tanker ships). Cargo ships bring imports of aggregate, sand, steel, and newsprint and exports of tallow to and from the industrial terminals on the eastern piers in San Francisco. OGVs produce emissions at levels that depend on operating mode. Common modes include open ocean cruising, cruising at reduced speed (in the reduced speed zone or RSZ) inside the Bay, maneuvering (lower speed operation near berths), and hoteling (at berth). For arriving ships, the RSZ mode occurs after the pilot takes command of the vessel at the Sea Buoy[6] until the vessel slows to a maneuvering speed directly in front of the Port. During hoteling, the main engines are off and the auxiliary engines are running. The sources of emissions include the vessels' main propulsion engines, auxiliary engines during hoteling, and boilers for heating. For this analysis, the District excluded emissions associated with cruising from the open ocean and 90% of the RSZ emissions since these emissions are released in the Bay away from the city. Emissions from the cruise terminal, including existing emissions from Berth 35 for years 2010 through 2014, were modeled from the proposed new location at Berth 27.

Harbor craft emissions include emissions from tug boats and excursion boats. Tug emissions are released from tug engines when the tugs assist OGVs (including barges) during arrivals and departures at the berths. Excursion boats that have home berths in San Francisco travel to Alcatraz and/or around the Golden Gate Bridge and Fisherman's wharf. Some excursion boats transit to destinations in Marin, Napa, and/or Alameda Counties. The emission estimates for harbor craft are based on two operating modes: vessel assist and transit to and from the vessel assist point using either the main propulsion engine or auxiliary diesel engines while berthed. Harbor craft emissions estimated in the SF Port inventory were incorporated when the craft was near berth, which constituted an estimated 20% of total emissions. The remaining 80% of emissions were assumed to be emitted during transit far from berth.

Tug boats are utilized in assisting ocean going vessel to dock and undock from the berths at the Port of San Francisco. Tug emissions during transit and assistance were attributed to each of the 13 source areas. Because most of the tug emissions occur in the Bay, the emissions were reduced by 80% to represent the fraction of emissions associated with maneuvering to and from the berths.

Emissions:

Table 6 presents a summary of the emission inventory for base year 2010 and project year 2014 that includes tug boat, OGV, and harbor craft emissions for each of the 13 source areas. Estimates indicate that cruise ships are the largest source of ship emissions in San Francisco. It was assumed that all PM emissions are attributable to diesel exhaust.

The emissions estimated from the 2010 report relied on emissions factors from 2005. Since then, CARB has adopted a marine main engine fuel regulation (2008) that requires all OGVs to use cleaner low sulfur fuels. Since January 2007, auxiliary engines in ocean going vessels were required to use low sulfur fuel when operating in California coastal waters (Marine Auxiliary Engine Clean Fuel Requirement). Harbor craft are likewise required to use the low sulfur fuel since January 2007. BAAQMD estimated that by using the low sulfur fuel, $PM_{2.5}$ emissions would be reduced by 54% for all ocean going vessels for base year 2010, relative to 2005 Port inventory report. Requirements for low sulfur fuel were already accounted for in the emissions factors for

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[6] The Sea Buoy is located 17 miles west of the Golden Gate Bridge.

harbor craft and consequently additional reductions were not incorporated. It was conservatively assumed that emissions in project year 2014 would be consistent with base year 2010 even though continued reductions are expected in future years based on increased use of low sulfur fuel.

Table 6. Ship emissions for base year 2010 and project year 2014.

	$PM_{2.5}$ Emissions (tons/year) from		
Location	**Main Engine**	**Auxiliary Engine**	**Boilers**
MTC	0.077	0.303	0.040
Darling	0.010	0.043	0.002
Hanson Pier 92	0.131	0.125	0.005
Hanson Mission Valley	0.065	0.096	0.004
Bode	0.124	0.118	0.005
Cruise Terminal	5.994	---	0.017
MARAD Area 1	0.004	0.002	---
MARAD Area 2	0.004	0.002	---
BAE Systems (Dry Dock)	0.059	---	---
Jeremiah O'Brien	0.008	---	---
Red/White Fleet	0.799	0.083	---
Blue/Gold	0.799	0.083	---
Hornblower	0.137	0.015	---

For the 2025 emissions estimates, cruise terminal emissions were further reduced based on CARB's Shore Power Regulation (adopted December 6, 2007) which requires ocean going vessels to plug into electrical infrastructure (shore power), rather than idling main engines during the loading and unloading of cargo and at dock. The Port of San Francisco has plug-in capabilities and the regulation requires cruise ships that make five or more calls or any ocean going vessels equipped to receive shore power to utilize shore power. No hoteling emissions were used in 2025 for ships that came to port in San Francisco at least five times. There are occasions when more than one ship is at port with shore power capabilities and only one ship will be allowed to plug in. However these occurrences are infrequent, the District projects that there will be 14 days in 2012 in which two or more ships will be in port on the same day. The cruise temporarily disabled the shore power facilities during America's Cup activities and associated remodeling of the terminal. Consequently, emissions reductions associated with the plug in capabilities were not incorporated in the base year 2010 and project year 2014 inventories. Emissions for 2025 from ocean going vessels were reduced by 31% from 2010 inventory based on availability and wide use of low sulfur fuels. Table 7 presents the emission inventory for 2025.

BAE Systems has installed one shore power terminal in response to recently awarded contract to use the dry dock to repair T-AKE vessels. It is too early to assess the number of ships that will use the dock as well as the frequency in which the shore power will be used and consequently was not incorporated into the modeling analysis. Emissions for BAE was held constant except for reductions associated with low sulfur fuel. Future modeling of the site may incorporate these changes.

Table 7. Ship emissions for future year 2025.

Location	$PM_{2.5}$ Emissions (tons/year) from		
	Main Engine	Auxiliary Engine	Boilers
MTC	0.057	0.206	0.040
Darling	0.008	0.029	0.002
Hanson Pier 92	0.131	0.125	0.005
Hanson Mission Valley	0.065	0.096	0.004
Bode	0.124	0.118	0.005
Cruise Terminal	1.639	---	0.003
MARAD Area 1	0.003	0.002	---
MARAD Area 2	0.003	0.002	---
BAE Systems (Dry Dock)	0.043	---	---
Jeremiah O'Brien	0.008	---	---
Red/White Fleet	0.799	0.083	---
Blue/Gold	0.799	0.083	---
Hornblower	0.137	0.015	---

2.5 Transit Center Operations

The Transit Center is a transportation and housing project that will create a new major transit hub in downtown San Francisco. The project will replace the former Transbay Terminal at First and Mission Streets in San Francisco with a regional transit hub connecting eight Bay Area counties and the State of California through 11 transit systems: Alameda-Contra Costa Transit (AC Transit), Bay Area Rapid Transit (BART), Caltrain, Golden Gate Transit, Greyhound, Muni, SamTrans, Western Contra Costa Transit Authority (WestCAT) Lynx, Amtrak, Paratransit and future High Speed Rail from San Francisco to Los Angeles/Anaheim. Once completed in 2017, the Transit Center will be a five-story building with one above-grade bus level, ground floor, concourse, and two below-grade rail levels. New bus ramps will be created to connect the Transit Center to a new offsite bus storage facility and the Bay Bridge. Existing transit operations will continue until 2017, but at a temporary terminal. Many of the transit carriers have been rerouted to the temporary terminal located 500 feet east of the proposed Transit Center. Emissions from the transit operations including emissions from the temporary terminal for years 2010 through 2017 were modeled from the proposed new Transit Center.

Activity information for the transit center operations was derived from a report on prepared for the San Francisco Planning Department in compliance with the requirements for environmental review of the Transit Center (ENVIRON 2011). However, emissions from that report were based on EMFAC2007 and have been recalculated for the SF CRRP modeling using EMFAC2011.

Activity:

The Transit Center will generate emissions from bus operations at the following areas (ENVIRON 2011):

- Transit Center Bus Deck Level – this level is located two levels above the ground level of the Transit Center. Buses will load and off-load passengers from the level's central island. The bus level will be the primary bus transit facility for AC Transit to operate service from the East Bay. Muni route to Treasure Island, Amtrak and Greyhound will also use this level;
- Ground Level Bus Plaza – an outdoor bus plaza is located at the eastern end of the Transit Center building between Fremont and Beale Streets, serving Muni, Golden Gate Transit and SamTrans buses;
- Bus Ramps – as mentioned above, the new elevated bus ramps will connect the Transit Center to a new offsite bus storage facility and the Bay Bridge. The bus ramps enter the Transit Center from the west; and
- Bus Storage Facility – two bus storage facilities under the I-80 Freeway, bounded by Second, Perry, Fourth and Stillman Streets will be built to house buses for AC Transit and Golden Gate Transit during weekday off-peak hours. The portion dedicated to AC Transit is between Second and Third Streets, and the portion dedicated to Golden Gate Transit is between Third and Fourth Streets.

Emissions:

Emissions from bus operations were calculated using total number of bus trips (ENVIRON 2011) at each of the above four areas, emission factors from EMFAC2011, measured trip lengths, and an average length of idling time per trip. Average emission factors for PM10 (diesel PM exhaust—running and idling) and $PM_{2.5}$ (running, idling, brake and tire wear) for buses were obtained for 2017 when Transit Center operations are scheduled to start and for future year 2025. Table 8 presents the summary of the Transit Center bus operational emissions. Details of the emissions calculations follow that of the operations emissions calculations reported in the ENVIRON report, but use EMAC2011 emission factors. Year 2017 Transit Center emissions were used for planning year 2014, even though the project will not have been completed by 2014. In effect, the 2017 emissions were used as a proxy for emissions at the temporary terminal.

Table 8. Emissions from Transit Center operations in years 2014 and 2025, by source group.

Source Group	Diesel PM Emissions 2017 (t/yr)	$PM_{2.5}$ Emissions 2017 (t/yr)	Diesel PM Emissions 2025 (t/yr)	$PM_{2.5}$ Emissions 2025 (t/yr)
Transit Center Bus Deck Level – 24 hour	4.36E-04	6.81E-04	2.76E-04	5.33E-04
Transit Center Bus Deck Level – 6 a.m. to 12 p.m. operation	3.15E-02	6.29E-02	2.80E-02	5.97E-02
Transit Center Bus Deck Level - Commute Hour Operation	1.36E-03	2.69E-03	1.21E-03	2.55E-03
Ground Level Bus Plaza – 24 hour	4.55E-03	7.67E-03	3.98E-03	7.14E-03
Ground Level Bus Plaza – 6 a.m. to 12 p.m. operation	2.22E-03	4.06E-03	1.96E-03	3.82E-03
Ground Level Bus Plaza – Commute Hour Operation	1.20E-04	2.03E-04	1.05E-04	1.89E-04
Bus Storage Facility – AC Transit Area	1.15E-02	2.34E-02	1.02E-02	2.22E-02
Bus Storage Facility – Golden Gate Transit Area	4.07E-03	8.26E-03	3.62E-03	7.85E-03
Bus Ramps – to I-80	4.45E-02	9.03E-02	3.97E-02	8.59E-02
Bus Ramps – to Bus Storage Facility	2.51E-02	5.09E-02	2.23E-02	4.83E-02

2.6 Construction Projects

Emissions from construction projects are difficult to quantify because construction activity is sporadic and emission factors vary depending on the type of equipment and phase of construction. Challenges arise in forecasting an accurate equipment list, engine year of the equipment, and the hours of equipment operation. While recognizing these challenges, BAAQMD developed an emissions inventory for major multi-year projects. Minor projects are evaluated individually by the San Francisco Planning Department and are not included in this analysis. This section describes the methodology used to estimate emissions from construction activity in base year 2010 and projected to occur in 2025. No emission estimates were made for project year 2014. Emissions were estimated to represent the phase of construction expected to occur over the course of the modeling year and are not meant to encompass the entire project construction. Only exhaust emissions from construction equipment were included in the inventory; the analysis did not quantify emissions from fugitive dust or road dust. Health risk estimated from the emissions of construction projects are for informational purposes only and were not included in the city-wide assessment.

Major multi-year projects included residential projects, commercial/office/retail mixed use projects, and major transportation projects. The San Francisco Planning Department (SFPLAN) and review of Environmental Impact Reports (San Francisco County Transportation Authority

2007, SFPLAN 2008, San Francisco Redevelopment Agency 2010, San Francisco County Transportation Authority 2011, San Francisco Metropolitan Transportation Agency 2012, Transbay Center Joint Powers Agency 2012) provided a list of major projects that were constructed partially or fully during 2010 including:

- Transbay Terminal Demolition,
- Central Subway utility work,
- Presidio Parkway (Doyle Drive) construction,
- Mission Bay,
- Bayview Hunters Point, and
- Exploratorium at Pier 15/17.

The District developed a construction equipment list and construction periods for each of the major projects based on environmental clearance reports and photographs. Emissions were then estimated for each piece of equipment using emission factors and load factors taken from CARB's OFFROAD model (CARB 2010), which includes revisions to activity levels, load factors, and populations of construction equipment in California. Only equipment that is expected to be used during the modeling year was included in the emissions estimates. Table 9 presents the estimated diesel PM for major projects in units of tons per year.

Table 9. 2010 Major Construction Project Emissions

Project Name	Activity in 2010	DPM (t/yr)
Transbay Terminal	Demolition of East Loop ramps, Utility relocations, Geotechnical drilling	0.091
Central Subway	Utility relocation along 4th Street between Townsend and Market, and Clemintina Street	0.068
Presidio Parkway	Phase 1 work adjacent to existing roadway: Utility work, excavation of SB tunnel, building demolition.	0.348
Mission Bay	Construction of medical offices	0.19
Hunter's Point	Development of housing units, Blocks 53 & 54	0.001
Exploratorium	Demolition work and refurbishment of Pier 15 & 17	0.138

The future year emissions for 2025 were more difficult to quantify in comparison to 2010 due to less concrete data sources, such as construction reports and photographs. To estimate potential emissions for construction activities in 2025, the District focused on large, multi-phase projects that are already approved for construction by San Francisco Planning. Emissions were estimated for the following multi-phase projects in 2025 (SFPLAN 2009b, SFPLAN 2010b, SFPLAN 2010d):

- Park Merced
- Mission Bay
- Treasure Island
- Candlestick Point - Hunters Point

Emission estimates were determined by reviewing the published Environmental Impact Report for each project (see Table 11). Since each of these project emissions were estimated prior to the 2010 release of CARB's updated off-road emissions model, the District reduced the emissions by 33%, the average correction determined by CARB based on reduction in load factors.

Table 11. 2025 Large, Multi-Year Project Construction Estimates

Project Name	Activity in 2025	DPM (t/yr)
Park Merced	Final year of Phase 3 of reconstruction of Park Merced	0.6
Treasure Island	Phase 4 - Building Construction	0.3
Candlestick HPII-1	Residential development, Lot CP-12	0.1
Candlestick HPII-2	Residential development, Lot CP-13	0.1
Mission Bay 2025-1	Below Market Rate Housing, Lot 9	0.1
Mission Bay 2025-2	Below Market Rate Housing, Lots 3/4 East	0.07
Mission Bay 2025-3	Below Market Rate Housing, Lots 6 & 7	0.16
Mission Bay 2025-4	Below Market Rate Housing, Lot 12	0.04

3. Air Dispersion Modeling

From each of the air pollution sources inventoried in Section 2, the CRRP aims to quantify the contribution to annual concentrations of $PM_{2.5}$ and cancer risk, assuming a 70 year exposure. Concentrations and risk calculations relied on air dispersion modeling to track the pollutant releases and dispersal. The technical approach adopted tracked thousands of individual sources and identified individual contributions to annual average $PM_{2.5}$ concentrations and lifetime cancer risk (Section 3.1).

A finely spaced receptor grid established locations where source contributions were evaluated over the entire city (Section 3.2). The receptors established around an individual source covered a subset (sub-grid) of the total array of receptors (master grid) but overlapped the master grid so that source contributions could readily be summed over all receptors.

Two dispersion models were applied in developing the CRRP: the American Meteorological Society/EPA Regulatory Model Improvement Committee Regulatory Mode (AERMOD; USEPA 2004) and Rcaline (Holstius 2011), a version of the CALINE3 model (Benson 1979, Benson 1992), developed by Caltrans. AERMOD was used to disperse unit emissions from on-road mobile sources, permitted sources, ships and harbor craft, buses at the Transit Center, and construction projects. Rcaline was applied used to disperse unit emissions from Caltrain. Critical inputs for determining the character and extent of pollutant dispersion for both models are meteorological variables, such as winds and mixing parameters (Section 3.3). The method of application and the development of inputs for AERMOD are outlined in Section 3.4. A similar discussion for Rcaline follows in Section 3.5.

3.1 Modeling Approach

Each source inventoried was modeled separately so that individual source contributions could be identified and assessed. To reduce the number of modeling runs required, each source was modeled with a unit emission rate[7] (1 g/s). Model output was a *dispersion factor* with units of concentration per unit emissions ([μg/m3]/[g/s]). Following this approach, annual average concentrations resulted from multiplying the dispersion factor by an annual average emission rate.
For example, emissions were estimated on more than 9,200 roadway segments in San Francisco (Section 2.1). For each roadway segment, a modeling run was made, simulating a period of one year and assuming a unit emission rate. For each roadway, the simulation produced an annual average dispersion factor at each receptor point. Annual average concentrations for each roadway segment resulted when dispersion factors were multiplied by the annual average emission rate for the roadway: annual concentrations for 2010 from multiplying by 2010 emissions and annual concentrations for 2025 from multiplying by 2025 emissions.

In this roadway example, two modeling runs were actually made (and two dispersion factors generated) for each roadway segment: one using a profile of activity representing total vehicle traffic and one using an activity profile representing heavy-duty truck traffic. Annual average $PM_{2.5}$ concentrations for total traffic resulted from multiplying total on-road $PM_{2.5}$ emissions by the dispersion factor for total traffic. Since a large fraction of diesel PM was from heavy-duty traffic, to estimate annual diesel PM concentrations (used for estimating cancer risk) the dispersion factor for heavy-duty truck traffic was used.

An advantage for modeling each source individually, instead of as part of a group of sources, was that it facilitated making changes in the emission rate of a single source without having to re-run the dispersion model. A disadvantage of this approach is that it requires tracking and storing many modeling input and output files.
Modeling a large number of sources, either individually or as part of a source group, requires a large amount of computing processor time, especially when there are many receptors. To reduce the elapsed time required to complete the analysis, a large number of computer processors were used in parallel. The computer platform used for dispersion modeling was a 14 node Linux cluster, each with eight Intel® Xeon® E5335 2 GHz processors. Model runs for each source were submitted in batch using the Linux `qsub` command that automatically submits jobs in queue to processors as they become available. Modeling a single source on a single processor was determined to be a simple but efficient method of speeding throughput.

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[7] The method of 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” or “Q” to represent an emission rate.

3.2 Receptor Grid

A master receptor grid was constructed to cover the entire city (Figure 6) with receptors spaced every 20 meters on a regular grid. The geographic coordinate system used throughout the modeling was a Universal Transverse Mercator (UTM) projection for zone 10 with the North American Datum of 1983 (NAD83). Some mapping of emissions sources was made within Google Earth™, for which the geographic datum is the World Geodetic System of 1984 (WGS84). NAD83 and WGS84 were assumed to be similar enough to each other that coordinates generated using one datum were interchangeable with the other. Each receptor was placed at a height of 1.8 meters from terrain height (commonly referred to as flagpole receptors) representing the breathing zone of an average adult.

For AERMOD modeling, individual sources, such as volume sources representing a roadway segment or a point source representing a smoke stack, were modeled with receptors defined on a sub-grid aligned to the master grid. The subgrid was defined using receptors in the mastor grid—identical grid spacing, origin, projection and datum parameters as the master grid—but covering a smaller area.

Each receptor subgrid was configured to be a rectangular array centered over the modeled source (Figure 6) with boundaries set at one or two kilometers from the source, depending on the source type. Individual roadway segments and segments of roads and parking near the Transit Center were modeled with a rectangular receptor array extending at least one kilometer from modeled sources[8]. For air pollution emitted from permitted sources, ships and harbor craft, and construction projects, a rectangular array was defined at least two kilometers from the modeled sources.

For Rcaline modeling, receptor grids were defined at regularly increasing distances from the line sources modeled. Receptors were set at regular distances along buffer rings defined at 10, 20, 50, 100, 250, 500, 750, and 1000 meters from each line source. This configuration of receptors resulted in significantly more realistic representation of concentration contours near line-source emissions than did receptors defined on a regular array (Holstius 2011). In a post processing step, concentrations were remapped to the master grid shown in Figure 6 using the R package `aikma` for bivariate intepolation of irregulary spaced data (Comprehensive R Archive Network 2012).

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[8] Or to the boundary of the master grid.

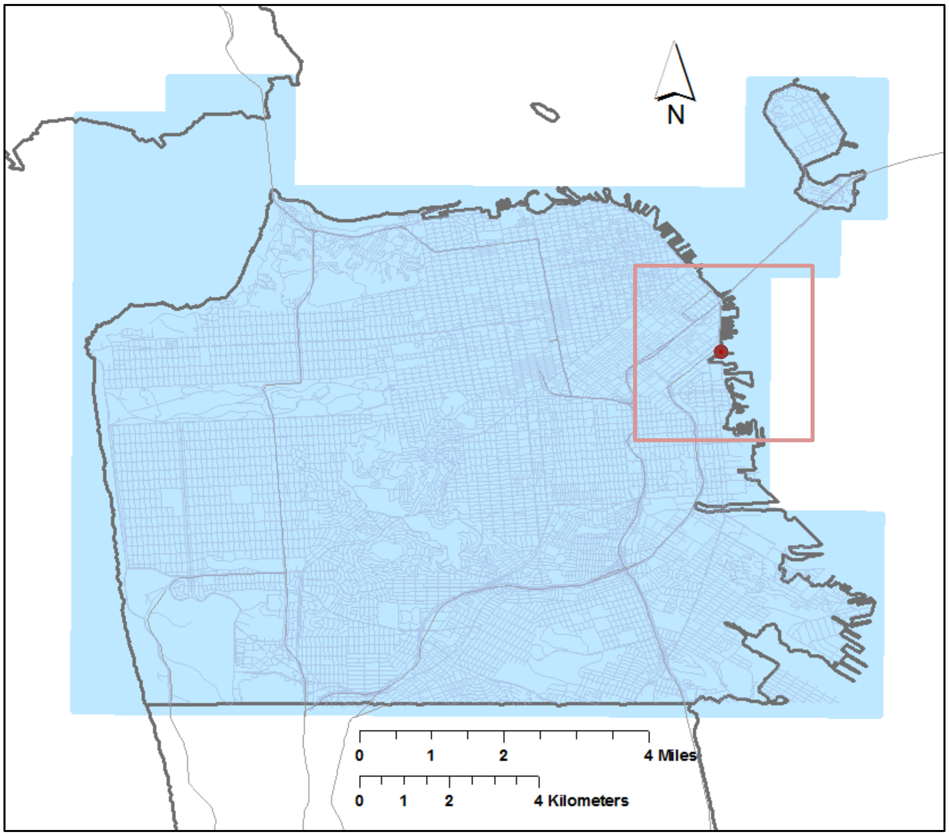


Figure 6. Master recetor grid (blue shaded area) with 20 meter spacing for the San Francisco CRRP. A receptor subgrid (such as the red rectangle) was defined around individual sources (such as the red dot representing the location of a permitted source) using receptors defined in the master grid with the same spacing.

3.3 Meteorological Data

BAAQMD operates a meteorological monitoring network of stations throughout the nine Bay Area counties that provide accurate measurements of ambient meteorological parameters to support many air quality related programs, including those requiring air dispersion modeling. The current network has 23 stations, three in San Francisco (Figure 7), and collects information on:

- Hourly averaged wind speed and direction (cup and vane);
- Temperature;
- Relative humidity;
- Solar radiation; and
- Rainfall.

Of the three meteorological stations located in San Francisco, the Mission Bay station was determined to be most widely representative of conditions in San Francisco and to be located near many of the emission sources in the City. Meteorological data has been collected from this site since 2004 and is situated near Channel Street (latitude: 37.7722N, longitude: 122.3947W). A wind rose generated using the 2008 Mission Bay data (Figure 8) shows frequency bins of wind speed (color levels) and wind direction (compass sector winds are blowing from). Winds most frequently blow from the west at about 5 m/s (or about 10 mi/hr).

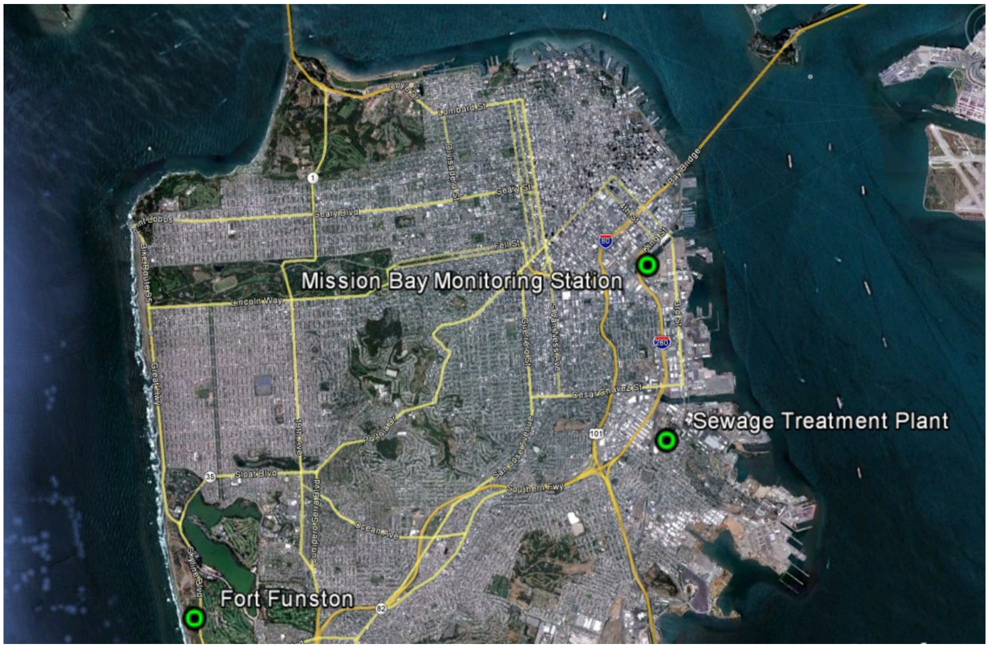


Figure 7. Meteorological monitoring stations in San Francisco

Mission Bay data for year 2008 were processed through AERMET, meteorological preprocessor to AERMOD, to create meteorological inputs to AERMOD. For Caltrain, the Rcaline model uses a compatible format to US EPA’s Industrial Source Complex (ISC) model. The District routinely processes the hourly meteorological data collected from the monitoring network into ISC format and makes it available to the public. To ensure consistency between all sources that were modeled, the District used Mission Bay 2008 data (in ISC format) to model emissions from Caltrain.

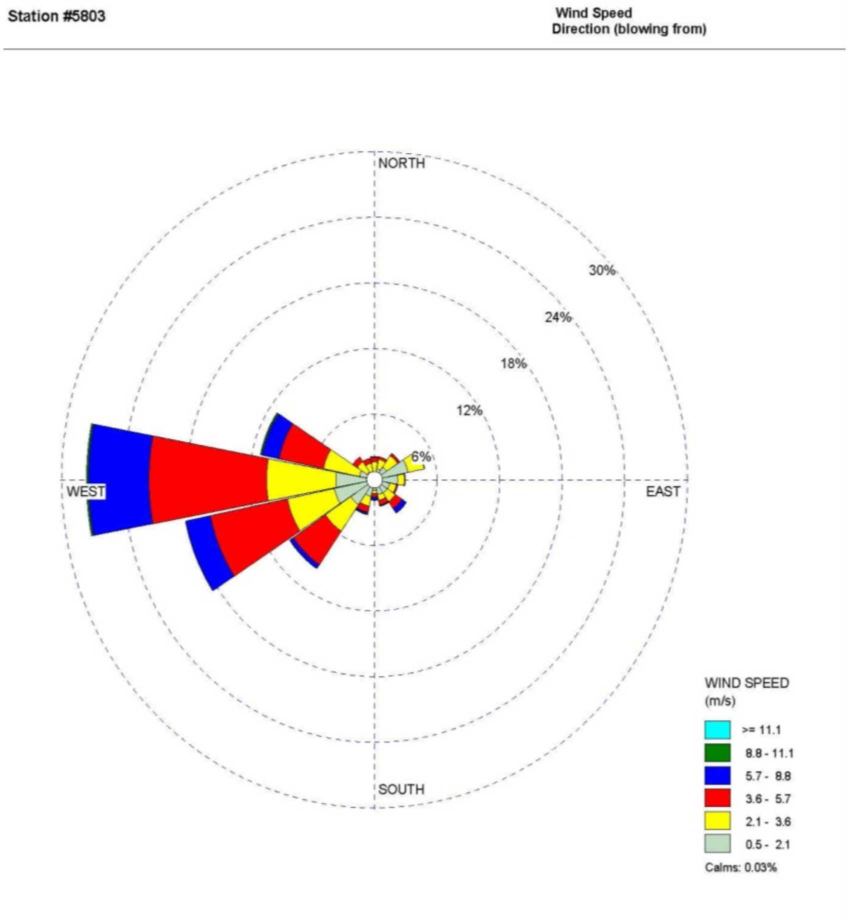


Figure 8. Mission Bay 2008 wind rose. Histogram colors indicate wind speed; compass sector indicates direction wind is blowing from.

3.4 AERMOD Model Configuration

AERMOD is a steady-state plume model that incorporates air dispersion based on planetary boundary layer turbulence structure and scaling concepts, including treatment of both surface and elevated sources, and both simple and complex terrain. The AERMOD program is comprised of three programs: (1) AERMET – preprocessor for making compatible meteorological data sets, (2) AERMAP – preprocessor for digital terrain data, and (3) AERMOD – air dispersion model. Files generated from AERMET and AERMAP are then read by AERMOD to estimate downwind concentrations.

AERMOD FORTRAN source code (version dated 11103—April 13, 2011) was downloaded from the US EPA Support Center for Regulatory Air Models (SCRAM) web site (http://www.epa.gov/scram001/dispersion_prefrec.htm). Source code was compiled on the District's Linux cluster using the Portland Group, Inc., `pgf95` (v8.0-6 64 bit) FORTRAN compiler. Running on the cluster allowed simulations to proceed in parallel on multiple processors available on the cluster to reduce elapsed time required for the modeling and analysis.

For each source, a Cartesian receptor grid (see Section 3.2) surrounding the source was used, with a receptor height of 1.8 meters (about 6 ft) above terrain height. A rural land use category was consistently selected to be representative of land cover in San Francisco. Building downwash effects were not incorporated since individual building heights were not generally available.

Digital terrain data from the Shuttle Radar Topography Mission (SRTM) were used to assigned terrain heights every 20 meters, consistent with the receptor grid spacing that was used in the air dispersion modeling. The SRTM data provides full coverage of the US in 1 by 1 degree blocks with an approximate resolution of 30 by 30 meters. AERMAP software was used to process the digital terrain data into a format compatible with AERMOD.

For on-road mobile sources, permitted sources, ship and harbor craft, buses at the Transit Center, and construction projects, the release parameters were developed for inputs to AERMOD. AERMOD requires that for each source, the user identify how the source will be modeled (i.e., point, area, and volume), the location of the source, and all associated modeling parameters such as emission rates, sources heights, temperature, etc. Source specific modeling parameters were used for the CRRP are described below.

On-Road Mobile Sources:

On-road emissions were modeled in AERMOD as adjacent volume sources, with the number of sources dependent on the length and width of the roadway segment. To locate the volume sources, an Esri™-formatted shapefile of San Francisco streets segments was subdivided into evenly spaced elements. The number of elements per roadway segment was determined by dividing the segment length by the street width. Each element represented the location of a volume source. A new shapefile, produced from elements in all street segments, was overlaid on the SRTM raster map of San Francisco. The pixel values of the SRTM map represented the height above terrain of all streets and buildings in the city. The SRTM pixel value beneath each element determined the element height. These heights were then used to specify the vertical location of each roadway volume source. The release height, above roadway height, was set to 2 m; the initial lateral dimension was variable, dependent on roadway width; and the initial vertical dimension was 2.3 m.

The diurnal activity patterns—one for total traffic and one for heavy-duty trucks—coupled with corresponding release parameters were input to the model. Simulations were run both for total traffic and for heavy-duty truck activity patterns.

Permitted Sources:

Most types of permitted sources were modeled as point releases when stack release parameters or default parameters were available. Gas stations were an exception, where vapor releases were modeled as volume sources, using number of gasoline dispensers to determine the initial dimensions of the volume source. Stack releases required information on the stack height and diameter and information on the release gas flow rate and temperature. Sources for which a permit application with modeling was completed, the modeling information was obtained from the application. For the remaining sources that were missing all or partial information, the defaults listed in Table 13 were applied.

Table 13. Default modeling parameters for stationary sources.

Source Description	Source Type Assumed	Default Parameters
Prime or Standby Generator	Stack	Stack Height = 3.66 m (12 ft) Stack Diameter = 1.83 m (0.6 ft) Stack Temperature = 739.8 C (872 F) Stack Velocity = 45.3 m/sec (8,923 ft/min)
Gasoline Dispensing Facility (Gas Station)	Volume	Number of Dispensers = 4, if not known Height = 1.03 m (3.4 ft) Initial lateral dimension = 1.98 m (6.49 ft, for assumed 4 dispensers, otherwise the equation below was applied (STI 2010): Lateral dimension (ft) = -0.0129 x n^2 + 1.08 x n + 2.39 where n = number of dispensers
Sources that have incomplete modeling information	Stack	In cases, where modeling information was not available, the following defaults were applied: Stack Height = 6.1 m (20 ft) Stack Diameter = 3.05 m (1 ft) Stack Temperature = 644 C(700 F) Stack Velocity = 17.8 m/s (3,500 ft/min)
No information available	Volume	For sources that have no information, the District used the following defaults: Release Height = 1.8 m Initial Lateral Dimension = 10 m Initial Vertical Dimension = 1 m

Ships and Harbor Craft:

Ocean going vessels, tug boats, and harbor craft were modeled as two-dimensional area sources. For each of the source areas, the release height, length, and width of the source were entered. The dimensions of the release area encompassed the docking areas and piers but did not include land areas (see Figures 4 and 5). For each of these areas, an assumed release height of 6 m was used for tugs and harbor craft. An initial release height of 50 m was used for OGVs.

Transfer Station Operations:

For modeling bus emissions from the Transit Center deck, a series of adjacent 10 m by 10 m volume sources that cover the approximate dimension of the deck exhaust system were used as described in an earlier report (ENVIRON 2011). A release height of 29 m was used, with an initial vertical dimension of 0.5 m and an initial lateral dimension calculated by dividing the width of the volume sources by 4.3.

For the ground level bus plaza, a similar series of adjacent 10 m by 10 m volume sources that cover the area of the bus plaza were used. A release height of 0.6 m was used, with an initial vertical dimension of 0.14 m and an initial lateral dimension calculated by dividing the width of the volume sources by 4.3.

For the bus ramps, a series of adjacent 8.62 m by 8.62 m volume sources that cover the area of the ramps were used. A varying release height was used to reflect the height at different locations of the ramps, with an initial vertical dimension of 0.14 m and an initial lateral dimension calculated by dividing the width of the volume sources by 4.3.

For the bus storage facility, a series of adjacent 10 m by 10 m volume sources that cover the two bus storage facilities were used. A release height of 0.6 meters was used, with an initial vertical dimension of 0.14 m and an initial lateral dimension calculated by dividing the width of the volume sources by 4.3. For each of the different locations (deck exhaust, plaza, ramps and storage facility) emissions were distributed uniformly amongst all volume sources. Details of the source parameters used are presented elsewhere (ENVIRON 2011).

Construction Projects:

All construction projects were modeled as area sources. For all major projects, the dimensions of the active construction sites in 2010 and 2025 were applied if available through the environmental documents. Where exact information on the major construction site was not available, the District used the entire area of the proposed construction as the emission area. Because the emissions are produced from construction equipment exhaust, there is already some turbulent mixing that occurs at the release. To account for this mixing, an initial vertical dimension of 1.4 meters was used. In addition, construction emissions were modeled assuming eight hours of activity per day from 8 am to 4 pm.

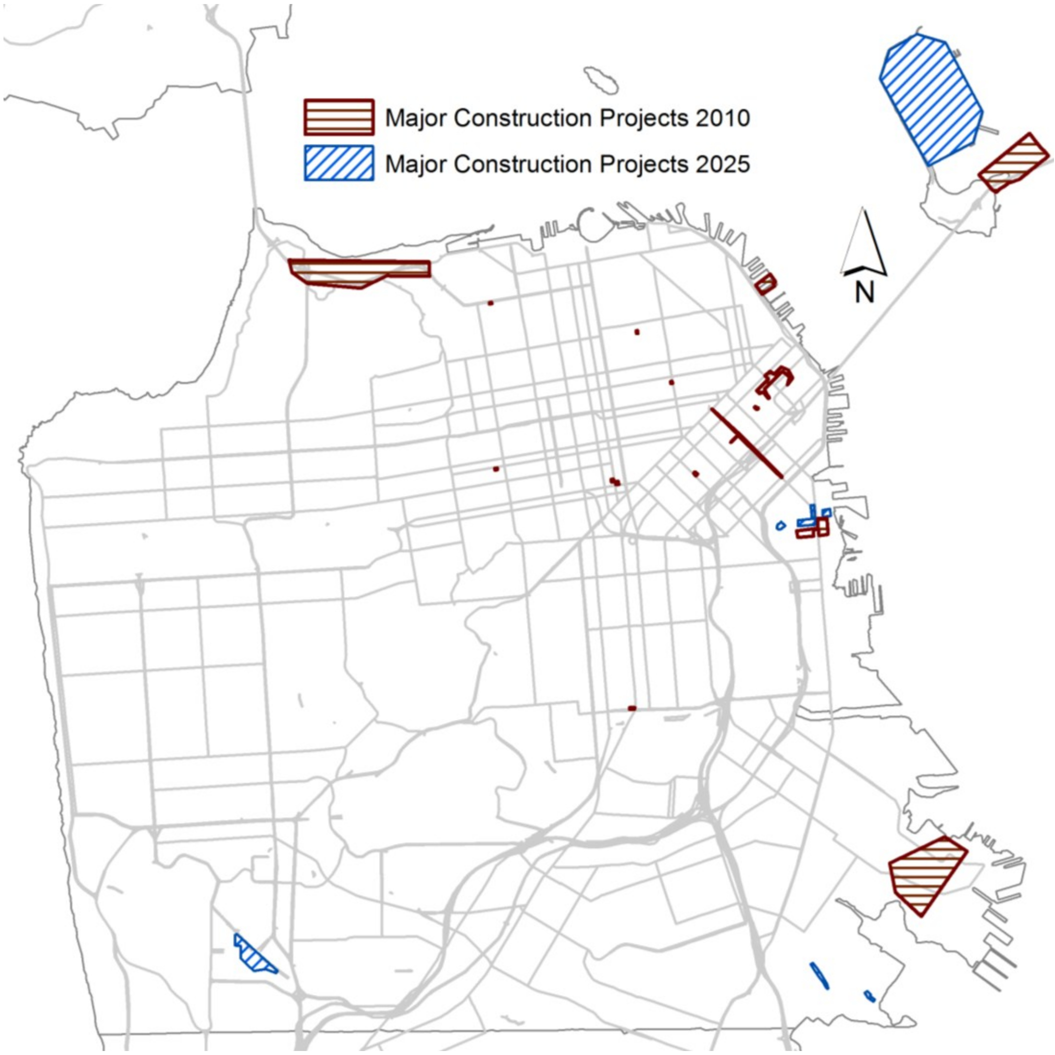


Figure 9. San Francisco major construction projects for 2010 (red horizontal shading) and 2025 (blue diagonal shading). Gray lines represent coastal boundaries and major roadways.

3.5 Rcaline Model Configuration

Caltrain:

Caltrain emissions were modeled using Rcaline (v0.95, Holstius 2011). The Rcaline model was run under the statistical programming language R (v2.12.1) as an interface for the CALINE3 model. The updated Rcaline model removes some of the limitations present in the Caltrans version of CALINE3 by allowing a large number of roadway links and receptor combinations that are only restricted by the computer's available memory and CPU capacity. Rcaline is able to receive and process Esri™ shapefiles as input.

A representation of the Caltrain rail network in San Francisco was available as an Esri™ shapefile from the 2008 Topographically Integrated Geographic Encoding and Referencing (TIGER) Line spatial database. Emissions estimated in Section 2 were then assigned to each link.

Effective release widths and railway height (assumed release height) were both set to 5 m. Rings enclosing each rail link were defined at buffer distances of 10, 20, 50, 100, 250, 500, 750, and 1,000 m from the link. Receptors were spaced evenly along the rings at intervals approximately corresponding to the ring buffer distances: 20, 50, 100, 150, 250, 500, 750, and 1000 m. Concentrations calculated at these receptor locations were remapped to the Cartesian master receptor grid (Section 3.2). As was the case for AERMOD simulations, a receptor height of 1.8 m was specified for use in Rcaline.

4. Fine Particle Concentrations and Cancer Risk

This section outlines methods applied to determine pollutant concentrations and cancer risk form emission sources identified, quantified, and provided as inputs to dispersion models.

4.1 Concentration Estimates

Concentration of a pollutant at each receptor location was calculated for a modeled source by multiplying annual average emissions of the pollutant from the source by the dispersion factor for the source. Dispersion factors are calculated using dispersion modeling with unit emissions from each source, as described in Section 3.1.

$$C_i = E_i \times F \,,$$

where

C_i = Annual average concentration for pollutant i (µg/m^3)

E_i = Annual average emission rate for pollutant i (g/s)

F = Dispersion factor, concentration per unit emission rate (µg/m^3)/(g/s)

Concentration of $PM_{2.5}$ was calculated for all source categories: on-road motor vehicles permitted stationary sources, Caltrain, ships and harbor craft, Transit Center operations, and construction projects. Concentrations of diesel PM and other pollutants were also calculated for these sources to estimate their contribution to potential cancer risk.

4.2 Risk Characterization Methods

Excess lifetime cancer risks are estimated as the incremental probability that an individual will develop cancer over a lifetime as a direct result of exposure to potential carcinogens. The estimated risk is a unitless probability, often expressed as the number of people who might get cancer per million people similarly exposed. The cancer risk attributed to a chemical was calculated over an assumed 70-year lifetime exposure by multiplying the chemical intake or dose through the lungs by the chemical-specific cancer potency factor (CPF). A year-specific age sensitivity factor (ASF) increases the risk in early years of exposure to account for increased sensitivities during fetal development and early childhood.

The equation used to calculate the potential excess lifetime cancer risk for the inhalation pathway is as follows:

$$Risk_i = 0.001 \times IF \times CPF_i \times \sum_j^{70\,years} C_{i,j} \times ASF_j,$$

where

$Risk_i$	=	Cancer risk; the incremental probability of an individual developing cancer as a result of inhalation exposure to a particular potential carcinogen i (unitless)
0.001	=	conversion factor (mg/µg)
IF	=	Intake Factor for inhalation (m^3/kg-day)
CPF_i	=	Cancer Potency Factor for pollutant i (mg chemical/kg body weight-day)$^{-1}$
$C_{i,j}$	=	Annual average concentration for pollutant i during year j (µg/m^3)
ASF_j	=	Age Sensitivity Factor for year j; the value of the factor is higher in early years of exposure (unitless)

Concentrations vary by year in response to annual average emissions for the year. Risk values were calculated for diesel PM from all the source categories. Organic gases from on-road gasoline-powered vehicles and other pollutants, such as PAHs and PERC, from permitted stationary sources also contributed to the cancer risk estimates. CPF and ASF values used were those recommended by CalEPA (CalEPA 2009, CalEPA 2011).

4.3 City-wide Mapping

Modeling and the calculations described above produced average annual $PM_{2.5}$ concentrations and cancer risk for each source within each source category on a grid of receptors with 20 m spacing extending one to two kilometers (depending on source type) in each direction from the source. The next processing step created city-wide maps for each source category by summing individual source contributions to $PM_{2.5}$ concentration and cancer risk across the subgrids to the master grid (see Section 3.2). The results for all source categories (excluding major construction projects) of $PM_{2.5}$ concentrations and cancer risk per year were totaled to produce a set of maps with all sources combined. Maps were produced for base year 2010, project year 2014, and future year 2025.

5. Results and Findings

Annual average $PM_{2.5}$ and cancer risk results derived from dispersion modeling are presented in this section in the form of a series of maps. A set of maps is included for each of the major source categories described in previous sections: roadways (Section 5.1), permitted stationary sources (Section 5.2), Caltrain (Section 5.3), ships and harbor craft (Section 5.4), Transit Center (Section 5.5), and major construction projects (Section 5.6). The final section (Section 5.7) presents the combined results for all of these sources together.

When discussing the maps and drawing conclusions from them, it is important to consider what they portray and how they were produced. Specifically, the dispersion modeling, from which the maps are derived, produced concentrations and risk estimates from direct emissions. The maps themselves therefore portray concentrations of directly emitted $PM_{2.5}$ and cancer risk associated with directly emitted TAC at locations near the sources of these emissions. The results do not reflect regional or long-range transport of air pollutants. Nor do they include the effects of the chemical transformation (formation or loss) of pollutants.

The modeling results, in particular maps of impacts of all sources combined, are intended to aid local planning efforts by identifying areas where emission reductions or other efforts may be implemented to help protect current and future residents from major local sources of air pollution. Impacted areas were identified by comparing modeled results of local contributions to CRRP thresholds. For cancer risk, this local contribution was used directly for comparison to a CRRP threshold. For $PM_{2.5}$, the local contribution was added to a background concentration for comparison to a CRRP threshold.

To estimate the background concentration of $PM_{2.5}$, monitored levels from six locations (Figure 10) were compared to the value predicted from dispersion modeling for the base year (2010) at those locations. Monitoring data from a special study conducted in 2008 were used along with routinely collected data from the BAAQMD routine monitoring site at the Arkansas Street site for the same year.

Table 14. Measured and modeled $PM_{2.5}$ concentrations (μg/m3) and their differences at San Francisco monitoring sites.

Monitoring Location	Measured Value (μg/m^3)	Modeled Value (μg/m^3)	Difference (μg/m^3)
BAAQMD Arkansas St	9.10	0.88	8.22
SFDPH Arkansas St	8.90	0.88	8.02
Southeast Community Center	9.30	0.84	8.46
Muni Maintenance Yard	8.90	0.44	8.46
Potrero Recreation Center	7.60	0.21	7.39
Malcolm X Academy	7.90	0.06	7.84
Average Difference			**8.06**

The average difference between the monitored and modeled values (8.06 μg/m^3; Table 14) was used as the citywide ambient level for $PM_{2.5}$. This difference was added to the predicted value at each receptor site for comparison to the CRRP threshold for $PM_{2.5}$.

Modeling results were generally developed for three years: a base year 2010, a project development year 2014, and a future year 2025. Where project emissions were assumed to be unchanged, only a single year is presented. When emissions from a source are eliminated (such as for Caltrain in 2025), no modeling results were developed.

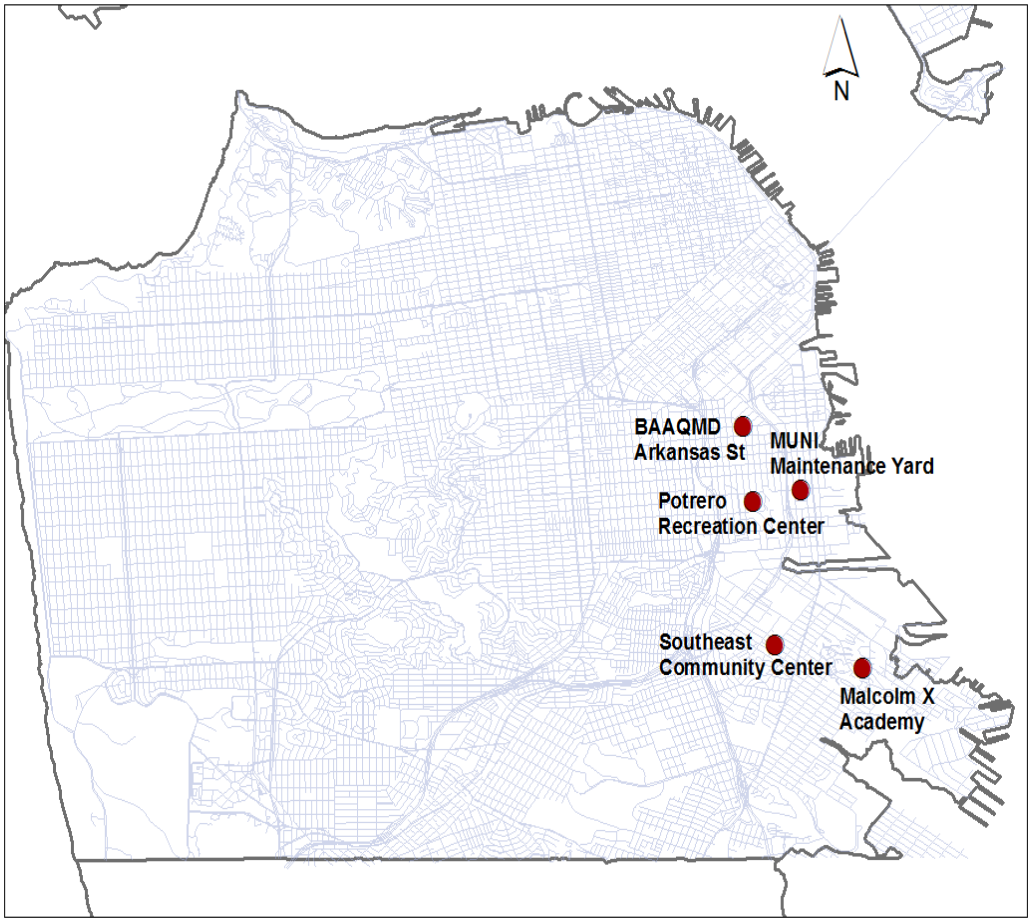
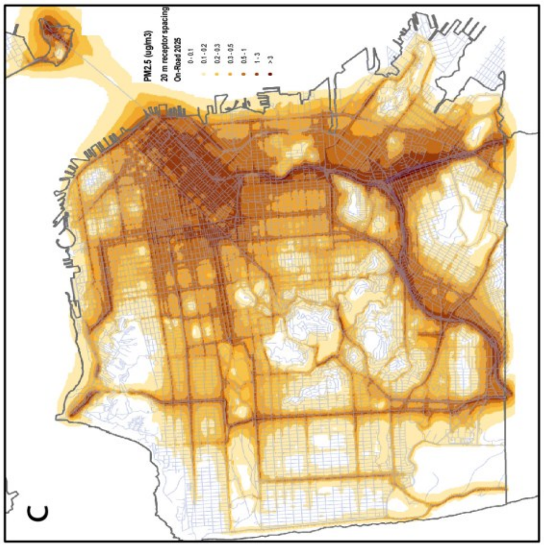


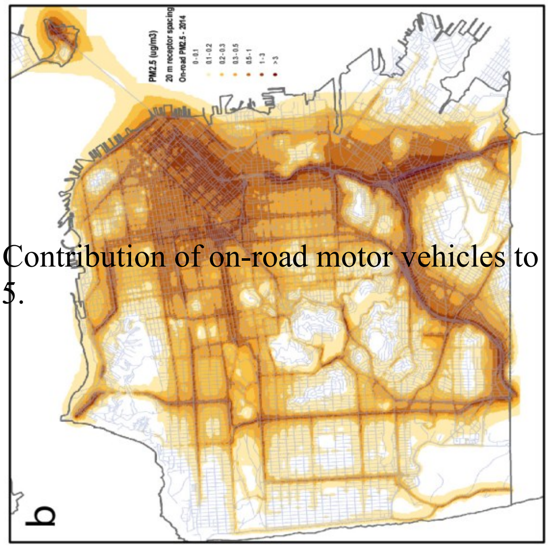
Figure 10. $PM_{2.5}$ monitoring locations in San Francisco, including 2008 special study sites.

5.1 Roadways

Annual $PM_{2.5}$*:*

The estimated contribution of directly emitted $PM_{2.5}$ from on-road motor vehicles to annual average $PM_{2.5}$ concentrations in San Francisco is mapped in Figure 11. Concentrations were mapped to the master receptor grid with color shading indicating the level of $PM_{2.5}$. In Figure 11, mapped concentration levels range from 0-0.1 µg/m3 (no shading) to more than 3 µg/m3 (darkest shading); darker shades indicate higher $PM_{2.5}$ concentrations. Emissions contributing to these mapped concentration increments include those from running exhaust but also from tire and brake wear. The spatial pattern of concentrations shown in Figure 11 closely follows the traffic activity: concentrations are highest near busy roadways, especially near the intersection of major freeways (such as 280 and 101) and where the roadway density is greatest (near downtown). All roadways in San Francisco with annual average daily traffic levels greater than 1,000 contribute to the roadway maps.





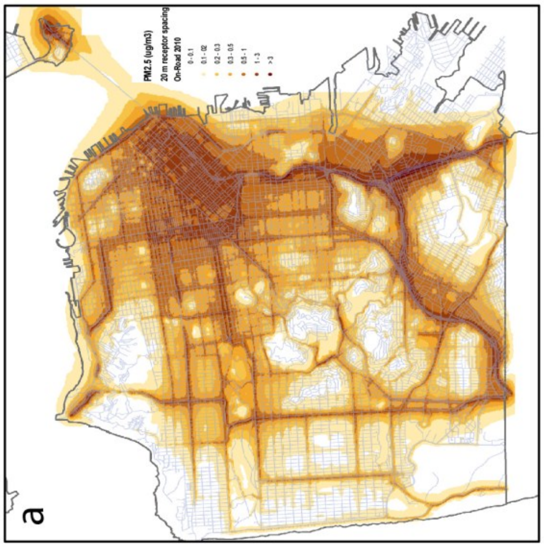


Figure 11. Contribution of on-road motor vehicles to annual average fine particulate matter (PM
and (c) 2025.

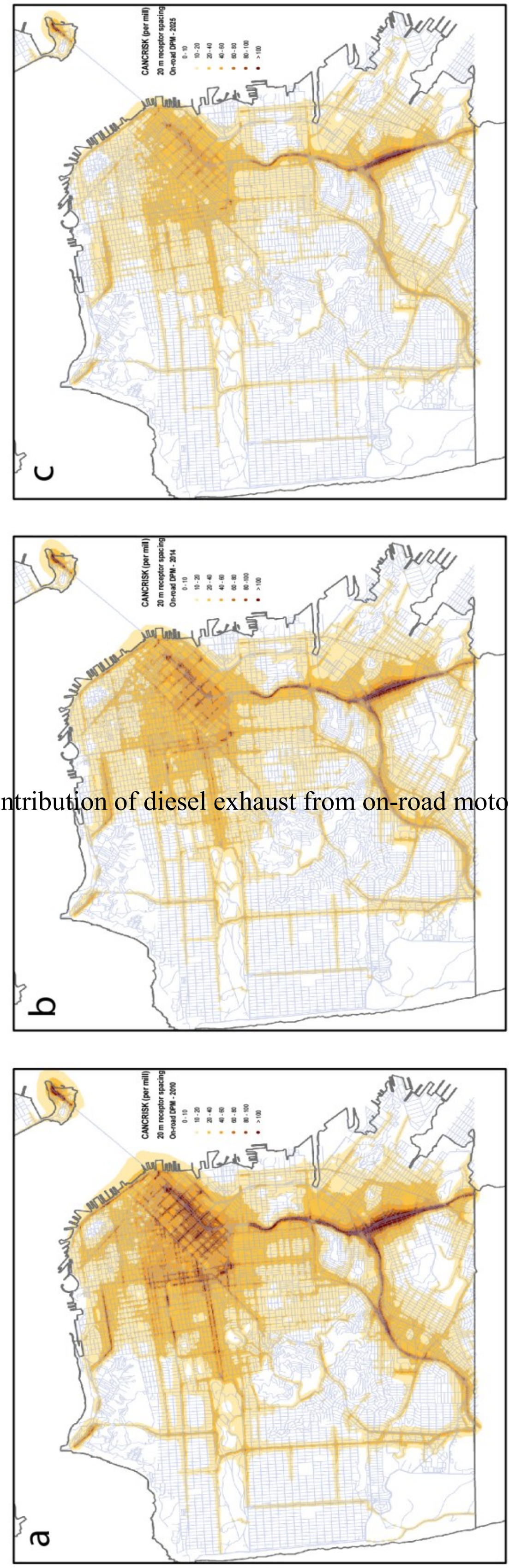


Figure 12. Contribution of diesel exhaust from on-road motor vehicles to cancer risk in (a) 2010, (b) 2014,

The incremental contribution of directly emitted $PM_{2.5}$ from on-road motor vehicles to $PM_{2.5}$ concentrations changes between years 2010 (Figure 11a), 2014 (Figure 11b), and 2025 (Figure 11c), but only by a small amount. Only small changes in $PM_{2.5}$ concentrations are indicated from one figure to the next. EMAC2011, used to generate emission factors, does report small reductions in PM exhaust emission factors between 2010 and 2025. These reductions in exhaust emission factors contribute to small emission reductions overall between these years. However, tire and brake wear emission factors hold constant, and there are projected increases in traffic in San Francisco, particularly evident in 2025 (Figure 11c) in the South Bayshore planning district (see Figure 9) where new development projects and more traffic emissions are expected. Increases in traffic tend to offset reductions in exhaust emission factors.

Cancer risk from diesel exhaust:

Figure 12 maps the contribution of diesel exhaust from on-road motor vehicles to the incremental potential cancer risk in San Francisco. Diesel particles from all sources have been recognized by OEHHA and CARB as having a high cancer potency factor. Incremental cancer risk was mapped to the master receptor grid with color shading indicating the level of risk (per million) assuming a 70-year exposure, and accounting for changes in emissions. In Figure 12, mapped risk levels range from 0-10 per million (no shading) to more than 100 per million (darkest shading); darker shades indicate higher potential cancer risk. The spatial pattern of risk shown in Figure 12 is greatly influenced by the distribution of heavy-duty diesel truck traffic activity because heavy-duty trucks have high emission factors for diesel particulate matter.

Recognizing the relatively high contribution of heavy-duty trucks to diesel particulate matter, in relation to their numbers, CARB has introduced important regulation of PM from on-road trucks and buses. The regulation requires diesel trucks and buses that operate in California to be upgraded to reduce emissions. Heavier trucks must be retrofitted with PM filters beginning January 1, 2012, and older trucks must be replaced starting January 1, 2015. By January 1, 2023, nearly all trucks and buses will need to have 2010 model year engines or equivalent. These diesel PM emission reductions emissions lowered cancer risk values shown in for all maps in Figure 12 (risks assume a 70-year exposure). However, risk reductions are greater for later years.

Cancer risk from non-diesel organic gases:

On-road, non-diesel cars and trucks emit toxic organic gases, such as benzene and 1,3-butadiene, that add to the incremental potential cancer risk in San Francisco. Maps in Figure 13 show the spatial distribution of cancer risk from gasoline-powered vehicles and the reductions in risk over time. Color shadings mark the same concentration levels in Figure 13 as in Figure 13. Cancer risk estimates from gasoline-powered vehicles included contributions from total organic gases (TOG) present in the exhaust emissions but included those from running evaporative losses, from un-combusted fuel escaping vehicle fuel lines and engines. As gasoline fleets become cleaner (lower emission factors for TOG) cancer risks are reduced for project year 2014 (Figure 13b) and future year 2025 (Figure 13c) relative to base year 2010 (Figure 13a).

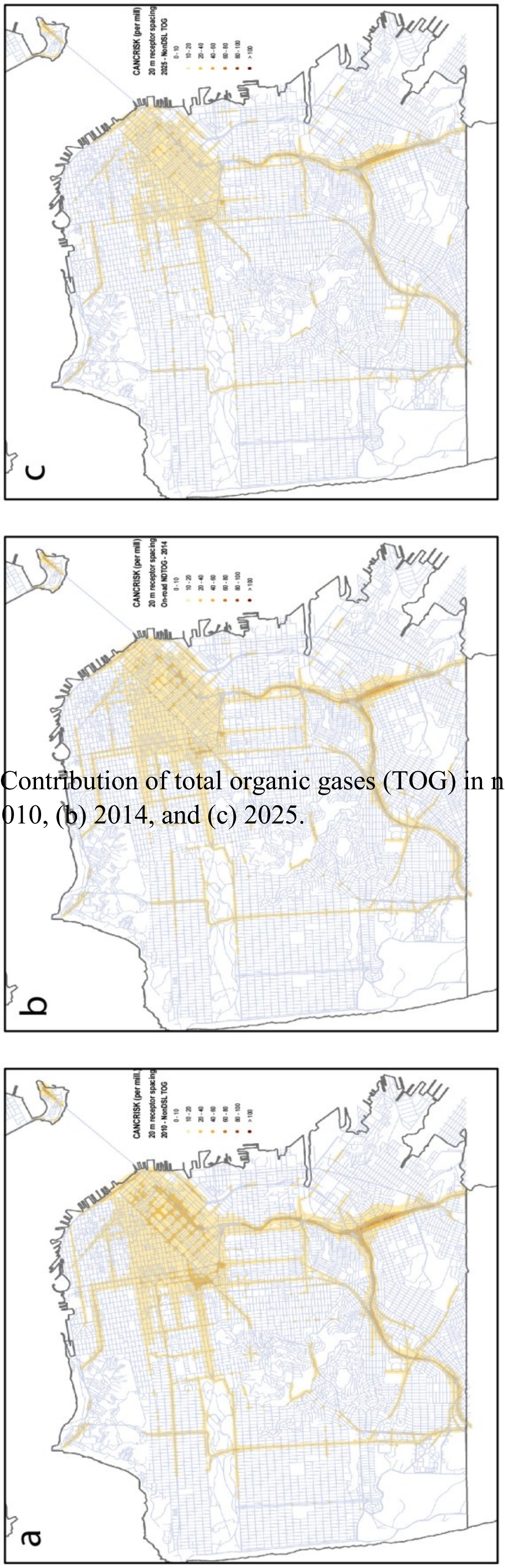


Figure 13. Contribution of total organic gases (TOG) in non-diesel exhaust from gasoline-powered on-
risk in (a) 2010, (b) 2014, and (c) 2025.

5.2 Permitted Stationary Sources

Annual $PM_{2.5}$:

The estimated contribution of directly emitted particles from permitted stationary sources to annual average $PM_{2.5}$ concentration in San Francisco is shown in Figure 14. In Figure 14, mapped concentration levels range from 0-0.1 µg/m3 (no shading) to more than 3 µg/m^3 (darkest shading); darker shades indicate higher $PM_{2.5}$ concentrations. Many of the sources contributing to local peaks in $PM_{2.5}$ concentration in Figure 14 are combustion-related sources, such as engines and backup generators. Other non-combustion sources release PM from activities such as sand blasting (e.g., near the Golden Gate Bridge), aggregate handling (near Islais Creek), or recycling (near the south east corner of the city). The contribution a stationary sources to $PM_{2.5}$ concentrations is determined by its emission rate and also by the type of release. For example, stack releases are influenced by stack height and by plume rise of the exhaust stream.

Emission rates of pollutants from stationary sources are regulated and monitored by the BAAQMD. Over time, emissions rates of $PM_{2.5}$ have dropped significantly due to existing rules adopted by the BAAQMD. However, no specific new regulations for fine particulate matter have been assumed for future years, so planning (2014) and future year (2025) year emission rates and concentrations are largely similar to 2010. Adjustments for year 2014 (and beyond), relative to 2010, were made to the emissions from two facilities: Potrero Power Plant and Bay View Management Company. The Potrero Power Plant closed in 2011 and contribution from the plant was not included in subsequent modeling. Bay View has committed to replacing historic generators in favor of newer engines which meet the District's permitting requirements by 2012. The emissions from this facility were adjusted to account for the use of newer technology.

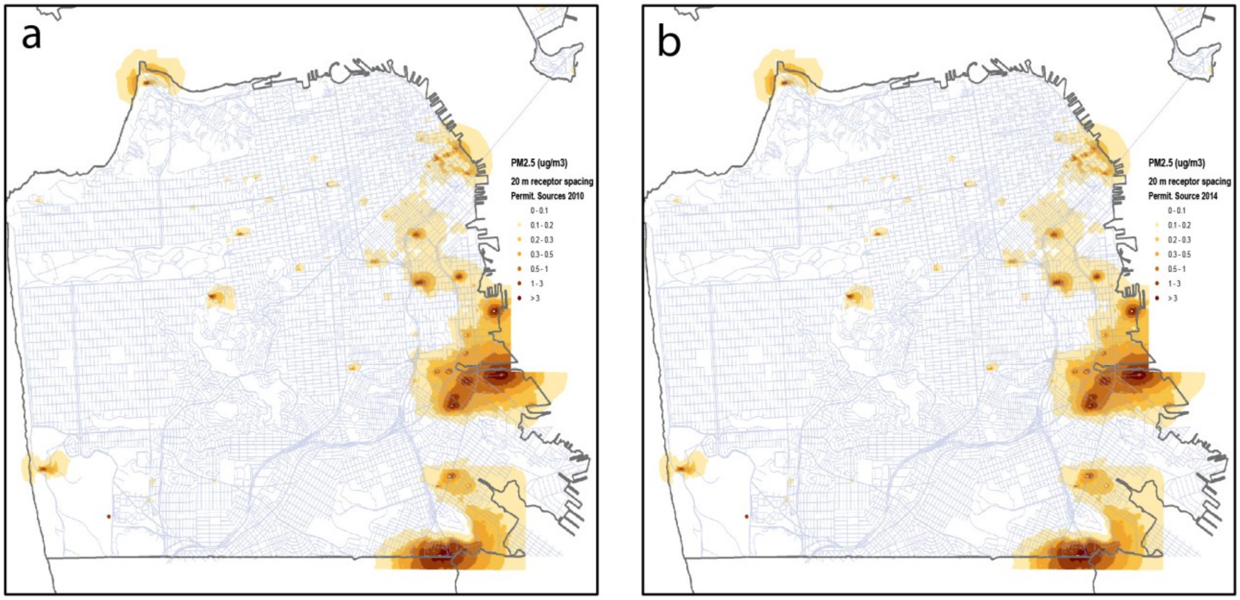


Figure 14. Contribution of permitted stationary sources to annual average fine particulate matter ($PM_{2.5}$) in (a) 2010 and (b) 2014. $PM_{2.5}$ levels in year 2025 from these sources were estimated to be the same as in 2014.

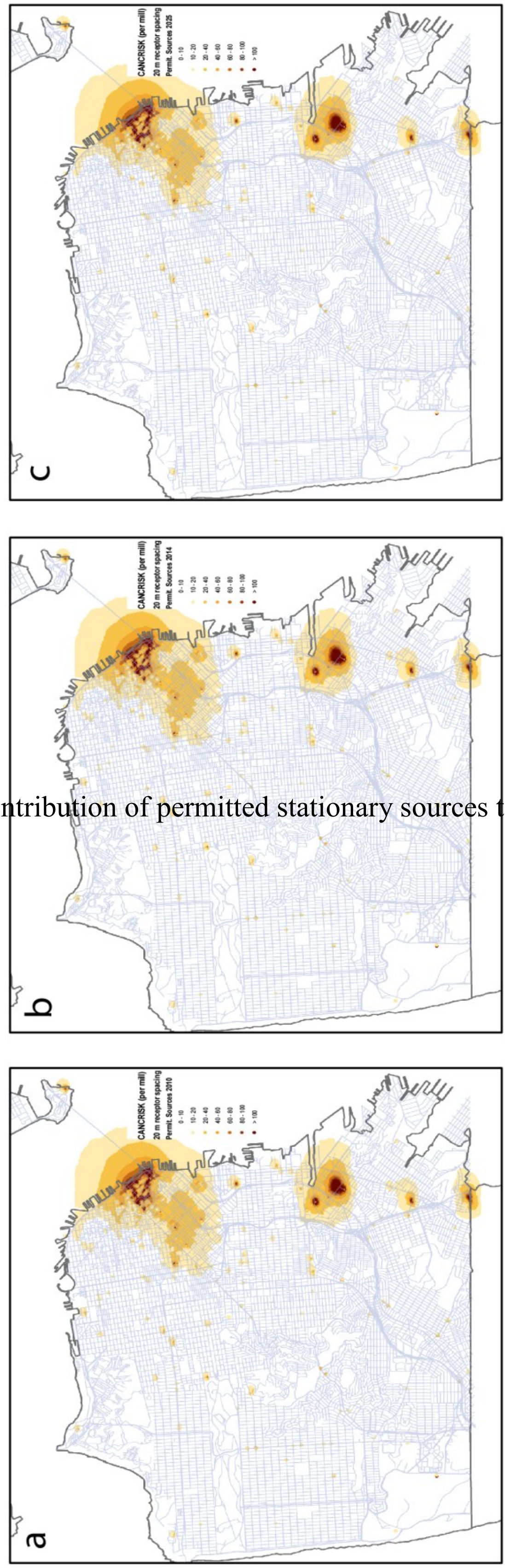


Figure 15. Contribution of permitted stationary sources to potential cancer risk in (a) 2010, (b) 201

Cancer Risk:

Combustion of diesel fuel is a major contributor to potential cancer risk from permitted stationary sources in San Francisco (Figure 15). For example, a large contributor to the area of high potential cancer risk in downtown San Francisco was backup diesel generators. Other sources, such as PERC drycleaners and gas stations, contribute many localized peaks in risk at scattered locations throughout the city. The sewage treatment plant produces a large peak from volatilized ages emitted from wastewater. Localized changes in risk were predicted from the elimination of PERC drycleaners by 2023.

5.3 Caltrain

Annual $PM_{2.5}$:

Annual average $PM_{2.5}$ concentrations in 2010 from Caltrain locomotive's diesel exhaust were estimated at between 0.1 and 0.2 $\mu g/m^3$ immediately adjacent to the rail line running through San Francisco (Figure 16a). Dominant westerly winds push higher concentrations to the east side of the rail line: the annual average $PM_{2.5}$ concentration contributed from Caltrain is roughly 0.1 $\mu g/m^3$ to a distance of about 50 m (about 150 ft) east of the tracks and drops quickly at greater distances. Highest concentrations of $PM_{2.5}$ were predicted near the downtown train station where extended periods of idling occur (20 min per train). Near the downtown station, $PM_{2.5}$ concentration levels of 0.1 $\mu g/m^3$ or greater extend to about 200 m (about 650 ft) east of the rail lines; values of 0.2 $\mu g/m^3$ or greater extend to about 50 m east of the lines.

$PM_{2.5}$ emissions and concentrations in project year 2014 were estimated to be the same as in base year 2010. However, in future year 2025, when the Caltrain service is projected to be electrified, locomotives will no longer emit diesel $PM_{2.5}$ and the concentration increment from Caltrain will be zero.

Cancer Risk:

The emitted diesel PM from Caltrain locomotives creates an increment in potential cancer risk along the rail line. In 2010, an increment in potential risk of 10 per million extends about 200 m (about 650 ft) east and 50 m (150 ft) west of the rail line (Figure 16b). A similar increment in potential risk from Caltrain extends about 500 m (about 1/3 mi) east and about 200 m west of the downtown station, where the incremental potential risk is highest. The calculated incremental potential risk for base year 2010 assumes that the Caltrain service will be electrified in 2025: diesel PM concentrations were assumed to remain constant from 2010 to 2025, but to drop to zero after 2025. The increment in potential risk in project year 2014 is closer to the projected date of Caltrain electrification, so risks were projected to be lower for 2014 (Figure 16c). These calculated risks would need to be reevaluated if the projected date for Caltrain electrification changes.

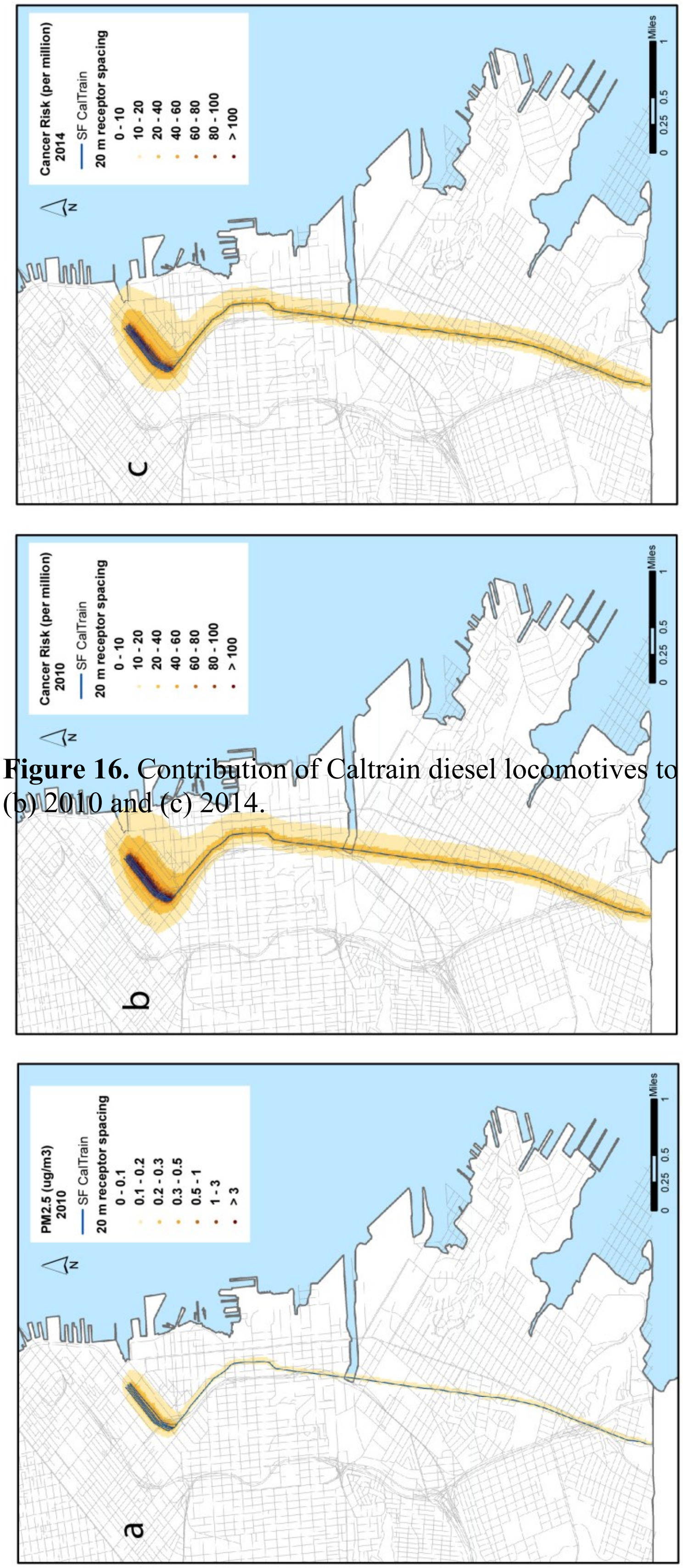


Figure 16. Contribution of Caltrain diesel locomotives to (a) annual average fine particu
(b) 2010 and (c) 2014.

5.4 Ocean Going Vessels, Tug Boats, and Harbor Craft

Annual $PM_{2.5}$:

The highest increment in annual average $PM_{2.5}$ estimated from OGVs, tugs, and harbor craft was predicted near Pier 41 in the northeast edge of the city (Figure 17). $PM_{2.5}$ concentrations, especially from the elevated releases of particles from tall OGV stacks, come onshore and intersect with terrain at Russian Hill and Telegraph Hill. From Pier 41, $PM_{2.5}$ concentrations ranging from 0.1 to 1 $\mu g/m^3$ extend southward onshore to about 600 m (about 1/3 mi). Smaller $PM_{2.5}$ peak concentrations were predicted in the south near Pier 94. On-shore concentrations of 0.1-0.2 $\mu g/m^3$ were predicted in the industrial area near Amador Street.

Because of shore power projects, which reduce near-shore exhaust from ship main engines near the northern piers, the contribution of $PM_{2.5}$ from OGVs is reduced for project and future years (Figures 17b and 17c, respectively) relative to the base year (Figure 17a).

Cancer Risk:

Cancer risk calculations treated all PM emitted by OGVs, tugs boats, and harbor craft as diesel PM, so the cancer risk maps in Figure 18 mirror the $PM_{2.5}$ maps in Figure 17. The highest increment in potential cancer risk was predicted near Pier 41. Cancer risk contributions, especially from the elevated OGV stacks, come onshore and intersect with terrain at Russian Hill and Telegraph Hill. From Pier 45 to Pier 29, potential cancer risk exceeds 100 per million. A much smaller area to the south, near Islais Creek, extending to Amador Street, also has potential risk concentrations of over 100 per million.

Small reductions over time in potential cancer risk from OGVs, due to improvements in shore power facilities, are shown in Figure 18. The extent of areas over 10 per million and the magnitude of the peak risk are reduced between base year 2010 (Figure 18a) and future year 2025 (Figure 18c).

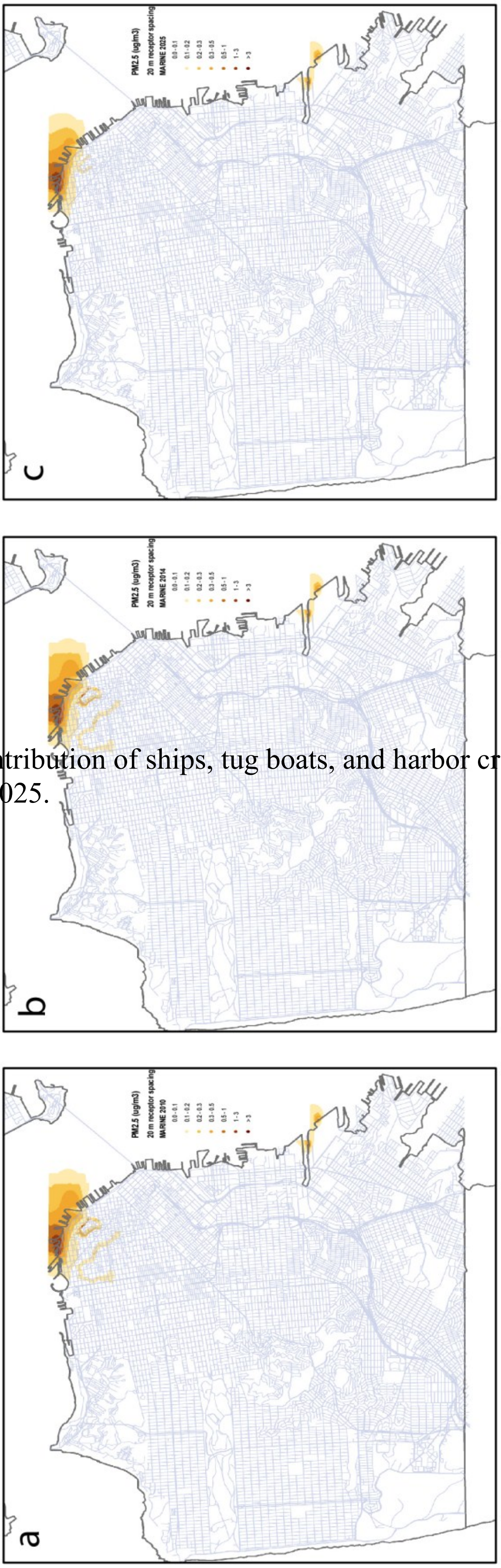


Figure 17. Contribution of ships, tug boats, and harbor craft to annual average fine particulate matt
2014, and (c) 2025.

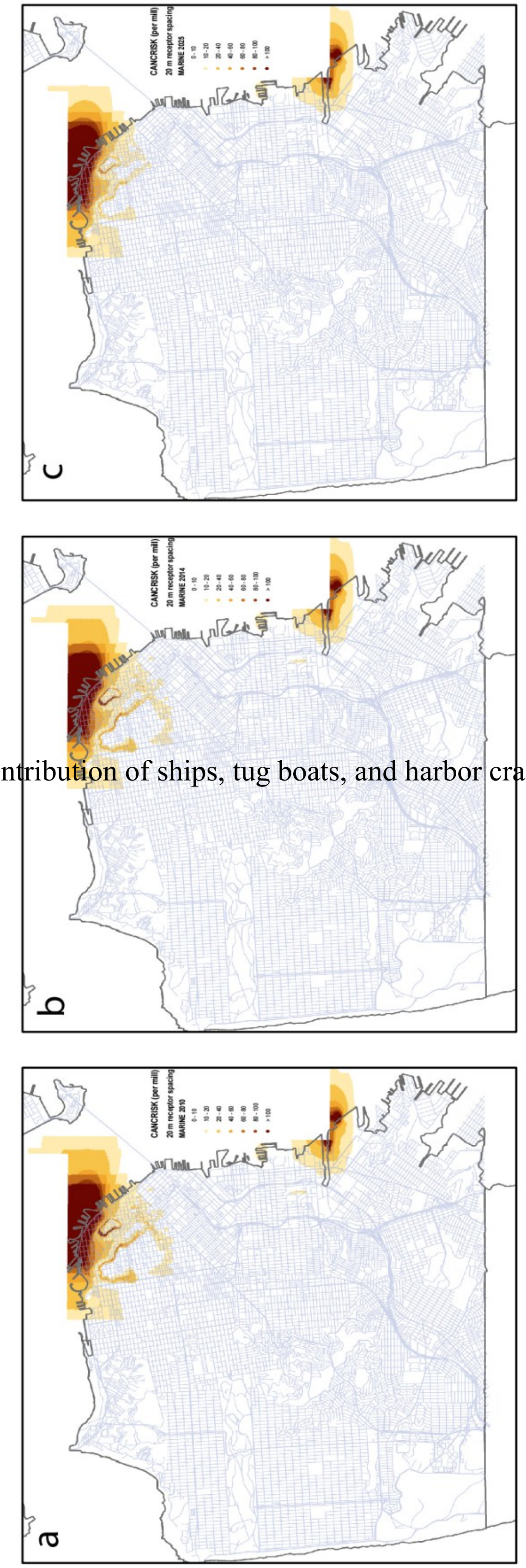


Figure 18. Contribution of ships, tug boats, and harbor craft to potential cancer risk in (a) 2010, (b)

5.5 Transit Center Operations

Annual $PM_{2.5}$:

Compared to other sources identified and modeled, Transit Center operations contribute a relatively small amount to the local annual average $PM_{2.5}$ concentrations (Figure 19). Elevated annual average $PM_{2.5}$, in the range of 0.1 to 0.2 mg/m3, occurs near the bus storage facility, the ground level bus plaza, and the transit center deck. Operations are scheduled to begin at the new Transit Center in 2017 and this was the first year modeled and presented (Figure 19a). Small reductions in $PM_{2.5}$ between 2017 and 2025 were predicted due to fleet turnover and cleaner buses in the future year (Figure 19b).

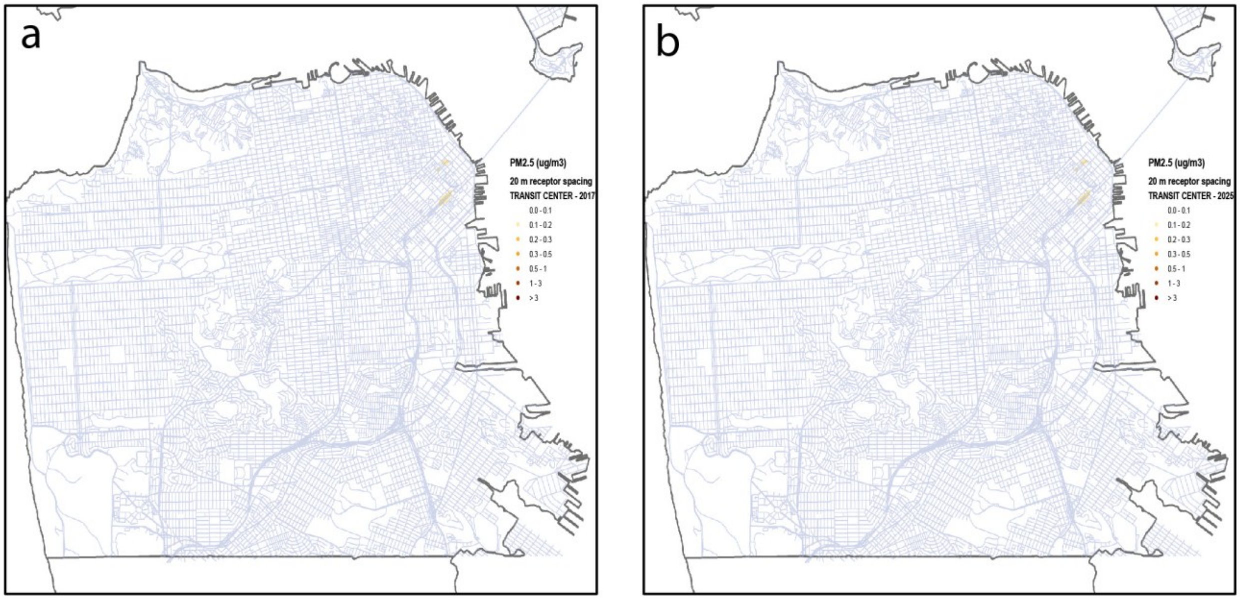


Figure 19. Contribution of Transit Center bus operations to annual average fine particulate matter ($PM_{2.5}$) in (a) 2017 and (b) 2025.

Cancer Risk:

Exhaust emissions of diesel PM from buses produced an estimated 20 to 40 per million increased potential cancer risk near the bus storage facility, the ground level bus plaza, and the transit center deck (Figure 20). A larger area with between 10 to 20 per million increased risk encompassed these areas and the bus ramps connecting the Transit Center to Interstate 80. Small reductions in risk were predicted in the future year 2025 (Figure 20b) compared to 2017 (Figure 20a).

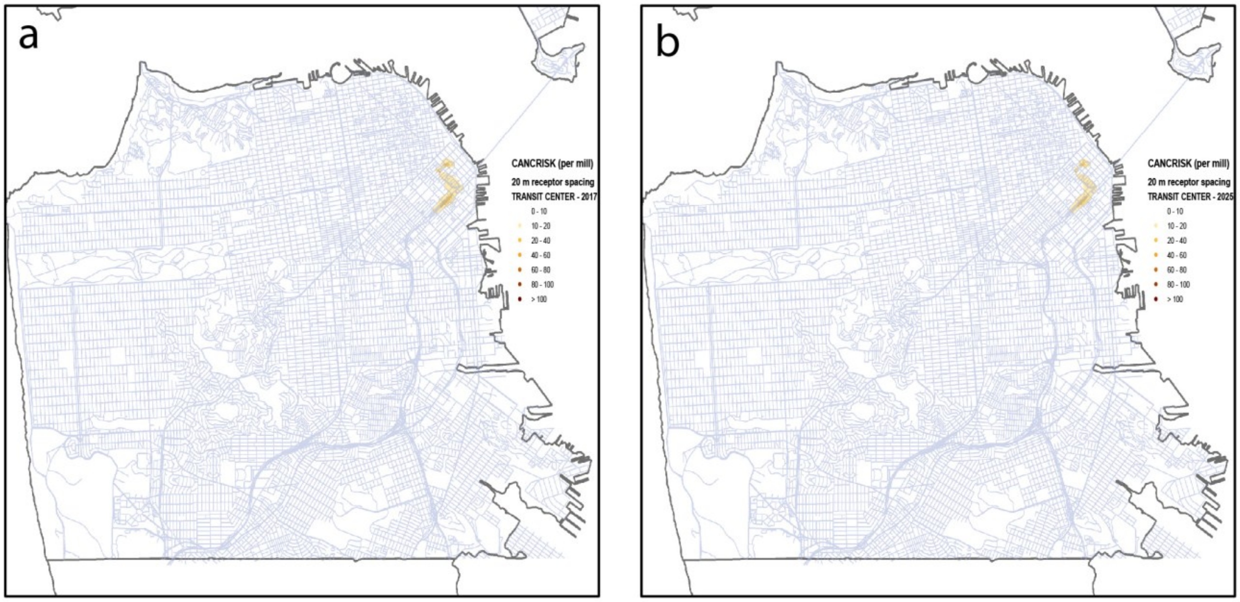


Figure 20. Contribution of Transit Center bus operations to potential cancer risk in (a) 2017 and (b) 2025.

5.6 Construction Projects

Annual $PM_{2.5}$*:*

The locations of the highest incremental contribution to annual average $PM_{2.5}$ from construction projects' diesel exhaust in 2010 (Figure 21a) and in 2025 (Figure 21b) correspond to the locations of major projects (Figure 9) that occurred in 2010 and those projected for 2025.

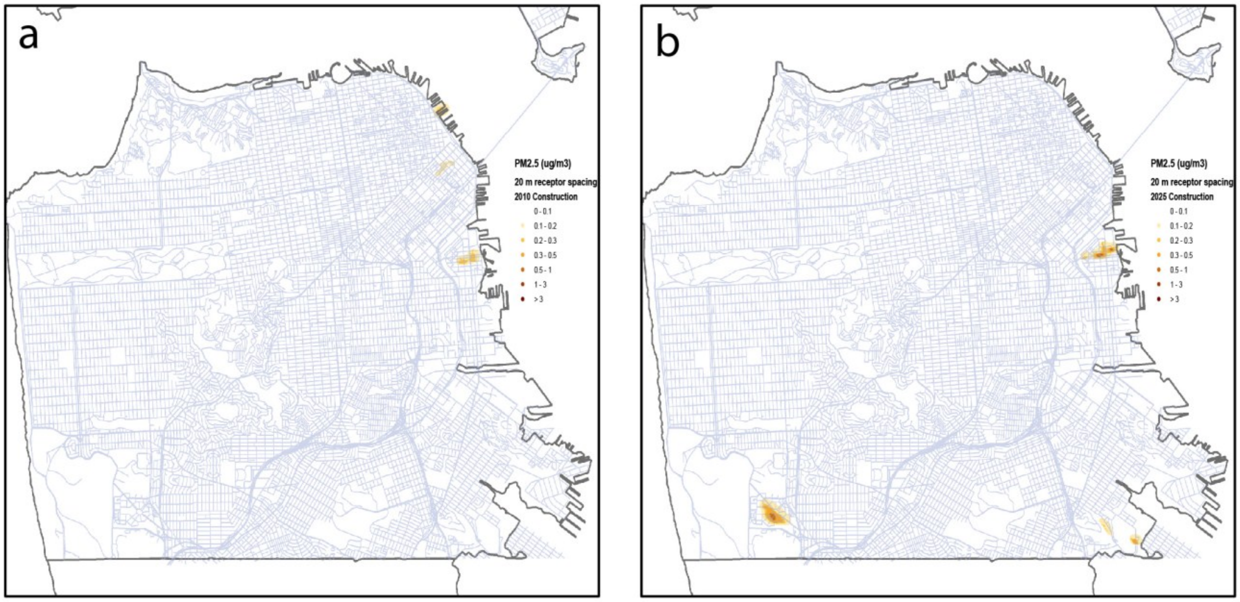


Figure 21. Contribution of construction projects to $PM_{2.5}$ in (a) 2010 and (b) 2025.

Cancer Risk:

Because construction emissions are variable in magnitude and location from year to year and because they were estimated only for the base year 2010 and future year 2025, the incremental contributions to potential cancer risk from construction projects in each case was based on a single year of exposure only. Figure 22 shows that peak incremental potential cancer risk from a single year of exposure in both base and future years peaks near the major construction projects, coinciding with the peak of incremental diesel exhaust PM.

The major construction analysis represents a snapshot of emissions expected to occur during the specific year of activity. The purpose of the analysis was to provide a general level of understanding regarding the likely impacts associated with large construction projects. However, the cancer risk and average $PM_{2.5}$ concentrations associated with major construction projects were not incorporated into the city-wide assessment because of the uncertainties associated with the emission estimates and future construction activities.

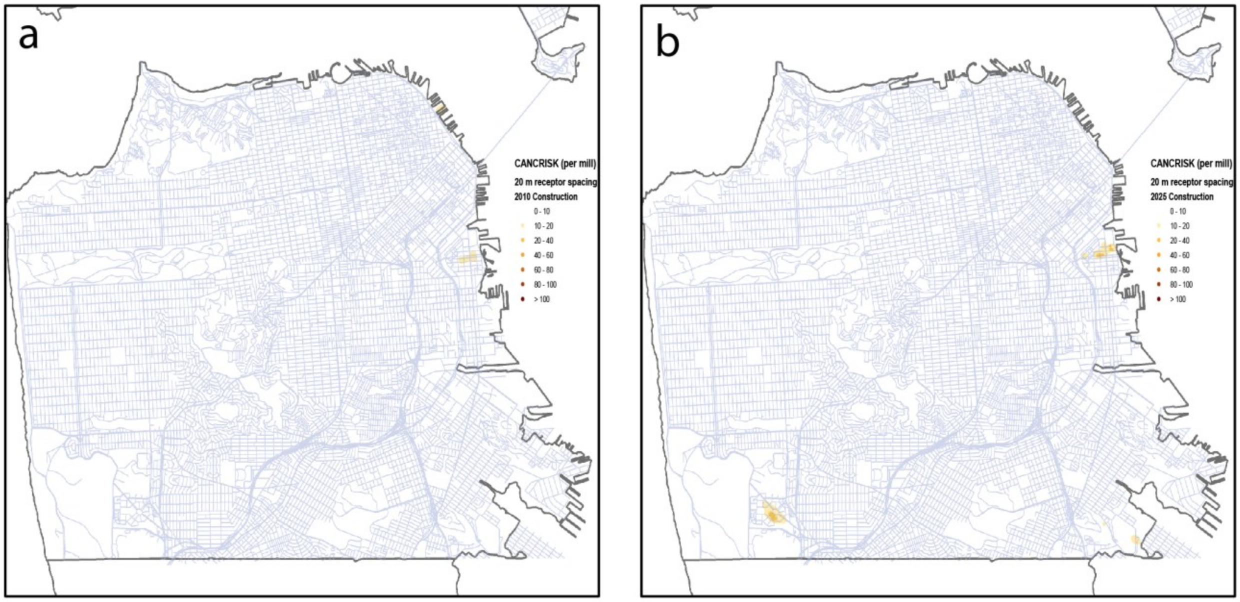


Figure 22. Contribution of construction projects to potential cancer risk in (a) 2010 and (b) 2025. For each year, cancer risk was calculated for a single year of construction only.

5.7 Combined Impacts

Annual $PM_{2.5}$*:*

Summing the incremental contributions of annual average $PM_{2.5}$ from all modeled sources produces an estimate of the combined impact of these local sources. Figure 23 shows the combined incremental impacts of $PM_{2.5}$ directly emitted from local sources. Adding background concentrations of $PM_{2.5}$ value (about 8 μg/m^3 estimated in Section 4.1) gives an estimate of total annual average $PM_{2.5}$, including secondarily formed PM and PM transported from distant sources. On-road mobile sources—cars and trucks—are major contributors to local $PM_{2.5}$ in San Francisco. In Figure 21, major roadways are clearly discernible and some of the highest PM areas are near the freeways where total traffic and truck traffic are highest. Areas along US 101, near the intersection with Interstate 280, stand out as those with some of the highest estimated annual average $PM_{2.5}$, with peak incremental concentrations reaching about 2 μg/m^3 in 2010 (Figure 21a; without the background added[9]). Projected changes in $PM_{2.5}$ concentrations in project year 2014 (Figure 21b) and 2025 (Figure 21c) are relatively small and mostly due to reductions in exhaust emissions from on-road motor vehicles due to fleet turnover and cleaner cars and trucks in the future. However these reductions are at least partially offset by increased traffic in many areas, which results in more PM emissions from tire and brake wear in future years. Increased traffic from new development projects in the Hunter's Point area in the result in higher $PM_{2.5}$ along local roadways.

Some specific sources of local $PM_{2.5}$, other than on-road sources, are indicated in Figure 24. Ship emissions and a few permitted stationary sources are highlighted as significant contributors.

Cancer Risk:

Combined source maps show that on-road mobile sources are also major contributors to incremental potential cancer risk (Figure 25). Diesel truck traffic on freeways and the downtown roadway network is largely responsible for the areas near these roadways with incremental potential cancer risk over 100 per million. The Caltrain station and ships and harbor craft are also major contributors to cancer risk near these areas. A large number of backup diesel generators associated with high rise buildings also add to potential cancer risk, particularly in the downtown areas. Figure 26 identifies additional contributions from a number of industrial facilities.

Relative to potential cancer risk in 2010 (Figure 25a) in future years (Figure 25b-c) significant reductions were projected. These anticipated reductions result mainly from State regulation of diesel exhaust emissions from on-road heavy-duty trucks. In 2025, cancer risk near Caltrain is expected to be eliminated with the electrification of the service. Shore power reduces the impact of OGVs in future years. Smaller, but locally important, reductions in potential cancer risk are due to the phase out of PERC from drycleaners.

As risk from others sources is reduced or eliminated in future years, the potential is clear for additional risk reductions from stationary sources, particularly for older diesel engines and back-up generators, many of which are in densely populated areas downtown.

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[9] Or about 10 μg/m^3 with the background added.

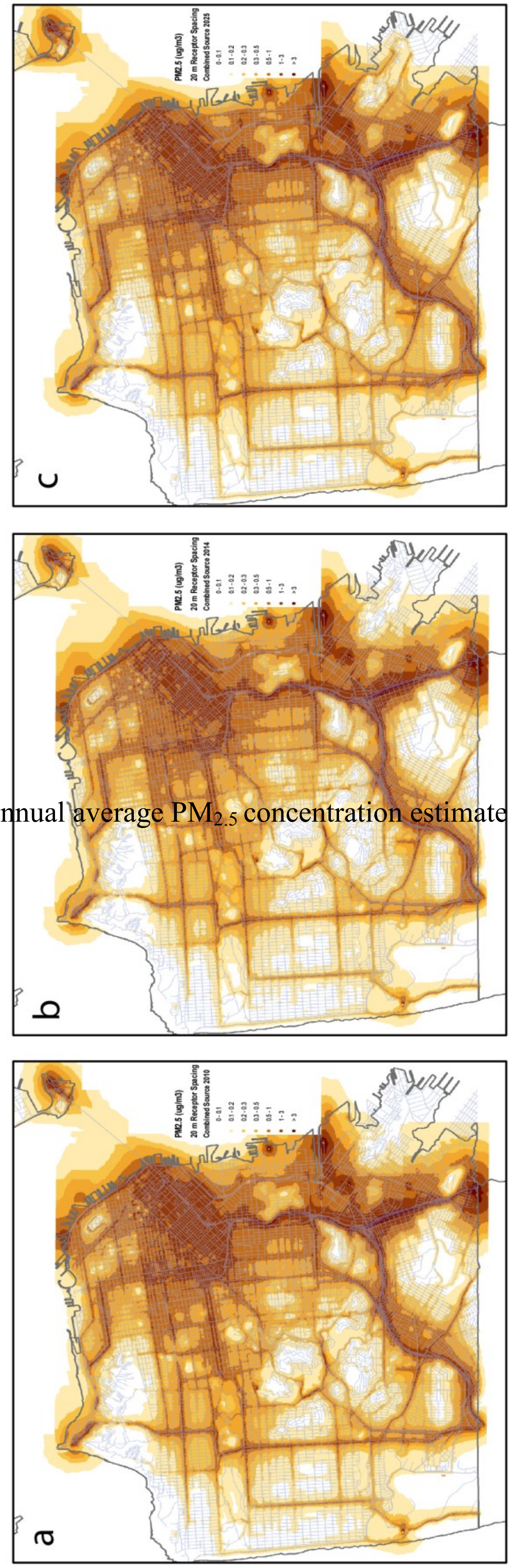
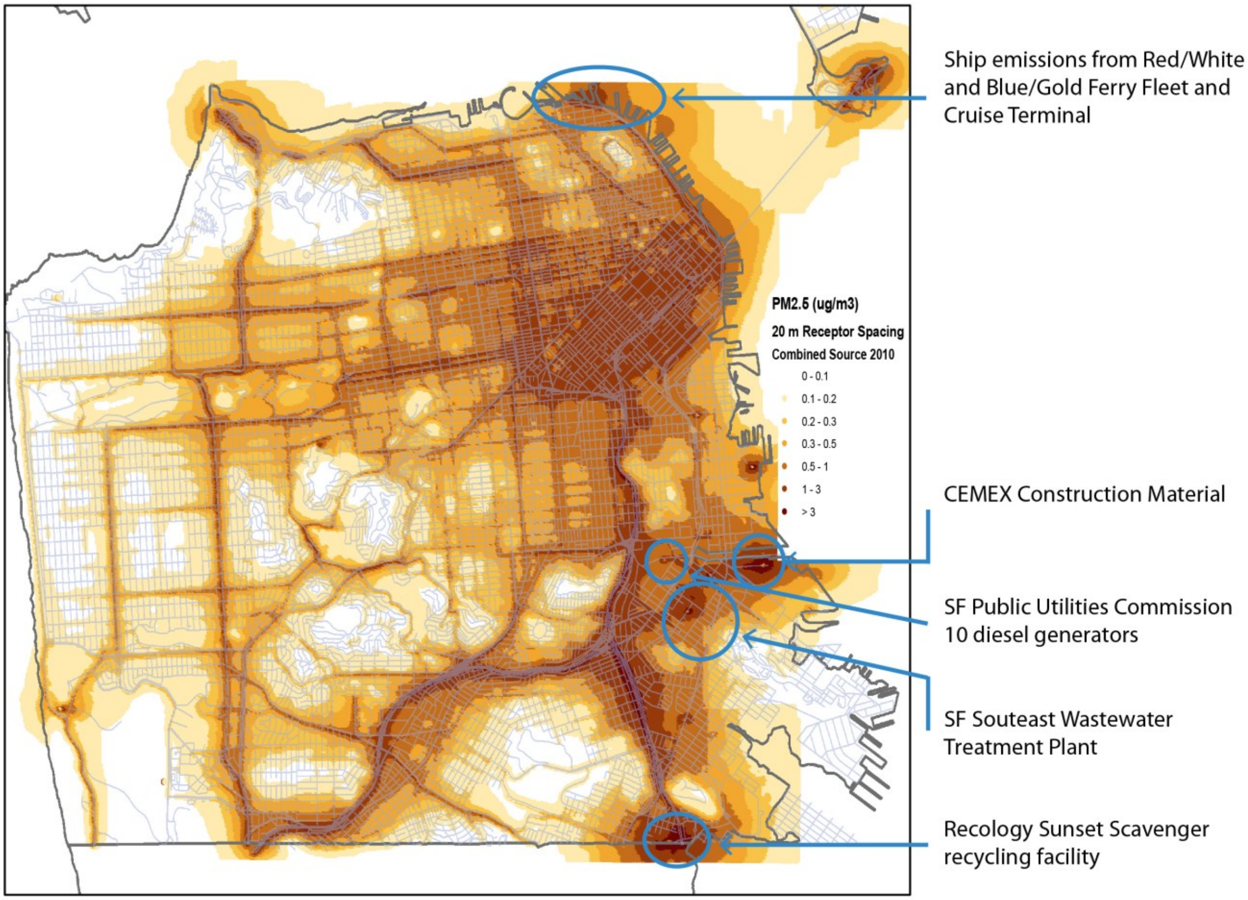


Figure 23. Annual average $PM_{2.5}$ concentration estimates from all modeled sources in (a) 2010, (b



Ship emissions from Red/White and Blue/Gold Ferry Fleet and Cruise Terminal

CEMEX Construction Material

SF Public Utilities Commission 10 diesel generators

SF Souteast Wastewater Treatment Plant

Recology Sunset Scavenger recycling facility

Figure 24. Identification of sources associated with high incremental contributions of $PM_{2.5}$.

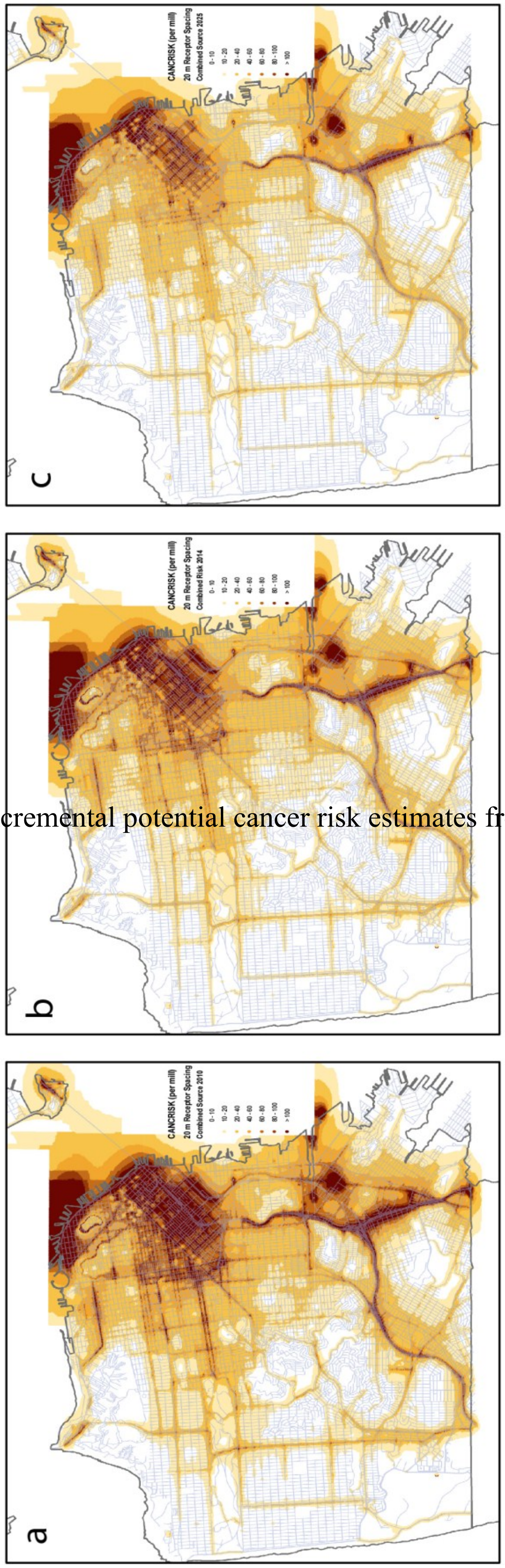


Figure 25. Incremental potential cancer risk estimates from all modeled sources for (a) 2010, (b) 2

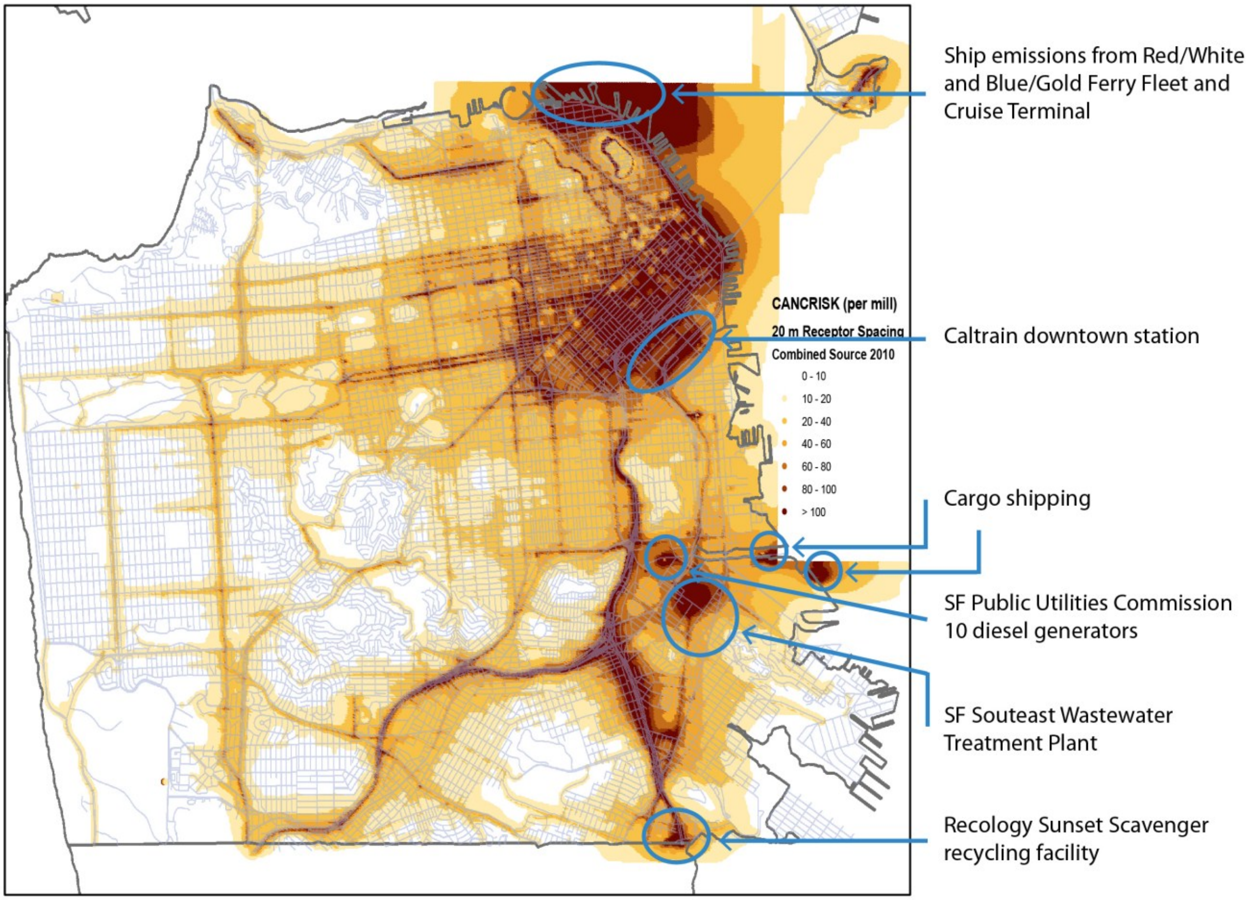


Figure 26. Identification of sources associated with high incremental contributions of potential cancer risk.

6. Uncertainties

In accordance with risk assessment guidance, the CRRP has qualitatively evaluated the uncertainties associated with the HRAs, including emissions estimation, the modeling approach, and risk estimation. A quantitative uncertainty analysis was beyond the scope of this evaluation since necessary uncertainty inputs were not available and the models applied did not include methods for propagating uncertainties. 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 Estimates

There are a number of uncertainties associated with the estimation of emissions from each of the source categories considered that may affect the subsequent estimation of exposure concentrations and risk characterization. For example, uncertainties associated with the estimation of emissions on-road motor vehicles may affect the subsequent estimation of exposure concentrations and risk characterization. Estimates of traffic volumes and truck fractions on specific roadways have significant uncertainties associated with them, especially in future years. Average truck fractions for surface streets were estimated by counting trucks seen in aero-photographs taken at specific times of the day. In most cases, the truck counts using the ortho-photo analysis yielded higher truck percentage and estimated higher emissions attributed to trucks than if default truck percentages from Caltrans California state highways studies were used. EMFAC2011 was used to estimate on-road emission factors for cars, trucks and buses in San Francisco and there were also uncertainties associated with these.

At the commencement of the CRRP development for San Francisco, emissions estimates for 2008 were the most recent available for permitted stationary sources. Since then, some sources were supplemented with 2009 data, but emissions from some sources may have changed between these dates and base year 2010. Where specific information was available about changes in future year emissions from permitted sources, this information was used; but uncertainty exists in forecasts for many stationary source categories.

In addition, some source categories were excluded from the modeling analysis. The emissions associated with commuter ferries to San Francisco Ferry Building were not included in the CRRP since they were not originally quantified in the Port of San Francisco reference report. The ferry building is used by six commuter ferry services including Golden Gate Ferry, Vallejo Baylink Ferry, Blue and Gold Ferry, Alameda/Oakland Ferry, Harbor Bay Ferry, and Water Emergency Transportation Authority (WETA) Ferry. In a report completed by Environ for a residential development at 8 Washington Street dated April 1, 2011, they estimated that commuter ferries produce 1.24 tons per year of diesel particulate matter from idling and maneuvering. Based on this emission estimates, commuter ferry contribute approximately 12% of the base year emissions in 2010 and 21% of the future year emissions for marine vessels. Marine emissions may be underestimated based on the exclusion of commuter ferries.

The modeling did incorporate PM emission changes due to the Potrero Power Plant closure and from updates at the Bay View facility based on review of District files and discussions with San Francisco Planning. PM emissions for the remaining facilities were held constant to base year 2010. It is likely that many of these facilities will have permit condition changes that will impact their future emissions. However at this time, the District cannot forecast what the future emissions maybe. For example, BAE Systems (dry dock) at Pier 70 was recently awarded a contract to repair Navy T-AKE vessels starting in 2011. To reduce some of the emissions, the dry dock also installed shore power at the pier this year. Because of the unknown number of T-AKE vessels that will be repaired at the dry dock and the expected emissions reductions associated with the shore power, the emissions for BAE Systems based on the District's 2009 inventory was used. Future CRRP analysis may include updates to the emission inventories that include, but are not limited to, adding commuter ferries emissions and updating the Pier 70 inventory.

Default emission factors were used to estimate emissions of all off-road equipment. This assumes that emissions from all equipment will be equal to the default emissions when some emissions may vary from this rate. Furthermore, a load factor is included in the calculation of emissions. This load factor was obtained from CARB's OFFROAD model and is a fleet wide average. This load factor may not be representative of the exact piece of equipment in use, but was the most reasonable estimate. In addition, the analysis only included evaluation of impacts associated with multi-year construction project, but does not forecast future emissions associated with new construction of both major and minor projects due to the lack of information regarding the location, duration, and type of equipment that will be used on the project. The construction analysis conducted in this evaluation was for information purposes only and was not incorporated into the city-wide analysis. San Francisco plans to reduce emissions from construction equipment by adopting a local ordinance that requires equipment to meet low emissions standards for sites within the city limits. Because construction emissions are intermittent, the local ordinance may be the most effective mitigation for ensuring long term reductions from construction activities.

6.2 Modeling Approach

In addition to uncertainty associated with emission estimates, there is also uncertainty associated with the estimated exposure concentrations. The limitations of the air dispersion model provide a source of uncertainty in the estimation of exposure concentrations. According to USEPA, errors due to the limitation of the algorithms implemented in the air dispersion model in the highest estimated concentrations of +/- 10 percent to 40 percent are typical (USEPA 2005).

In San Francisco, with its many multi-story and high-rise buildings, urban flow patterns are likely influenced by recirculation and channeling in urban canyons. The dispersion modeling does not account for such patterns. The urban heat island effect which results from surface heating of paved and built-up environment leads to longer periods of mixing and generally lower predicted air concentrations. AERMOD allows the user to model urban heat island impacts by selecting urban land use option. Although San Francisco fits the definition of an urban area, AERMOD was run using rural land use option in order to estimate conservative air pollutant concentrations.

In addition, we did not have building height information for including building downwash, the effects of which the modeling does estimate. The building downwash option in AERMOD accounts for the buildup of air pollution in the building cavity due to recirculating winds created by nearby buildings. The effects are governed by the building geometry and the wind direction. To take advantage of this option in the model, we would require information on all the building heights and stacks within the City. Typically, building downwash effects often lead to higher concentrations downwind of the stack release. Not capturing these effects and using meteorological data from single monitoring site to represent transport throughout the city add to errors and uncertainties in the modeling approach.

Throughout the city, receptors were placed at a height of 1.8 meters (commonly called flagpole receptor height) above the surface terrain. This option is used to conservatively model exposures within an individual's breathing zone at ground level. Using flagpole receptors may not always capture the highest predicted concentration in cases where both the source and the residential receptors are elevated above the surface terrain.

Uncertainties in input parameters used to represent and model emission releases add uncertainty to the modeling approach. For all emission sources, where parameters such as stack height and diameter were unknown, we used source parameters which were either recommended as defaults or expected to produce more conservative results. In particular, many of the stack parameters for standby diesel generators were unknown and default release parameters were used. However in cases where the actual stack height is greater than the default used in the model, the exposure concentrations may be underpredicted at downwind receptor locations. Since there can be discrepancies in actual emissions characteristics of a source and its representation in the model, exposure concentrations used in this assessment represent approximate exposure concentrations. For example errors and uncertainties persist in the specification of locations of stacks at facilities, in spite of significant effort expended to improve the permitted source database.

6.3 Risk Characterization Methods

Numerous assumptions must be made in order to estimate human exposure to chemicals. These assumptions include parameters such as breathing rates, exposure time and frequency, exposure duration, and human activity patterns. While a mean value derived from scientifically defensible studies is a reasonable estimate of central tendency, the exposure variables used in this assessment are only estimates.

CalEPA/OEHHA cancer potency factors (CPFs) for toxic air contaminants were used to estimate cancer risks associated with pollutant exposures the emission sources modeled. However, the CPF values derived by Cal/EPA for many pollutants, including that for diesel PM, are uncertain in both the estimation of response and dose. Public health and regulatory organizations such as the International Agency for Research on Cancer, World Health Organization, and USEPA agree that diesel exhaust may cause cancer in humans. However, there is significant uncertainty in the value applied for the CPF.

The USEPA 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 a site and that the estimated risks do not necessarily represent actual risks experienced by populations at or near a site (USEPA 1989).

The method applied to estimate cancer risk includes the age sensitivity factor (ASF) recommended by CalEPA/OEHHA which increases the effective CPF to account for increased sensitivity of the young to cancer-causing pollutants. However there may be pollutants in the urban environment whose cancer toxicity is magnified in ways that are not accounted for because of the presence other pollutants (synergic effects) or because of pre-existing conditions or sensitivities. Furthermore, there may be pollutants whose toxicity is not yet recognized or quantified and, as such, is unaccounted for in this risk assessment.

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8. Appendix A: Acronyms and Abbreviations

AADT	annual average daily traffic
AERMAP	AERMOD terrain preprocessing program
AERMET	AERMOD meteorological preprocessing program
AERMOD	American Meteorological Society/EPA Regulatory Model Improvement Committee Regulatory Mode
ASF	age sensitivity factor
BAAQMD	Bay Area Air Quality Management District
BART	Bay Area Rapid Transit
CALINE3	third generation of the California Department of Transportation Roadway Model
Caltrans	California Department of Transportation
CARB	California Air Resources Board
CARE	Community Air Risk Evaluation Program
CEIDARS	California Emissions Inventory Development and Reporting System
CPF	cancer potency factor
CPU	central processing unit
CRRP	Community Risk Reduction Plan
CSV	comma separated value
DPM	diesel particulate matter
EMFAC	California State emissions factor model for on-road mobile sources
GDF	gas dispensing facility
GIS	Geographic Information System
HRA	health risk assessment
ISC	Industrial Source Complex
NAD83	North American Datum of 1983
NEI	National Emissions Inventory
OGV	ocean going vessel
PAH	polycyclic aromatic hydrocarbons
PDF	Portable Document Format, developed by Adobe Systems Incorporated
PERC	perchloroethylene
PM	particulate matter
$PM_{2.5}$	fine particulate matter with aerodynamic diameter equal to or less than 2.5 microns
PSD	prevention of significant deterioration
Rcaline	version of CALINE run under the statistical programming language R
SamTrans	San Mateo County Transit
SCRAM	US EPA Support Center for Regulatory Air Models
SF-CHAMP	San Francisco County Chained Activity Modeling Process
SFDPH	San Francisco Department of Public Health
SFPLAN	San Francisco Planning Department
SIC	Standard Industrial Classification
STI	Sonoma Technology, Incorporated
TAC	toxic air contaminant
TIGER	Topographically Integrated Geographic Encoding and Referencing
TOG	total organic gases
USEPA	United States Environmental Protection Agency
UTM	Universal Transverse Mercator
VMT	vehicle miles traveled
WestCAT	Western Contra Costa Transit Authority
WGS84	World Geodetic System of 1984

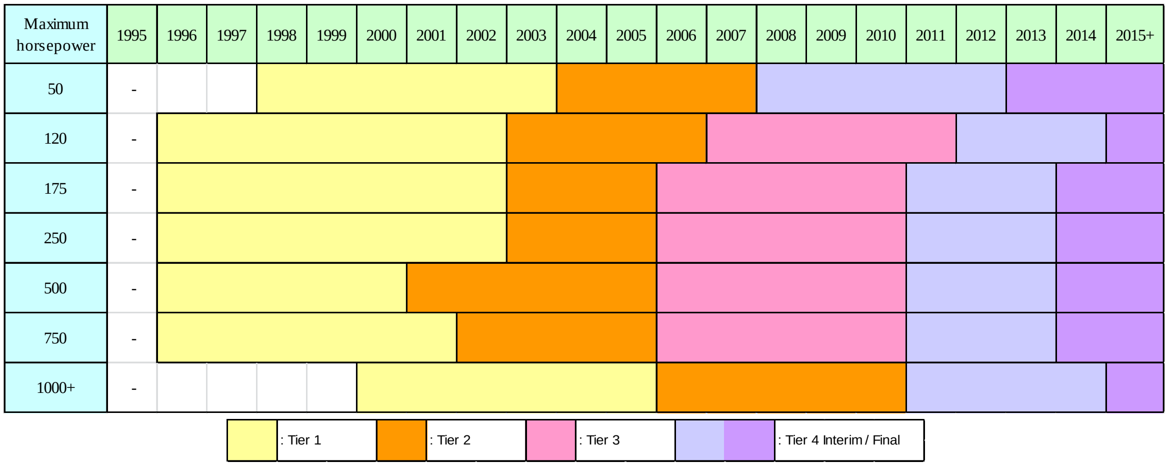
Appendix B – Equipment Types Included in the Construction and Mining Equipment Emissions Inventory

Category	Equipment Type
Construction and Mining Equipment	Bore/Drill Rigs
	Cranes
	Crawler Tractors
	Excavators
	Graders
	Off-Highway Tractors
	Off-Highway Trucks
	Other Construction Equipment
	Pavers
	Paving Equipment
	Rollers
	Rough Terrain Forklifts
	Rubber Tired Dozers
	Rubber Tired Loaders
	Scrapers
	Skid Steer Loaders
	Surfacing Equipment
	Tractors/Loaders/Backhoes
	Trenchers

Appendix C – Construction Feasibility Analysis

In order to analyze the In-Use Off-Road Equipment Model dataset by Tier, the Environmental Protection Agency (EPA) and California Air Resources Board (CARB) emission standards were combined into the In-Use Off-Road Equipment Model horsepower (hp) bins. Refer to Table E-1 for those combined particulate matter (PM) standards by hp bin.

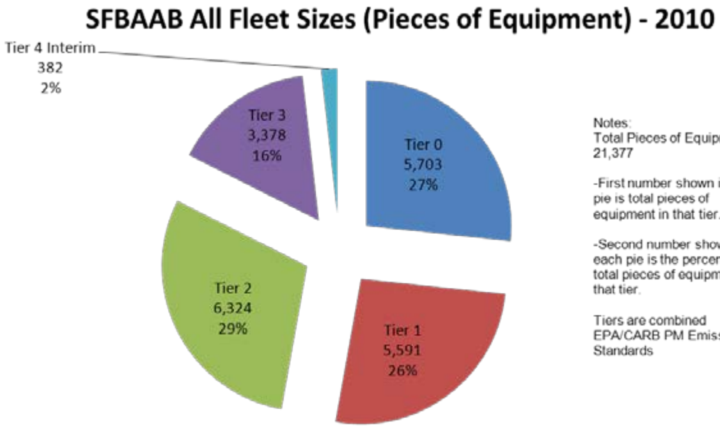
TABLE C-1
CALIFORNIA AIR RESOURCES BOARD AND U.S. ENVIRONMENTAL PROTECTION AGENCY OFF-ROAD COMPRESSION-IGNITION (DIESEL) ENGINE STANDARDS BY HORSEPOWER BIN – PARTICULATE MATTER



Maximum horsepower	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015+
50	-			🟨	🟨	🟨	🟨	🟨	🟨	🟧	🟧	🟧	🟧	🟦	🟦	🟦	🟦	🟦	🟪	🟪	🟪
120	-	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟧	🟧	🟧	🟧	🟥	🟥	🟥	🟥	🟥	🟦	🟦	🟦	🟪
175	-	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟧	🟧	🟧	🟥	🟥	🟥	🟥	🟥	🟦	🟦	🟦	🟪	🟪
250	-	🟨	🟨	🟨	🟨	🟨	🟨	🟨	🟧	🟧	🟧	🟥	🟥	🟥	🟥	🟥	🟦	🟦	🟦	🟪	🟪
500	-	🟨	🟨	🟨	🟨	🟨	🟧	🟧	🟧	🟧	🟧	🟥	🟥	🟥	🟥	🟥	🟦	🟦	🟦	🟪	🟪
750	-	🟨	🟨	🟨	🟨	🟨	🟨	🟧	🟧	🟧	🟧	🟥	🟥	🟥	🟥	🟥	🟦	🟦	🟦	🟪	🟪
1000+	-					🟨	🟨	🟨	🟨	🟨	🟨	🟧	🟧	🟧	🟧	🟧	🟦	🟦	🟦	🟦	🟪

🟨 : Tier 1 🟧 : Tier 2 🟥 : Tier 3 🟦🟪 : Tier 4 Interim / Final

Using the information from Table E-1, the following pages provide charts of different queries run in the In-Use Off-Road Equipment Model for the San Francisco Bay Area Air Basin (SFBAAB) that were analyzed in determining feasibility of requiring equipment to have engines that meet different emission standards (tiers).



SFBAAB All Fleet Sizes (Pieces of Equipment) - 2010

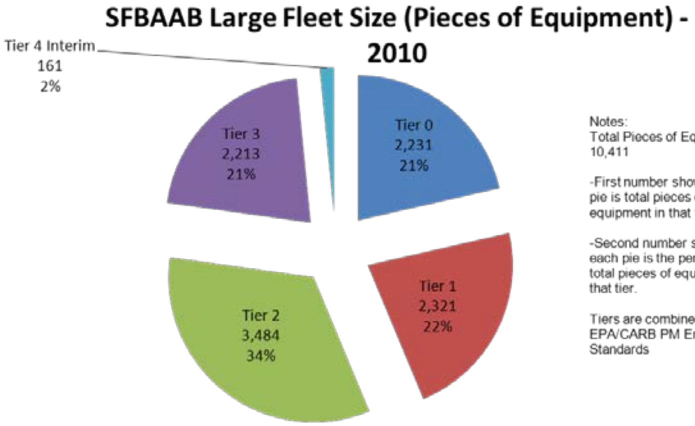
Notes:
Total Pieces of Equipment - 21,377

-First number shown in each pie is total pieces of equipment in that tier.

-Second number shown in each pie is the percent of total pieces of equipment in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category



SFBAAB Large Fleet Size (Pieces of Equipment) - 2010

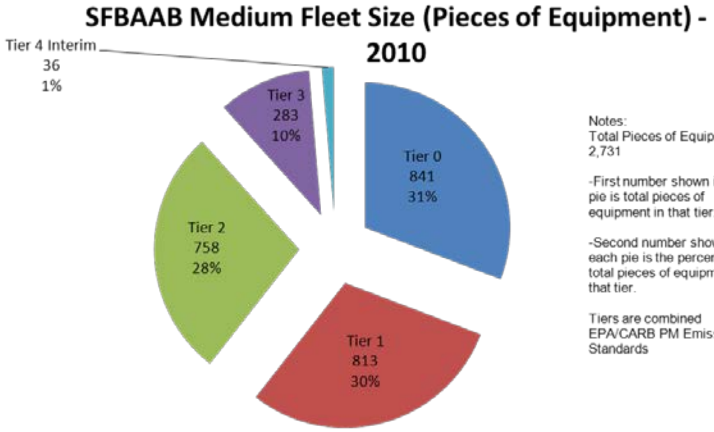
Notes:
Total Pieces of Equipment - 10,411

-First number shown in each pie is total pieces of equipment in that tier.

-Second number shown in each pie is the percent of total pieces of equipment in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category



SFBAAB Medium Fleet Size (Pieces of Equipment) - 2010

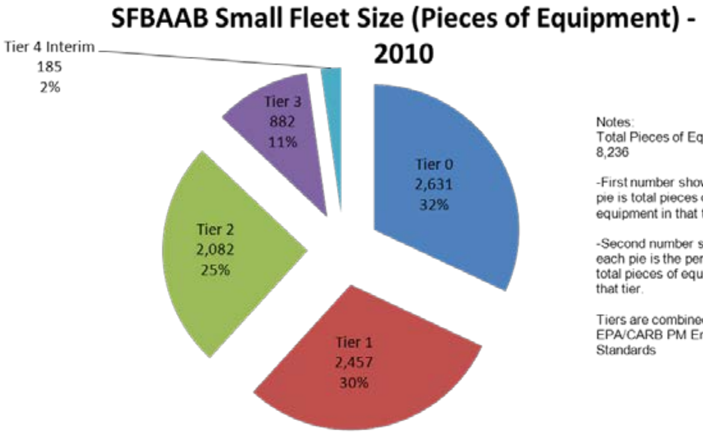
Notes:
Total Pieces of Equipment - 2,731

-First number shown in each pie is total pieces of equipment in that tier.

-Second number shown in each pie is the percent of total pieces of equipment in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category



SFBAAB Small Fleet Size (Pieces of Equipment) - 2010

Notes:
Total Pieces of Equipment - 8,236

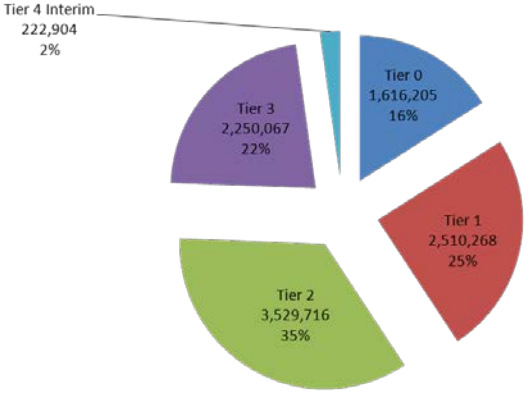
-First number shown in each pie is total pieces of equipment in that tier.

-Second number shown in each pie is the percent of total pieces of equipment in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB All Fleet Sizes (Activity Hours) - 2010



Notes:
Total Activity Hours - 10,129,160

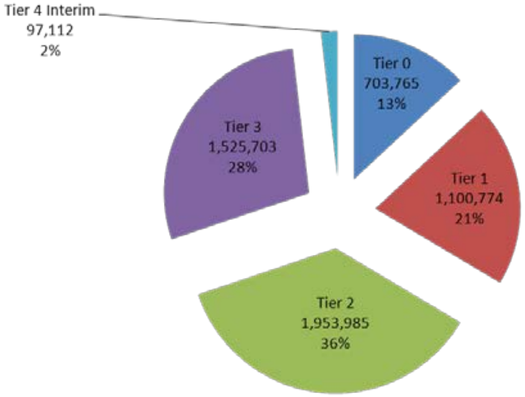
-First number shown in each pie is total activity hours in that tier.

-Second number shown in each pie is the percent of total activity hours in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB Large Fleet Size (Activity Hours) - 2010



Notes:
Total Activity Hours- 5,381,340

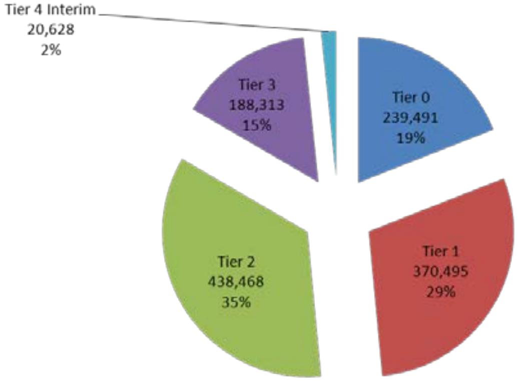
-First number shown in each pie is total activity hours in that tier.

-Second number shown in each pie is the percent of total activity hours in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB Medium Fleet Size (Activity Hours) - 2010



Notes:
Total Activity Hours - 1,257,396

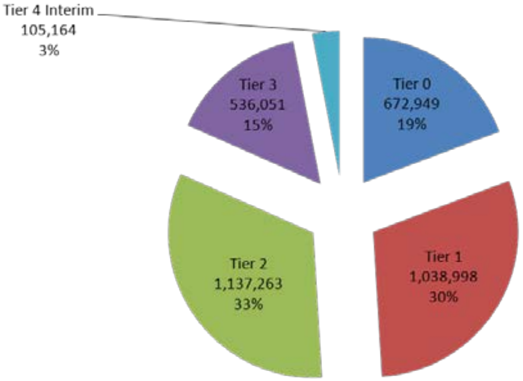
-First number shown in each pie is total activity hours in that tier.

-Second number shown in each pie is the percent of total activity hours in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB Small Fleet Size (Activity Hours) - 2010



Notes:
Total Activity Hours - 3,490,425

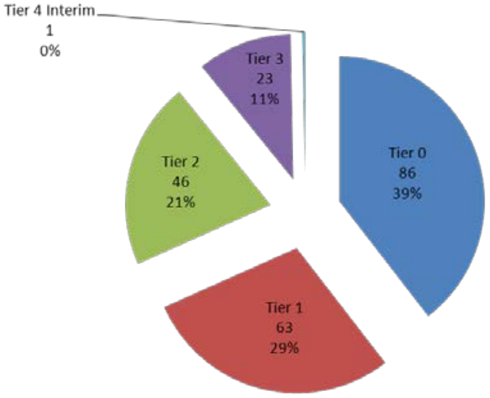
-First number shown in each pie is total activity hours in that tier.

-Second number shown in each pie is the percent of total activity hours in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB All Fleet Sizes (PM10 Emissions) - 2010



Notes:
Total PM10 Emissions - 219 tons

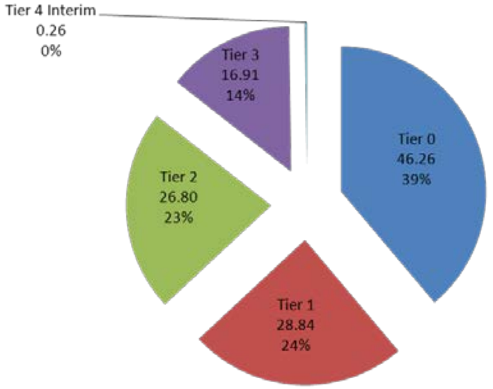
-First number shown in each pie is total PM10 emissions in that tier.

-Second number shown in each pie is the percent of total PM10 emissions in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB Large Fleet Size (PM10 Emissions) - 2010



Notes:
Total PM10 Emissions - 119 tons

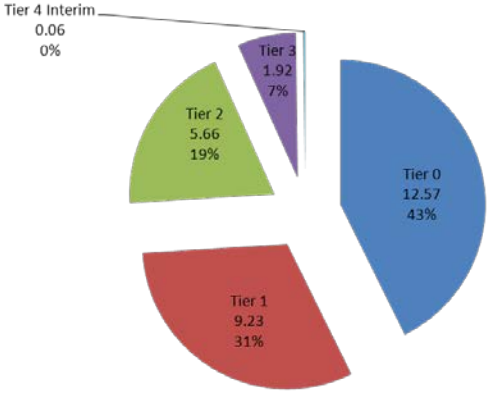
-First number shown in each pie is total PM10 emissions in that tier.

-Second number shown in each pie is the percent of total PM10 emissions in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB Medium Fleet Size (PM10 Emissions) - 2010



Notes:
Total PM10 Emissions - 29 tons

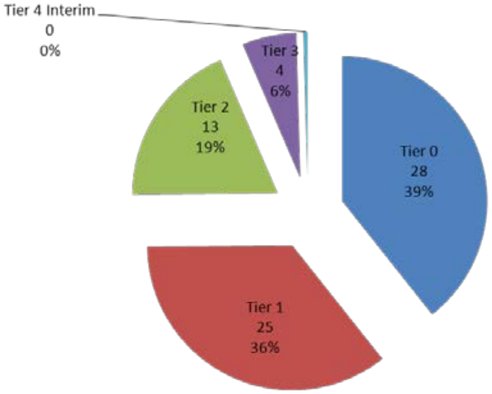
-First number shown in each pie is total PM10 emissions in that tier.

-Second number shown in each pie is the percent of total PM10 emissions in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB Small Fleet Size (PM10 Emissions) - 2010



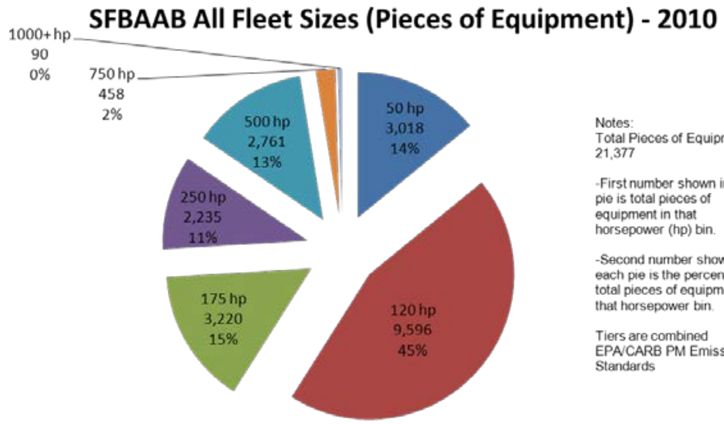
Notes:
Total PM10 Emissions - 70 tons

-First number shown in each pie is total PM10 emissions in that tier.

-Second number shown in each pie is the percent of total PM10 emissions in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category



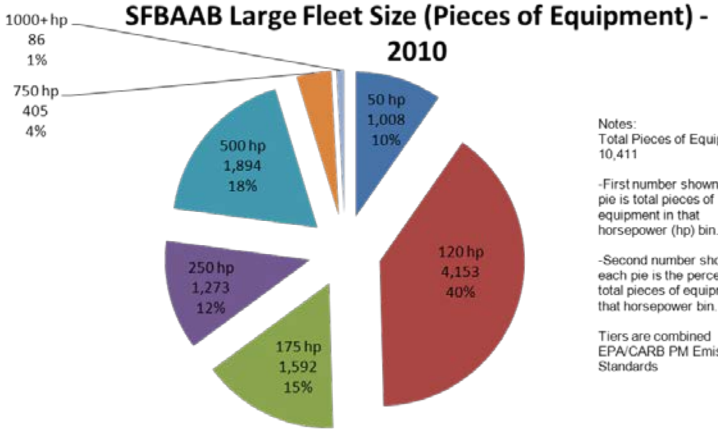
Notes:
Total Pieces of Equipment - 21,377

-First number shown in each pie is total pieces of equipment in that horsepower (hp) bin.

-Second number shown in each pie is the percent of total pieces of equipment in that horsepower bin.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category



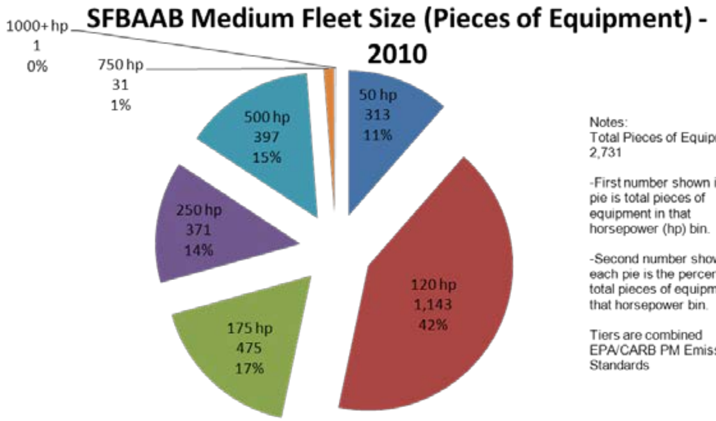
Notes:
Total Pieces of Equipment - 10,411

-First number shown in each pie is total pieces of equipment in that horsepower (hp) bin.

-Second number shown in each pie is the percent of total pieces of equipment in that horsepower bin.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category



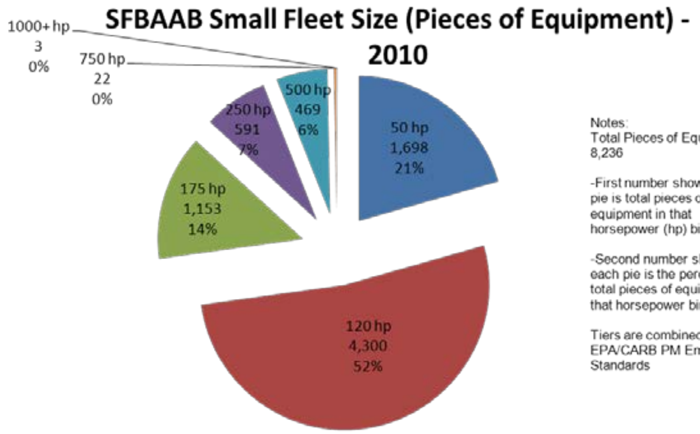
Notes:
Total Pieces of Equipment - 2,731

-First number shown in each pie is total pieces of equipment in that horsepower (hp) bin.

-Second number shown in each pie is the percent of total pieces of equipment in that horsepower bin.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category



Notes:
Total Pieces of Equipment - 8,236

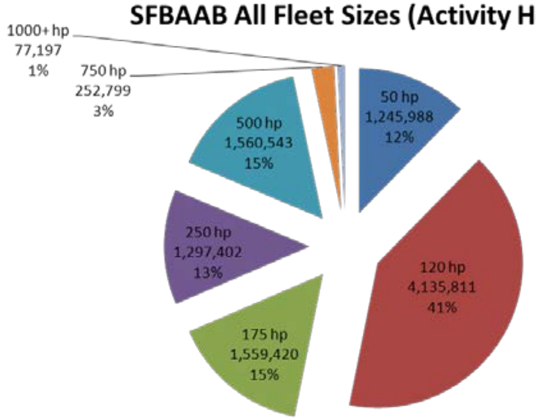
-First number shown in each pie is total pieces of equipment in that horsepower (hp) bin.

-Second number shown in each pie is the percent of total pieces of equipment in that horsepower bin.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB All Fleet Sizes (Activity Hours) - 2010



Notes:
Total Activity Hours - 10,129,160

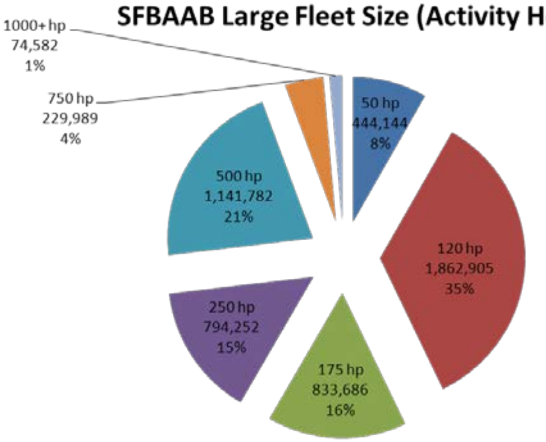
-First number shown in each pie is total activity hours in that horsepower (hp) bin.

-Second number shown in each pie is the percent of total activity hours in that horsepower bin.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category.

SFBAAB Large Fleet Size (Activity Hours) - 2010



Notes:
Total Activity Hours - 5,381,340

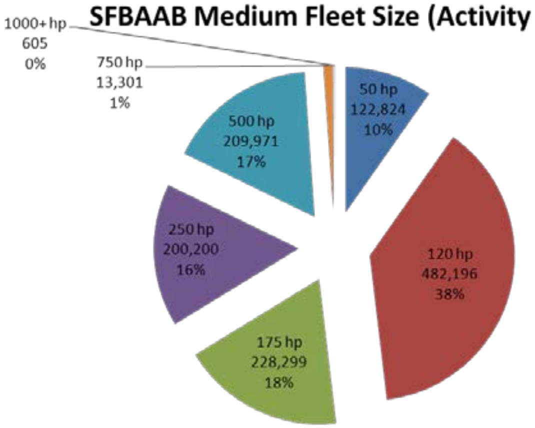
-First number shown in each pie is total activity hours in that horsepower (hp) bin.

-Second number shown in each pie is the percent of total activity hours in that horsepower bin.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category.

SFBAAB Medium Fleet Size (Activity Hours) - 2010



Notes:
Total Activity Hours - 1,257,396

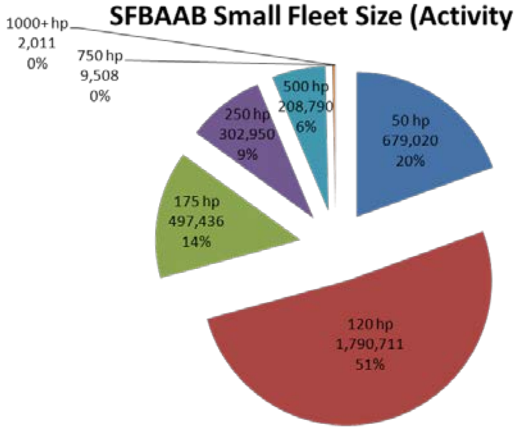
-First number shown in each pie is total activity hours in that horsepower (hp) bin.

-Second number shown in each pie is the percent of total activity hours in that hp bin.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category.

SFBAAB Small Fleet Size (Activity Hours) - 2010



Notes:
Total Activity Hours - 3,490,425

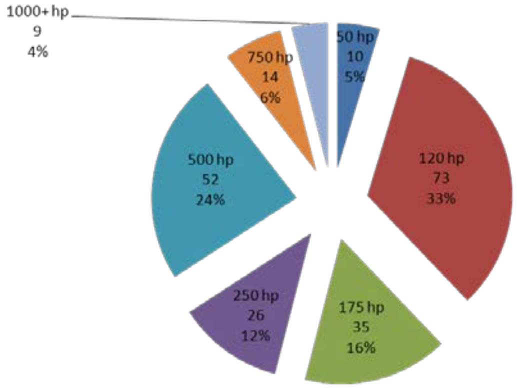
-First number shown in each pie is total activity hours in that horsepower (hp) bin.

-Second number shown in each pie is the percent of total activity hours in that horsepower bin.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category.

SFBAAB All Fleet Sizes (PM10 Emissions) - 2010



Notes:
Total PM10 Emissions - 219 tons

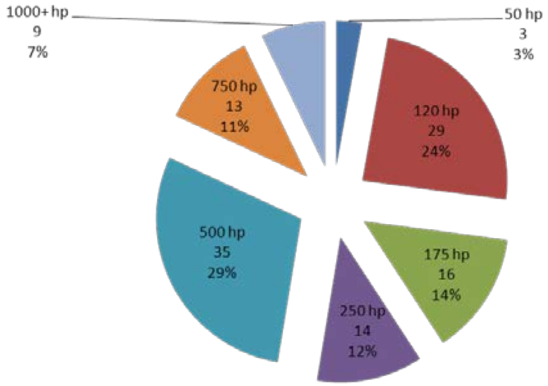
-First number shown in each pie is total PM10 emissions in that horsepower (hp) bin.

-Second number shown in each pie is the percent of total PM10 emissions in that horsepower bin.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB Large Fleet Size (PM10 Emissions) - 2010



Notes:
Total PM10 Emissions - 119 tons

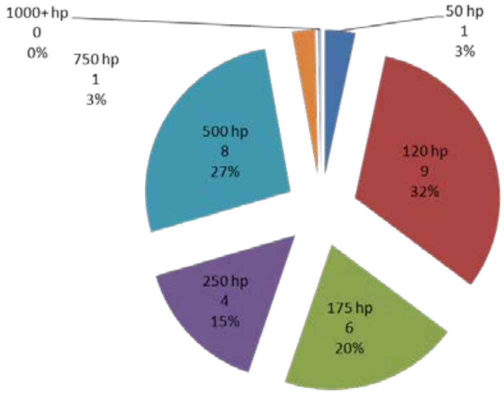
-First number shown in each pie is total PM10 emissions in that horsepower (hp) bin.

-Second number shown in each pie is the percent of total PM10 emissions in that horsepower bin.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB Medium Fleet Size (PM10 Emissions) - 2010



Notes:
Total PM10 Emissions - 29 tons

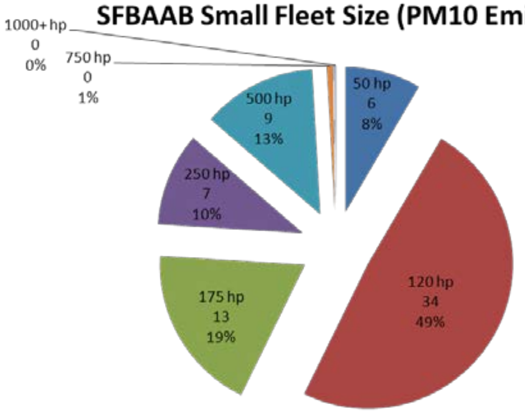
-First number shown in each pie is total PM10 emissions in that horsepower (hp) bin.

-Second number shown in each pie is the percent of total PM10 emissions in that horsepower bin.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB Small Fleet Size (PM10 Emissions) - 2010



Notes:
Total PM10 Emissions - 70 tons

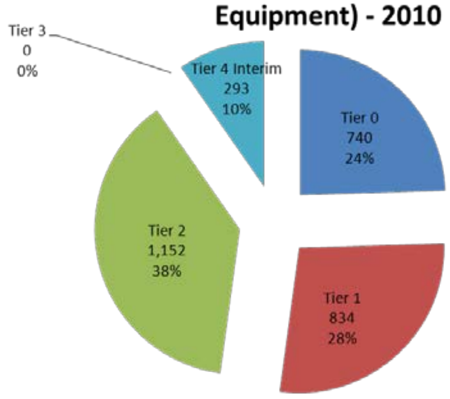
-First number shown in each pie is total PM10 emissions in that horsepower (hp) bin.

-Second number shown in each pie is the percent of total PM10 emissions in that horsepower bin.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB All Fleet Sizes - 50 HP Bin (Pieces of Equipment) - 2010



Notes:
Total Pieces of Equipment - 3,018

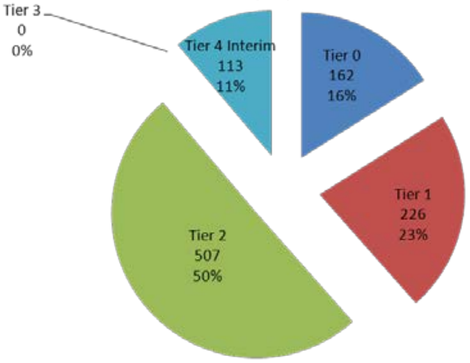
-First number shown in each pie is total pieces of equipment in that tier.

-Second number shown in each pie is the percent of total pieces of equipment in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB Large Fleet Size- 50 HP Bin (Pieces of Equipment) - 2010



Notes:
Total Pieces of Equipment - 1,008

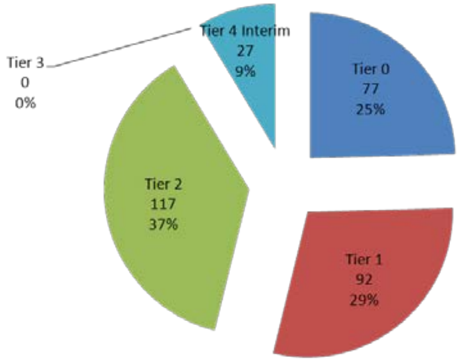
-First number shown in each pie is total pieces of equipment in that tier.

-Second number shown in each pie is the percent of total pieces of equipment in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB Medium Fleet Size- 50 HP Bin (Pieces of Equipment) - 2010



Notes:
Total Pieces of Equipment - 313

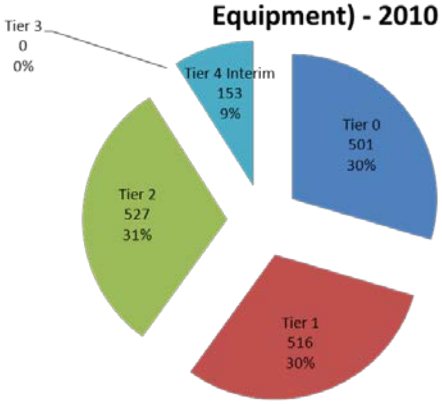
-First number shown in each pie is total pieces of equipment in that tier.

-Second number shown in each pie is the percent of total pieces of equipment in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB Small Fleet Size- 50 HP Bin (Pieces of Equipment) - 2010



Notes:
Total Pieces of Equipment - 1,698

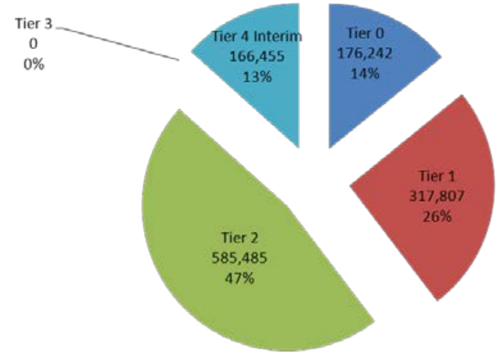
-First number shown in each pie is total pieces of equipment in that tier.

-Second number shown in each pie is the percent of total pieces of equipment in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB All Fleet Sizes - 50 HP Bin (Activity Hours) - 2010



Notes:
Total Activity Hours - 1,245,988

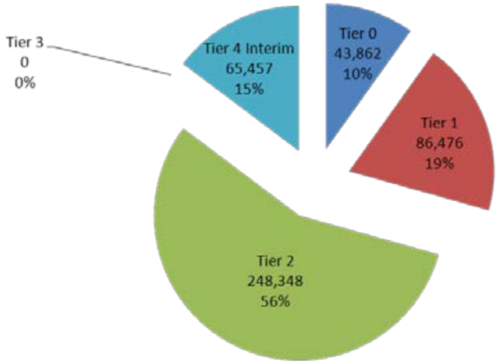
-First number shown in each pie is total activity hours in that tier.

-Second number shown in each pie is the percent of total activity hours in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB Large Fleet Size- 50 HP Bin (Activity Hours) - 2010



Notes:
Total Activity Hours - 444,144

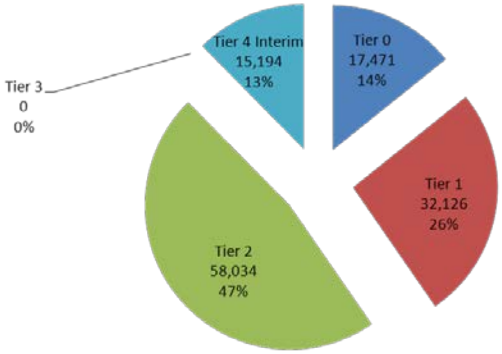
-First number shown in each pie is total activity hours in that tier.

-Second number shown in each pie is the percent of total activity hours in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB Medium Fleet Size- 50 HP Bin (Activity Hours) - 2010



Notes:
Total Activity Hours - 122,824

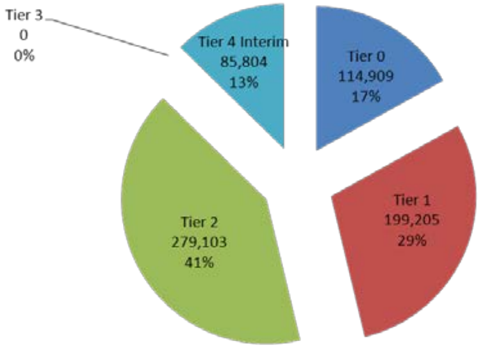
-First number shown in each pie is total activity hours in that tier.

-Second number shown in each pie is the percent of total activity hours in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB Small Fleet Size- 50 HP Bin (Activity Hours) - 2010



Notes:
Total Activity Hours - 679,020

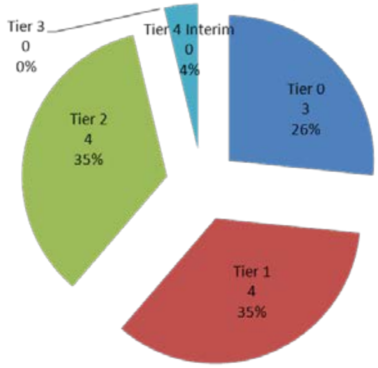
-First number shown in each pie is total activity hours in that tier.

-Second number shown in each pie is the percent of total pieces of equipment in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB All Fleet Sizes - 50 HP Bin (PM10 Emissions) - 2010



Notes:
Total PM10 Emissions - 10 tons

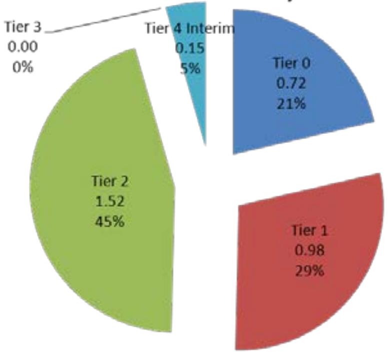
-First number shown in each pie is total PM10 emissions in that tier.

-Second number shown in each pie is the percent of total PM10 emissions in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category.

SFBAAB Large Fleet Size - 50 HP Bin (PM10 Emissions) - 2010



Notes:
Total PM10 Emissions - 3 tons

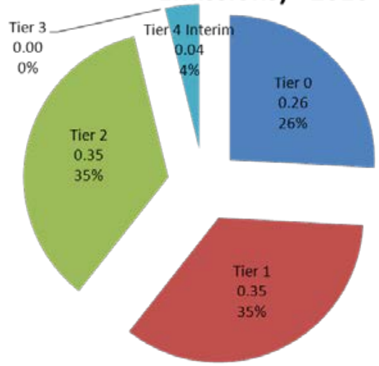
-First number shown in each pie is total PM10 emissions in that tier.

-Second number shown in each pie is the percent of total PM10 emissions in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category.

SFBAAB Medium Fleet Size - 50 HP Bin (PM10 Emissions) - 2010



Notes:
Total PM10 Emissions - 1 ton

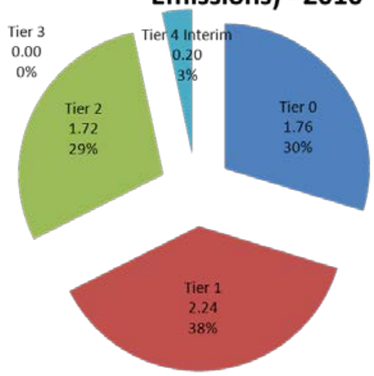
-First number shown in each pie is total PM10 emissions in that tier.

-Second number shown in each pie is the percent of total PM10 emissions in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category.

SFBAAB Small Fleet Size - 50 HP Bin (PM10 Emissions) - 2010



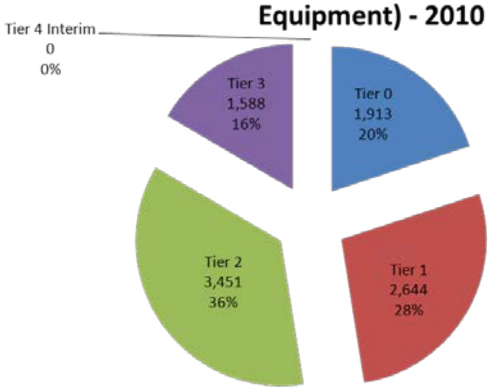
Notes:
Total PM10 Emissions - 6 tons

-First number shown in each pie is total PM10 emissions in that tier.

-Second number shown in each pie is the percent of total PM10 emissions in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category.



SFBAAB All Fleet Sizes - 120 HP Bin (Pieces of Equipment) - 2010

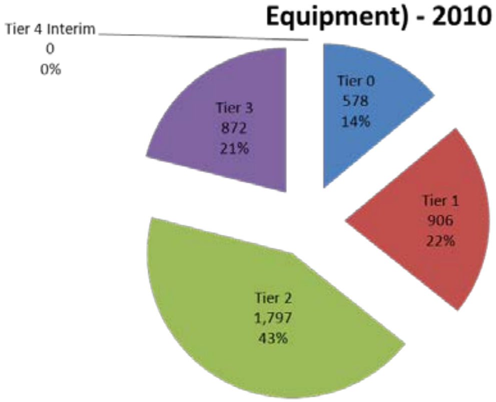
Notes:
Total Pieces of Equipment - 9,596

-First number shown in each pie is total pieces of equipment in that tier.

-Second number shown in each pie is the percent of total pieces of equipment in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category



SFBAAB Large Fleet Size- 120 HP Bin (Pieces of Equipment) - 2010

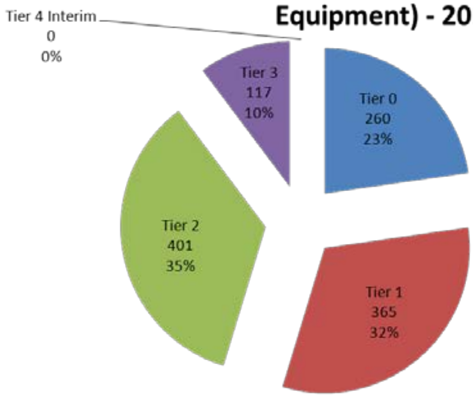
Notes:
Total Pieces of Equipment - 4,153

-First number shown in each pie is total pieces of equipment in that tier.

-Second number shown in each pie is the percent of total pieces of equipment in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category



SFBAAB Medium Fleet Size- 120 HP Bin (Pieces of Equipment) - 2010

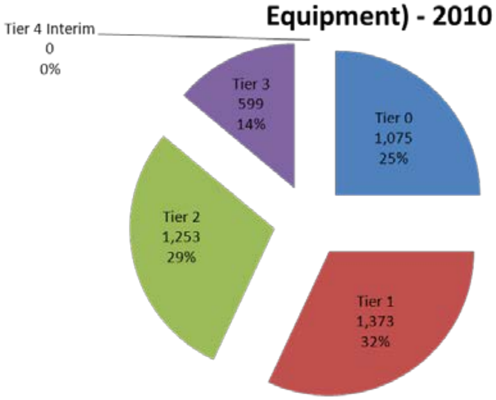
Notes:
Total Pieces of Equipment - 1,143

-First number shown in each pie is total pieces of equipment in that tier.

-Second number shown in each pie is the percent of total pieces of equipment in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category



SFBAAB Small Fleet Size- 120 HP Bin (Pieces of Equipment) - 2010

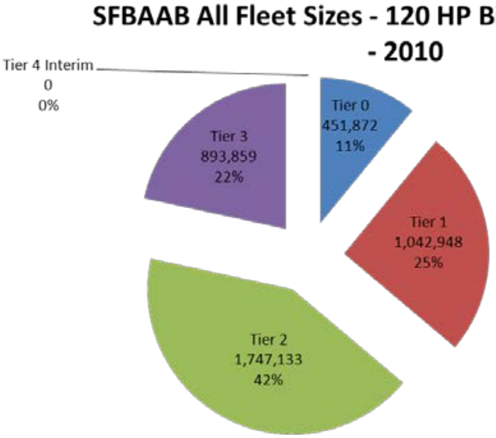
Notes:
Total Pieces of Equipment - 4,300

-First number shown in each pie is total pieces of equipment in that tier.

-Second number shown in each pie is the percent of total pieces of equipment in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category


SFBAAB All Fleet Sizes - 120 HP Bin (Activity Hours) - 2010

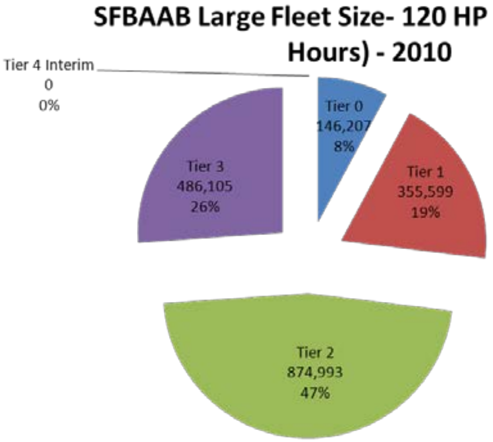
Notes:
Total Activity Hours - 4,135,811

-First number shown in each pie is total activity hours in that tier.

-Second number shown in each pie is the percent of total activity hours in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category


SFBAAB Large Fleet Size- 120 HP Bin (Activity Hours) - 2010

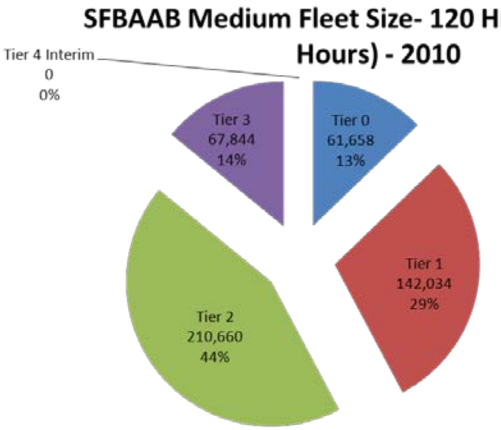
Notes:
Total Activity Hours - 1,862,905

-First number shown in each pie is total activity hours in that tier.

-Second number shown in each pie is the percent of total activity hours in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category


SFBAAB Medium Fleet Size- 120 HP Bin (Activity Hours) - 2010

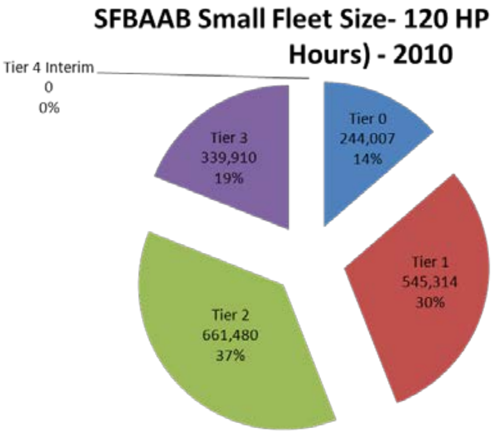
Notes:
Total Activity Hours - 482,196

-First number shown in each pie is total activity hours in that tier.

-Second number shown in each pie is the percent of total activity hours in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category


SFBAAB Small Fleet Size- 120 HP Bin (Activity Hours) - 2010

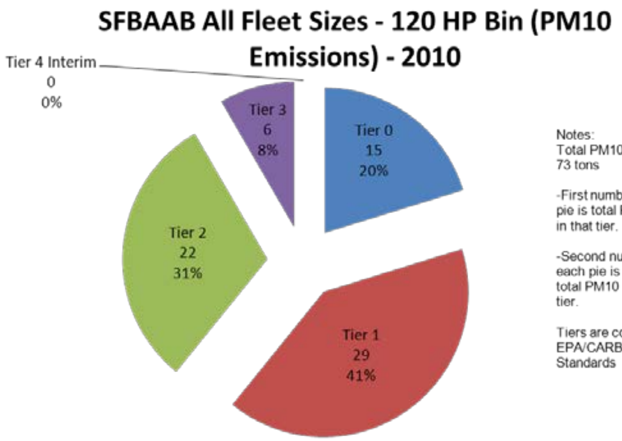
Notes:
Total Activity Hours - 1,790,711

-First number shown in each pie is total activity hours in that tier.

-Second number shown in each pie is the percent of total activity hours in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category



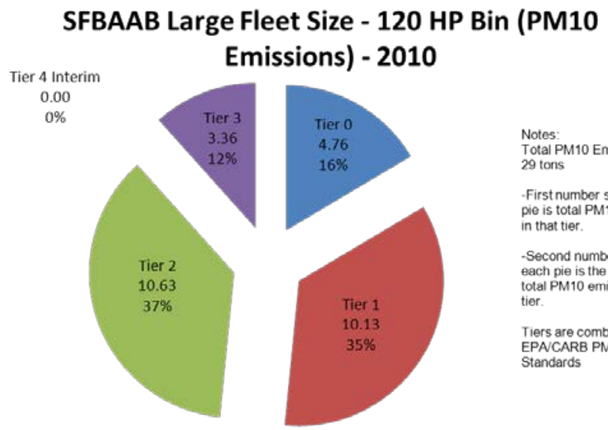
Notes:
Total PM10 Emissions - 73 tons

-First number shown in each pie is total PM10 emissions in that tier.

-Second number shown in each pie is the percent of total PM10 emissions in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category



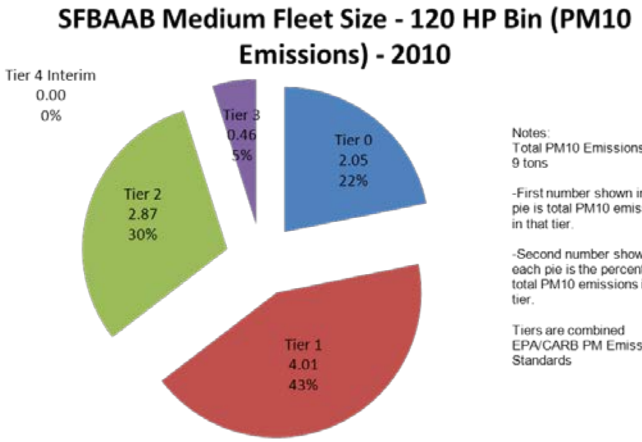
Notes:
Total PM10 Emissions - 29 tons

-First number shown in each pie is total PM10 emissions in that tier.

-Second number shown in each pie is the percent of total PM10 emissions in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category



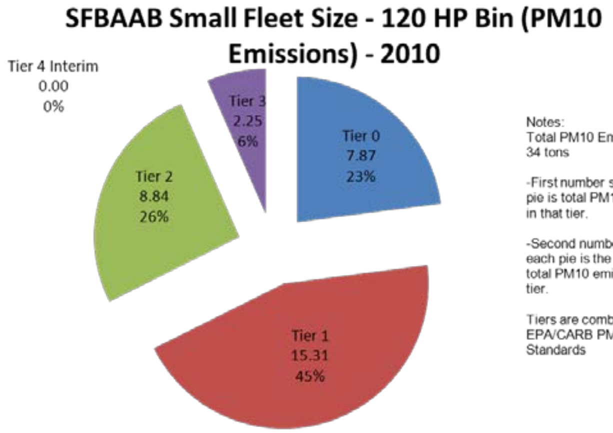
Notes:
Total PM10 Emissions - 9 tons

-First number shown in each pie is total PM10 emissions in that tier.

-Second number shown in each pie is the percent of total PM10 emissions in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category



Notes:
Total PM10 Emissions - 34 tons

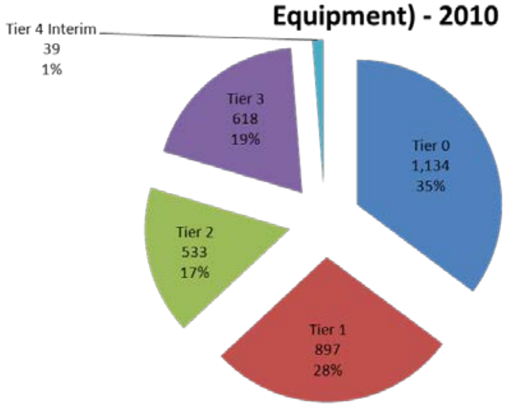
-First number shown in each pie is total PM10 emissions in that tier.

-Second number shown in each pie is the percent of total PM10 emissions in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB All Fleet Sizes - 175 HP Bin (Pieces of Equipment) - 2010



Notes:
Total Pieces of Equipment - 3,220

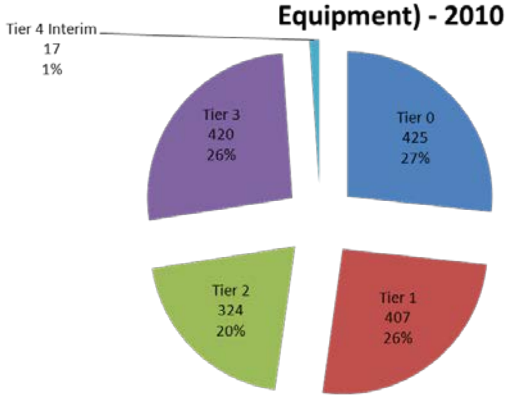
-First number shown in each pie is total pieces of equipment in that tier.

-Second number shown in each pie is the percent of total pieces of equipment in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB Large Fleet Size- 175 HP Bin (Pieces of Equipment) - 2010



Notes:
Total Pieces of Equipment - 1,592

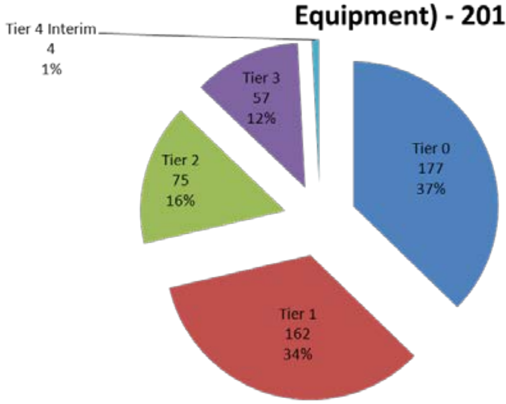
-First number shown in each pie is total pieces of equipment in that tier.

-Second number shown in each pie is the percent of total pieces of equipment in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB Medium Fleet Size- 175 HP Bin (Pieces of Equipment) - 2010



Notes:
Total Pieces of Equipment - 475

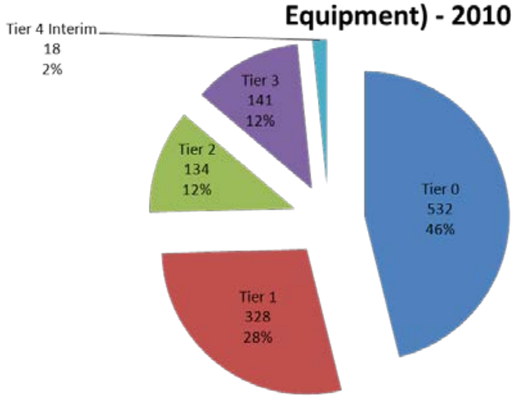
-First number shown in each pie is total pieces of equipment in that tier.

-Second number shown in each pie is the percent of total pieces of equipment in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB Small Fleet Size- 175 HP Bin (Pieces of Equipment) - 2010



Notes:
Total Pieces of Equipment - 1,153

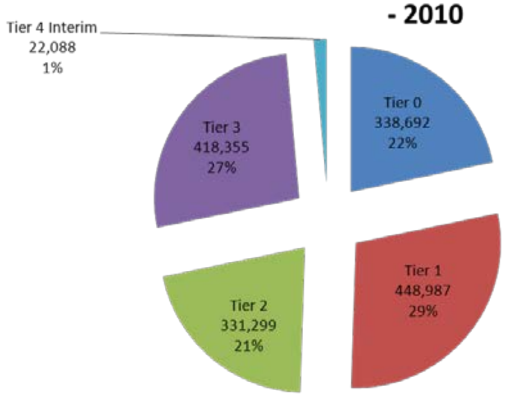
-First number shown in each pie is total pieces of equipment in that tier.

-Second number shown in each pie is the percent of total pieces of equipment in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB All Fleet Sizes - 175 HP Bin (Activity Hours) - 2010



Notes:
Total Activity Hours - 1,559,420

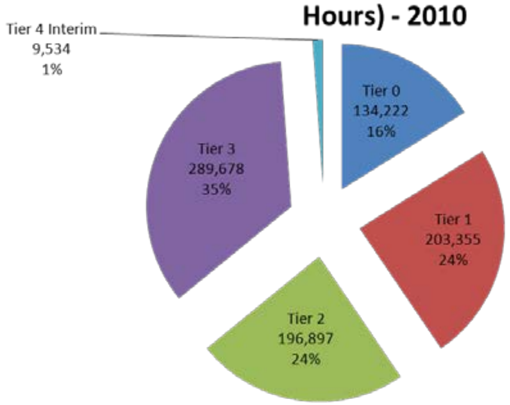
-First number shown in each pie is total activity hours in that tier.

-Second number shown in each pie is the percent of total activity hours in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB Large Fleet Size- 175 HP Bin (Activity Hours) - 2010



Notes:
Total Activity Hours - 833,686

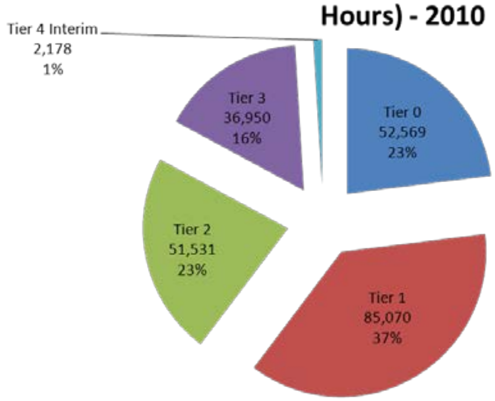
-First number shown in each pie is total activity hours in that tier.

-Second number shown in each pie is the percent of total activity hours in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB Medium Fleet Size- 175 HP Bin (Activity Hours) - 2010



Notes:
Total Activity Hours - 228,299

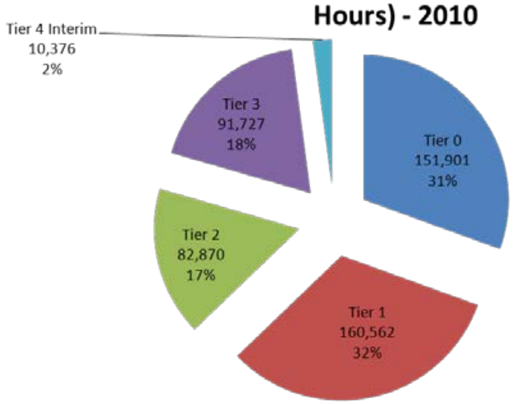
-First number shown in each pie is total activity hours in that tier.

-Second number shown in each pie is the percent of total activity hours in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB Small Fleet Size- 175 HP Bin (Activity Hours) - 2010



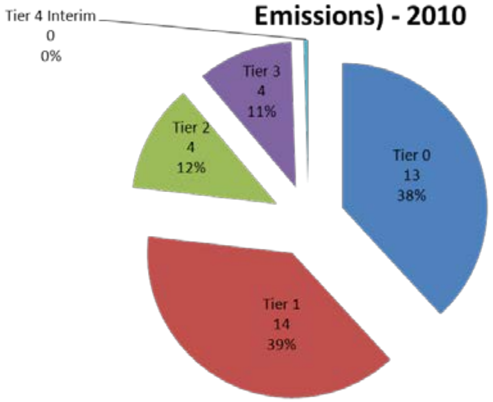
Notes:
Total Activity Hours - 497,436

-First number shown in each pie is total activity hours in that tier.

-Second number shown in each pie is the percent of total activity hours in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category



SFBAAB All Fleet Sizes - 175 HP Bin (PM10 Emissions) - 2010

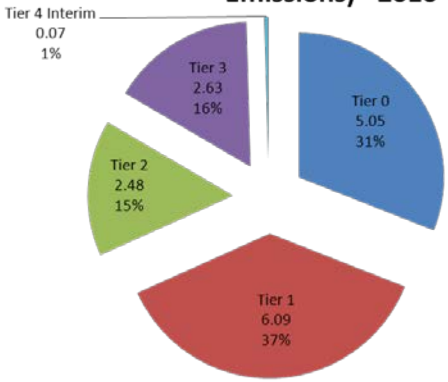
Notes:
Total PM10 Emissions - 35 tons

-First number shown in each pie is total PM10 emissions in that tier.

-Second number shown in each pie is the percent of total PM10 emissions in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category



SFBAAB Large Fleet Size - 175 HP Bin (PM10 Emissions) - 2010

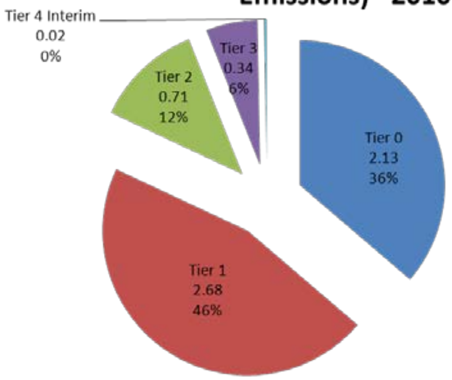
Notes:
Total PM10 Emissions - 16 tons

-First number shown in each pie is total PM10 emissions in that tier.

-Second number shown in each pie is the percent of total PM10 emissions in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category



SFBAAB MediumFleet Size - 175 HP Bin (PM10 Emissions) - 2010

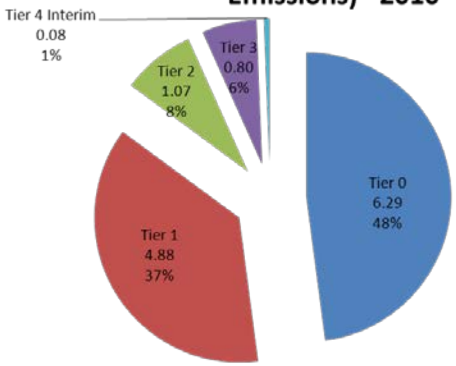
Notes:
Total PM10 Emissions - 6 tons

-First number shown in each pie is total PM10 emissions in that tier.

-Second number shown in each pie is the percent of total PM10 emissions in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category



SFBAAB Small Fleet Size - 175 HP Bin (PM10 Emissions) - 2010

Notes:
Total PM10 Emissions - 13 tons

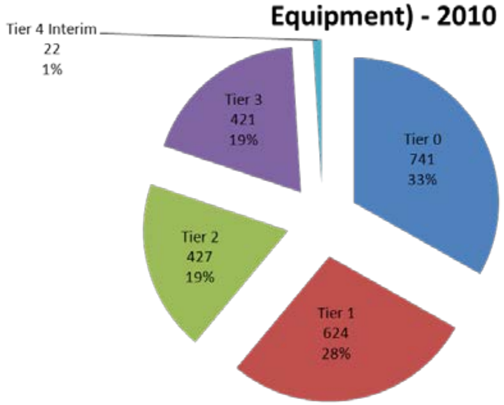
-First number shown in each pie is total PM10 emissions in that tier.

-Second number shown in each pie is the percent of total PM10 emissions in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB All Fleet Sizes - 250 HP Bin (Pieces of Equipment) - 2010



Notes:
Total Pieces of Equipment - 2,235

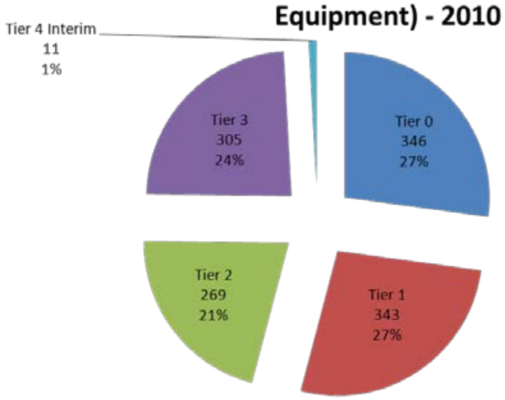
-First number shown in each pie is total pieces of equipment in that tier.

-Second number shown in each pie is the percent of total pieces of equipment in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category.

SFBAAB Large Fleet Size- 250 HP Bin (Pieces of Equipment) - 2010



Notes:
Total Pieces of Equipment - 1,273

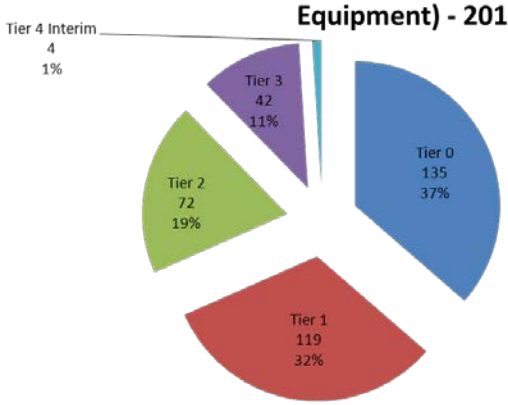
-First number shown in each pie is total pieces of equipment in that tier.

-Second number shown in each pie is the percent of total pieces of equipment in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category.

SFBAAB Medium Fleet Size- 250 HP Bin (Pieces of Equipment) - 2010



Notes:
Total Pieces of Equipment - 371

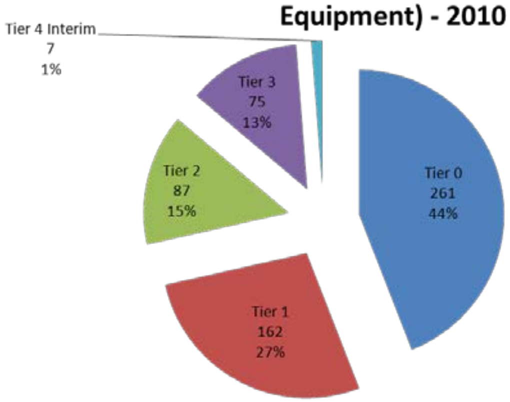
-First number shown in each pie is total pieces of equipment in that tier.

-Second number shown in each pie is the percent of total pieces of equipment in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category.

SFBAAB Small Fleet Size- 250 HP Bin (Pieces of Equipment) - 2010



Notes:
Total Pieces of Equipment - 591

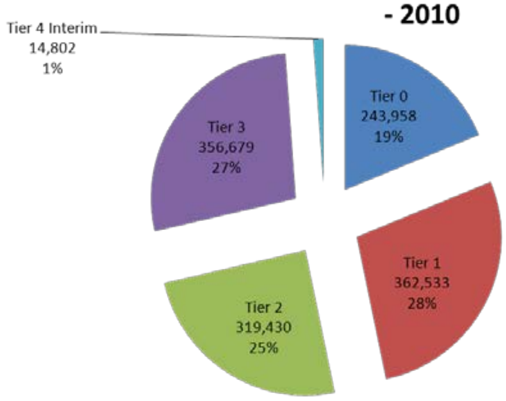
-First number shown in each pie is total pieces of equipment in that tier.

-Second number shown in each pie is the percent of total pieces of equipment in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category.

SFBAAB All Fleet Sizes - 250 HP Bin (Activity Hours) - 2010



Notes:
Total Activity Hours - 1,297,402

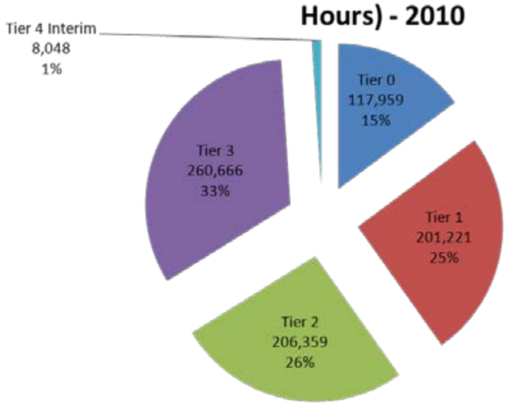
-First number shown in each pie is total activity hours in that tier.

-Second number shown in each pie is the percent of total activity hours in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB Large Fleet Size- 250 HP Bin (Activity Hours) - 2010



Notes:
Total Activity Hours - 794,252

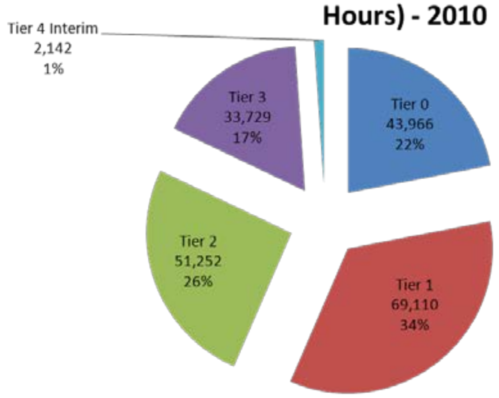
-First number shown in each pie is total activity hours in that tier.

-Second number shown in each pie is the percent of total activity hours in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB Medium Fleet Size- 250 HP Bin (Activity Hours) - 2010



Notes:
Total Activity Hours - 200,200

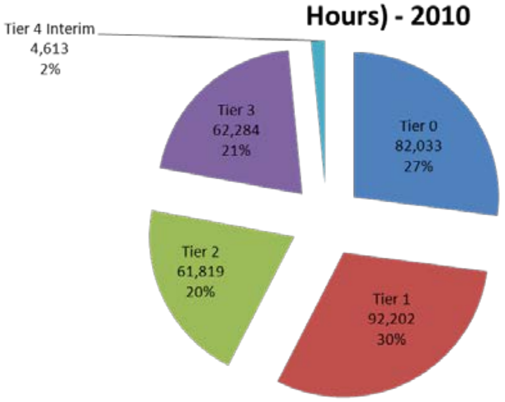
-First number shown in each pie is total activity hours in that tier.

-Second number shown in each pie is the percent of total activity hours in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB Small Fleet Size- 250 HP Bin (Activity Hours) - 2010



Notes:
Total Activity Hours - 302,950

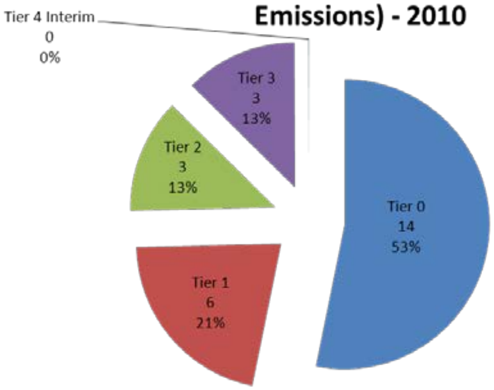
-First number shown in each pie is total activity hours in that tier.

-Second number shown in each pie is the percent of total activity hours in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB All Fleet Sizes - 250 HP Bin (PM10 Emissions) - 2010



Notes:
Total PM10 Emissions - 26 tons

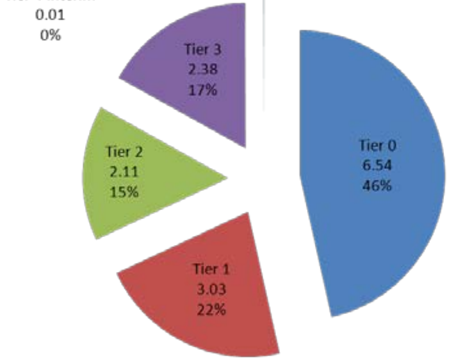
-First number shown in each pie is total PM10 emissions in that tier.

-Second number shown in each pie is the percent of total PM10 emissions in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB Large Fleet Size - 250 HP Bin (PM10 Emissions) - 2010



Notes:
Total PM10 Emissions - 14 tons

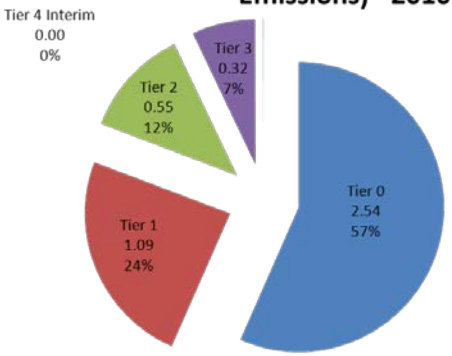
-First number shown in each pie is total PM10 emissions in that tier.

-Second number shown in each pie is the percent of total PM10 emissions in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB Medium Fleet Size - 250 HP Bin (PM10 Emissions) - 2010



Notes:
Total PM10 Emissions - 4 tons

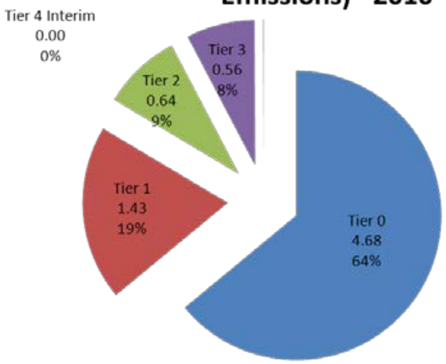
-First number shown in each pie is total PM10 emissions in that tier.

-Second number shown in each pie is the percent of total PM10 emissions in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB Small Fleet Size - 250 HP Bin (PM10 Emissions) - 2010



Notes:
Total PM10 Emissions - 7 tons

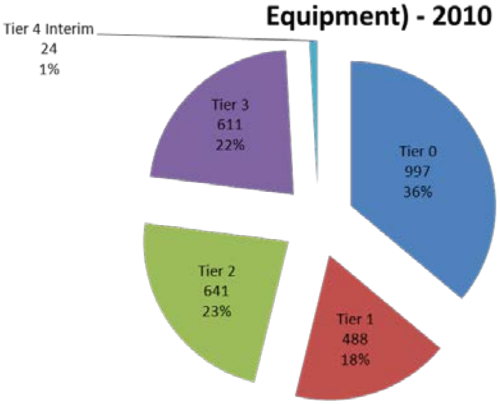
-First number shown in each pie is total PM10 emissions in that tier.

-Second number shown in each pie is the percent of total PM10 emissions in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB All Fleet Sizes - 500 HP Bin (Pieces of Equipment) - 2010



Notes:
Total Pieces of Equipment - 2,761

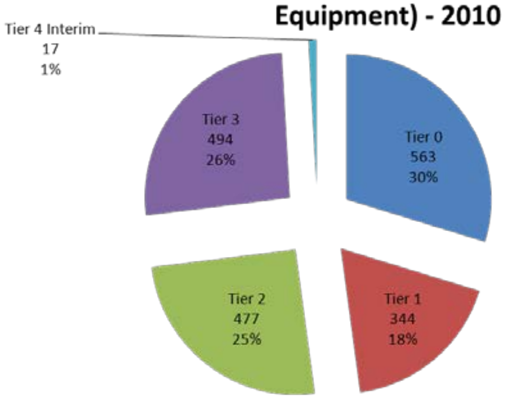
-First number shown in each pie is total pieces of equipment in that tier.

-Second number shown in each pie is the percent of total pieces of equipment in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB Large Fleet Size- 500 HP Bin (Pieces of Equipment) - 2010



Notes:
Total Pieces of Equipment - 1,894

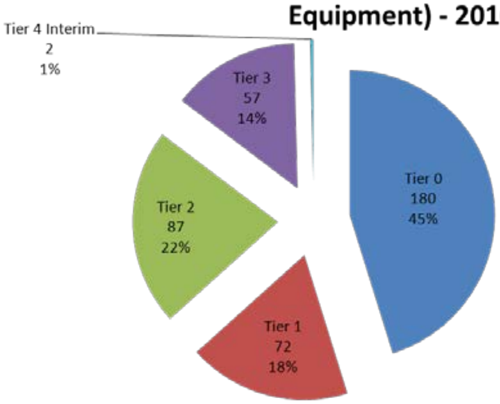
-First number shown in each pie is total pieces of equipment in that tier.

-Second number shown in each pie is the percent of total pieces of equipment in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB Medium Fleet Size- 500 HP Bin (Pieces of Equipment) - 2010



Notes:
Total Pieces of Equipment - 397

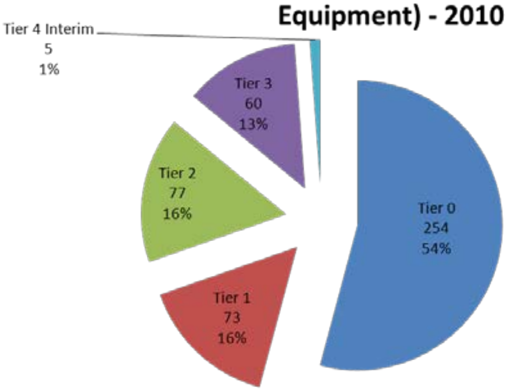
-First number shown in each pie is total pieces of equipment in that tier.

-Second number shown in each pie is the percent of total pieces of equipment in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB Small Fleet Size- 500 HP Bin (Pieces of Equipment) - 2010



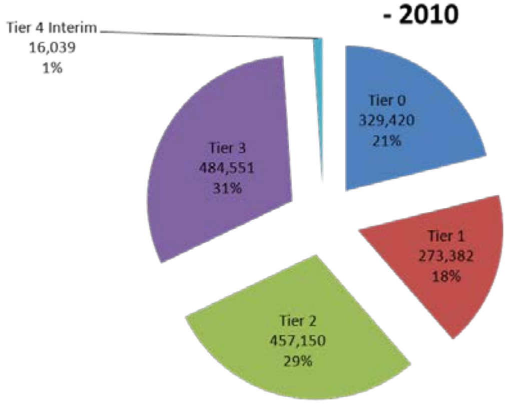
Notes:
Total Pieces of Equipment - 469

-First number shown in each pie is total pieces of equipment in that tier.

-Second number shown in each pie is the percent of total pieces of equipment in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category



SFBAAB All Fleet Sizes - 500 HP Bin (Activity Hours) - 2010

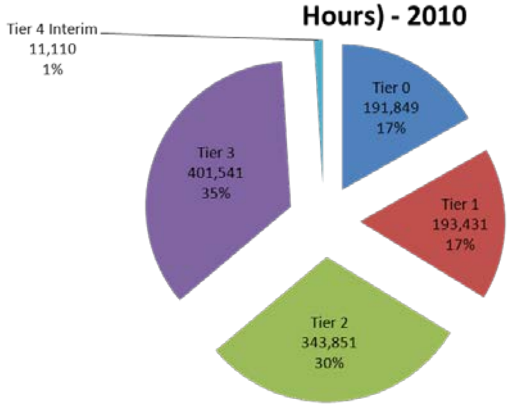
Notes:
Total Activity Hours - 1,560,543

-First number shown in each pie is total activity hours in that tier.

-Second number shown in each pie is the percent of total activityhours in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category.



SFBAAB Large Fleet Size- 500 HP Bin (Activity Hours) - 2010

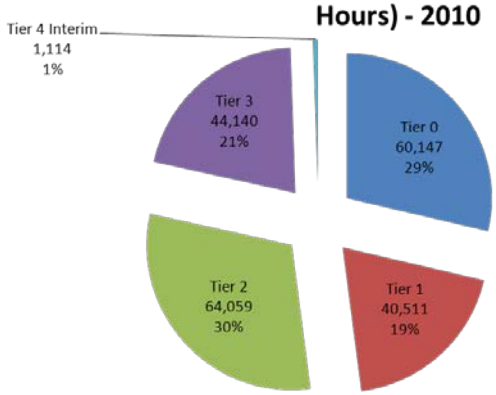
Notes:
Total Activity Hours - 1,141,782

-First number shown in each pie is total activity hours in that tier.

-Second number shown in each pie is the percent of total activity hours in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category.



SFBAAB Medium Fleet Size- 500 HP Bin (Activity Hours) - 2010

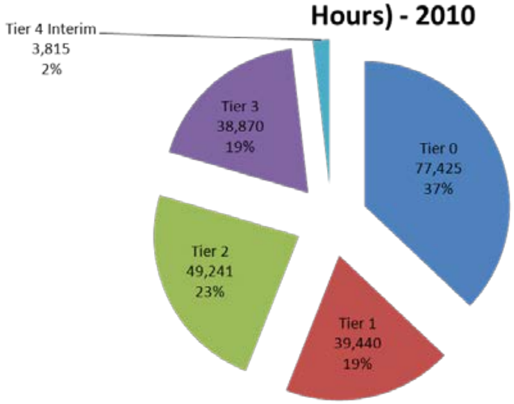
Notes:
Total Activity Hours - 209,971

-First number shown in each pie is total activity hours in that tier.

-Second number shown in each pie is the percent of total activity hours in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category.



SFBAAB Small Fleet Size- 500 HP Bin (Activity Hours) - 2010

Notes:
Total Activity Hours - 208,790

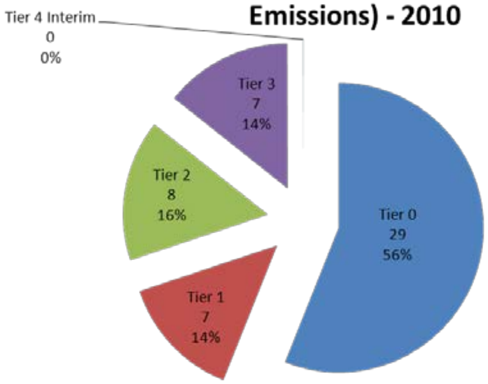
-First number shown in each pie is total activity hours in that tier.

-Second number shown in each pie is the percent of total activity hours in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category.

SFBAAB All Fleet Sizes - 500 HP Bin (PM10 Emissions) - 2010



Notes:
Total PM10 Emissions - 52 tons

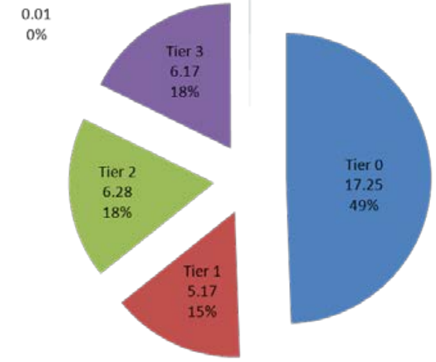
-First number shown in each pie is total PM10 emissions in that tier.

-Second number shown in each pie is the percent of total PM10 emissions in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category.

SFBAAB Large Fleet Size - 500 HP Bin (PM10 Emissions) - 2010



Notes:
Total PM10 Emissions - 35 tons

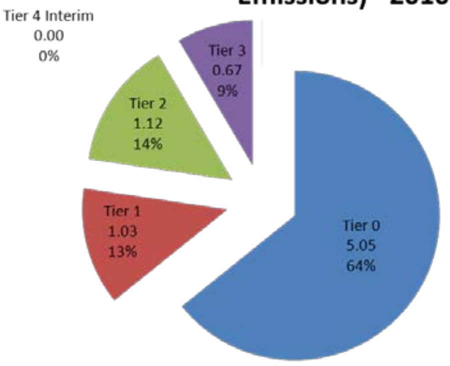
-First number shown in each pie is total PM10 emissions in that tier.

-Second number shown in each pie is the percent of total PM10 emissions in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category.

SFBAAB Medium Fleet Size - 500 HP Bin (PM10 Emissions) - 2010



Notes:
Total PM10 Emissions - 8 tons

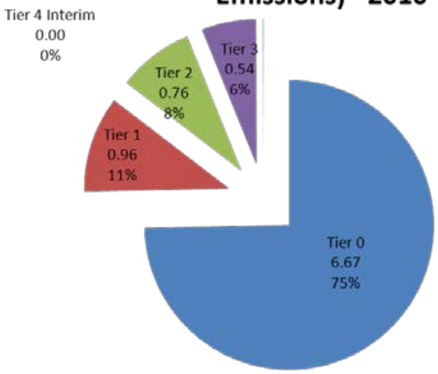
-First number shown in each pie is total PM10 emissions in that tier.

-Second number shown in each pie is the percent of total PM10 emissions in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category.

SFBAAB Small Fleet Size - 500 HP Bin (PM10 Emissions) - 2010



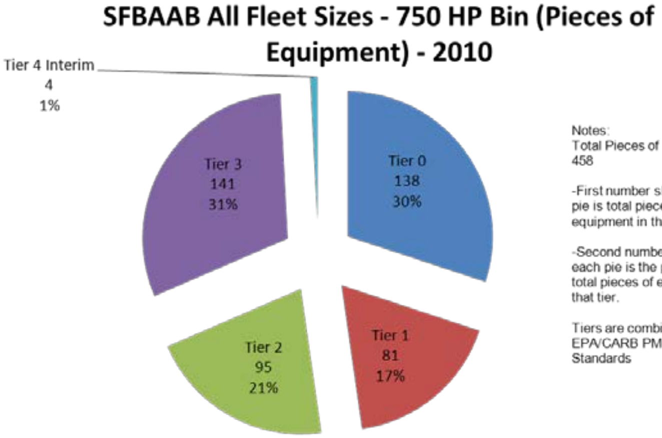
Notes:
Total PM10 Emissions - 9 tons

-First number shown in each pie is total PM10 emissions in that tier.

-Second number shown in each pie is the percent of total PM10 emissions in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category.



SFBAAB All Fleet Sizes - 750 HP Bin (Pieces of Equipment) - 2010

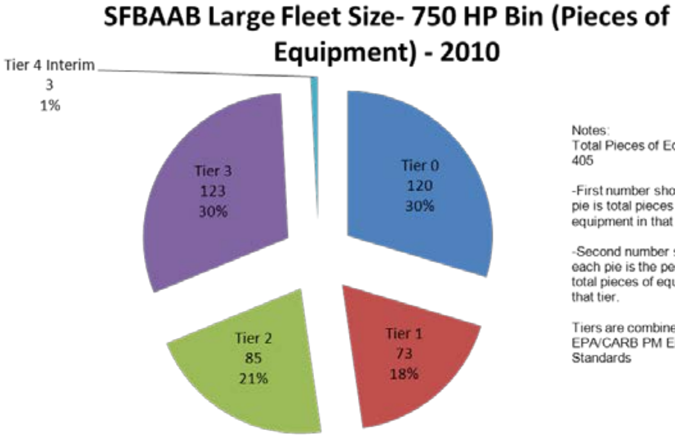
Notes:
Total Pieces of Equipment - 458

-First number shown in each pie is total pieces of equipment in that tier.

-Second number shown in each pie is the percent of total pieces of equipment in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category



SFBAAB Large Fleet Size- 750 HP Bin (Pieces of Equipment) - 2010

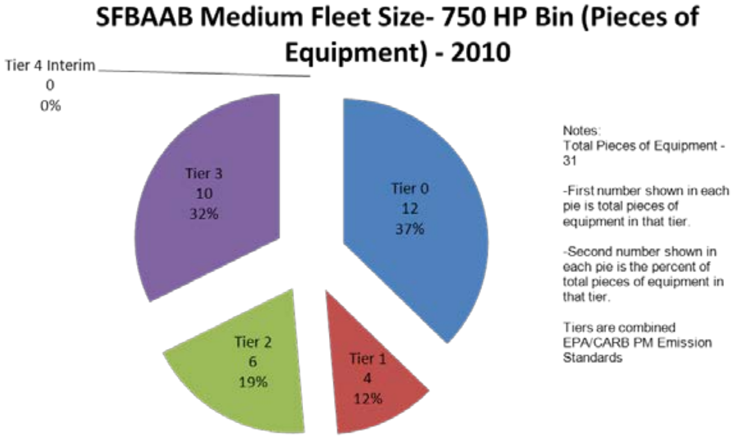
Notes:
Total Pieces of Equipment - 405

-First number shown in each pie is total pieces of equipment in that tier.

-Second number shown in each pie is the percent of total pieces of equipment in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category



SFBAAB Medium Fleet Size- 750 HP Bin (Pieces of Equipment) - 2010

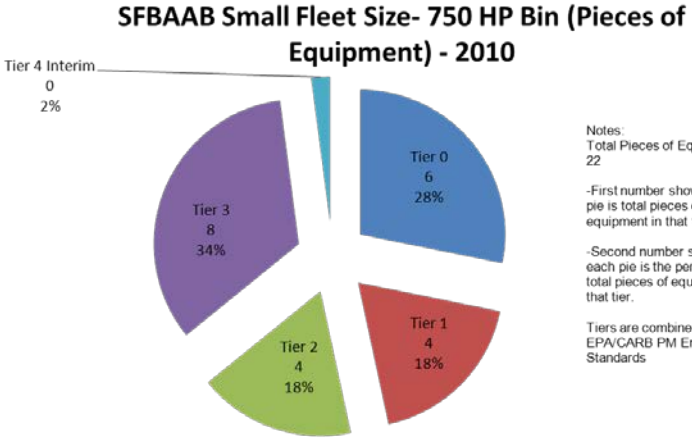
Notes:
Total Pieces of Equipment - 31

-First number shown in each pie is total pieces of equipment in that tier.

-Second number shown in each pie is the percent of total pieces of equipment in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category



SFBAAB Small Fleet Size- 750 HP Bin (Pieces of Equipment) - 2010

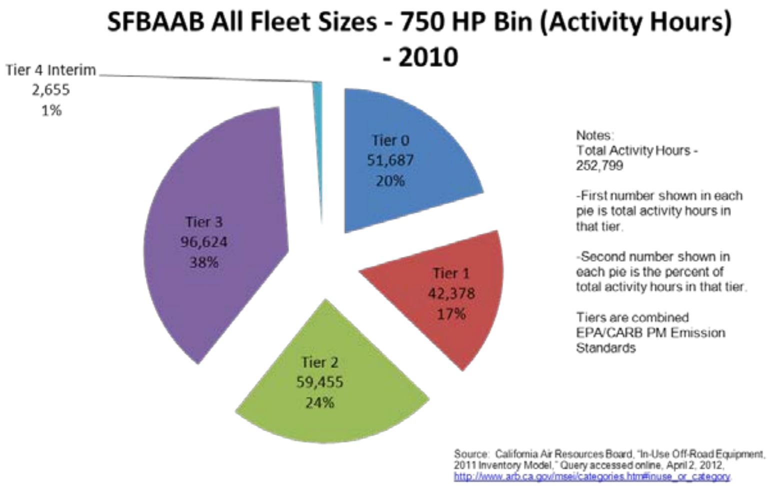
Notes:
Total Pieces of Equipment - 22

-First number shown in each pie is total pieces of equipment in that tier.

-Second number shown in each pie is the percent of total pieces of equipment in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category



SFBAAB All Fleet Sizes - 750 HP Bin (Activity Hours) - 2010

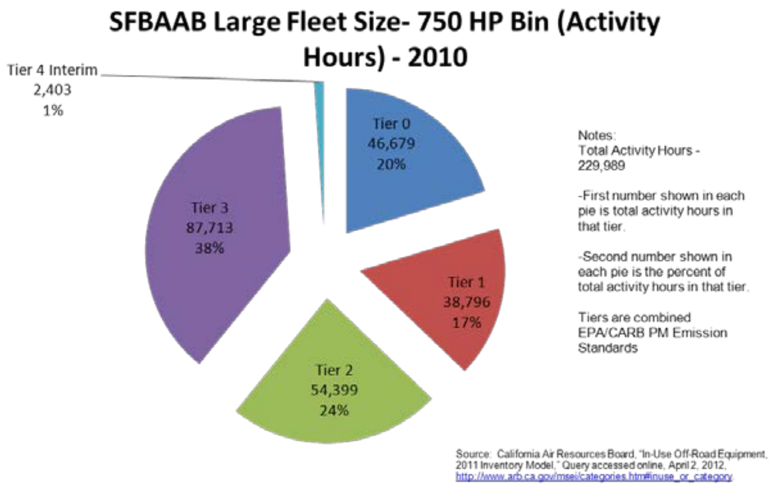
Notes:
Total Activity Hours - 252,799

-First number shown in each pie is total activity hours in that tier.

-Second number shown in each pie is the percent of total activity hours in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category



SFBAAB Large Fleet Size- 750 HP Bin (Activity Hours) - 2010

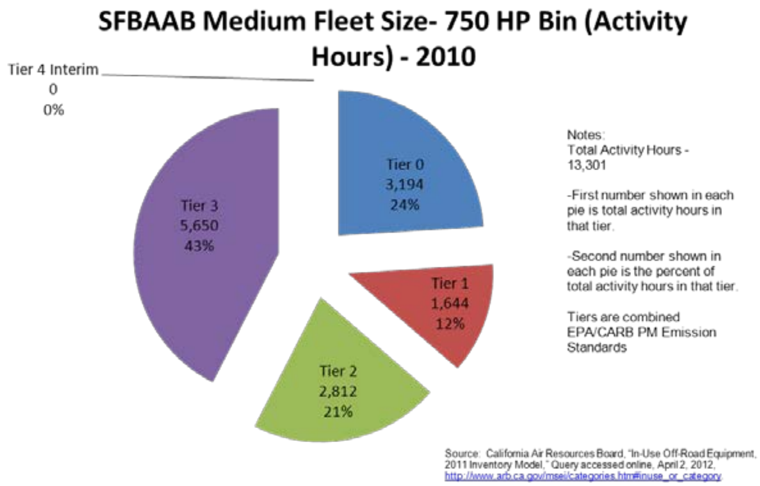
Notes:
Total Activity Hours - 229,989

-First number shown in each pie is total activity hours in that tier.

-Second number shown in each pie is the percent of total activity hours in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category



SFBAAB Medium Fleet Size- 750 HP Bin (Activity Hours) - 2010

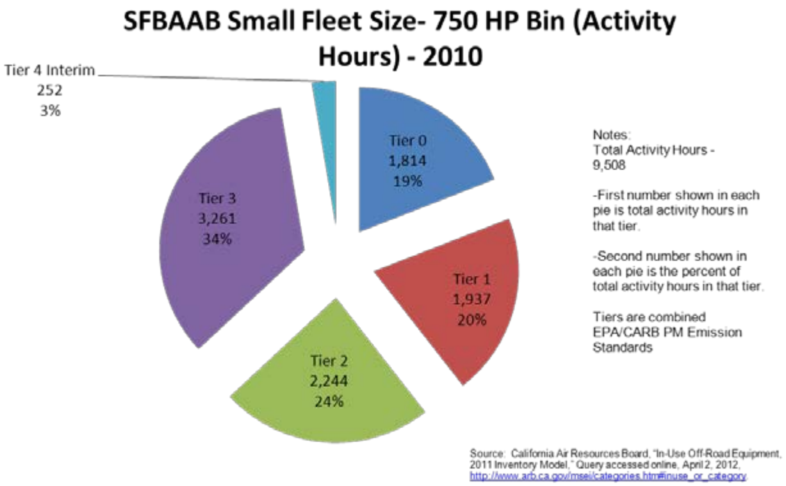
Notes:
Total Activity Hours - 13,301

-First number shown in each pie is total activity hours in that tier.

-Second number shown in each pie is the percent of total activity hours in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category



SFBAAB Small Fleet Size- 750 HP Bin (Activity Hours) - 2010

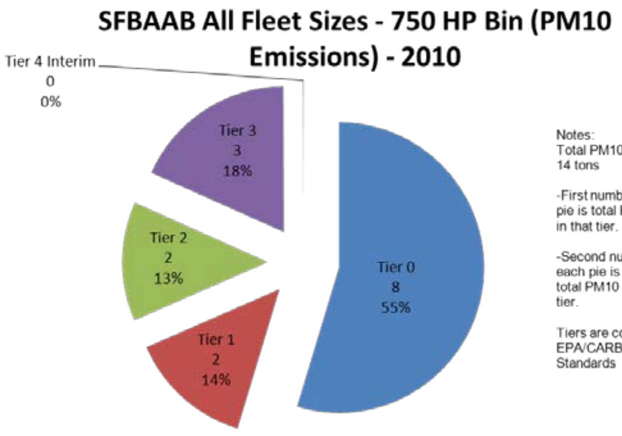
Notes:
Total Activity Hours - 9,508

-First number shown in each pie is total activity hours in that tier.

-Second number shown in each pie is the percent of total activity hours in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category


SFBAAB All Fleet Sizes - 750 HP Bin (PM10 Emissions) - 2010

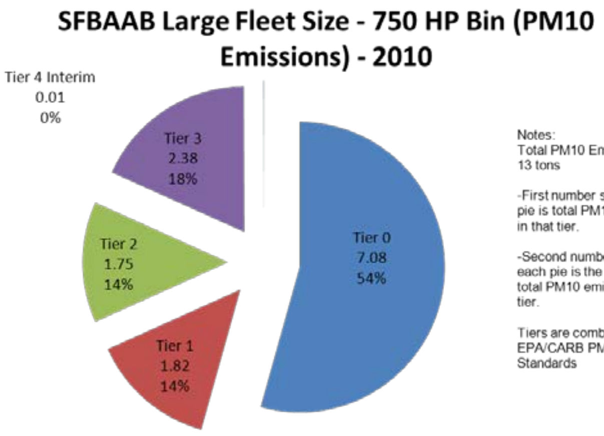
Notes:
Total PM10 Emissions - 14 tons

-First number shown in each pie is total PM10 emissions in that tier.

-Second number shown in each pie is the percent of total PM10 emissions in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category


SFBAAB Large Fleet Size - 750 HP Bin (PM10 Emissions) - 2010

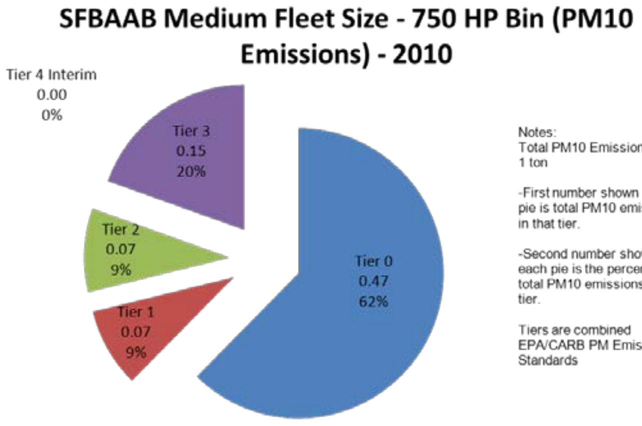
Notes:
Total PM10 Emissions - 13 tons

-First number shown in each pie is total PM10 emissions in that tier.

-Second number shown in each pie is the percent of total PM10 emissions in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category


SFBAAB Medium Fleet Size - 750 HP Bin (PM10 Emissions) - 2010

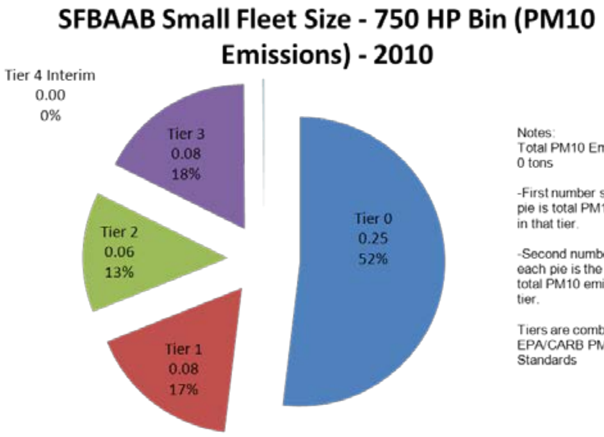
Notes:
Total PM10 Emissions - 1 ton

-First number shown in each pie is total PM10 emissions in that tier.

-Second number shown in each pie is the percent of total PM10 emissions in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category


SFBAAB Small Fleet Size - 750 HP Bin (PM10 Emissions) - 2010

Notes:
Total PM10 Emissions - 0 tons

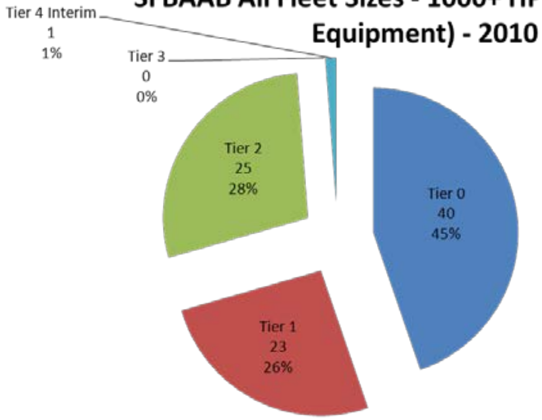
-First number shown in each pie is total PM10 emissions in that tier.

-Second number shown in each pie is the percent of total PM10 emissions in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB All Fleet Sizes - 1000+ HP Bin (Pieces of Equipment) - 2010



Notes:
Total Pieces of Equipment - 90

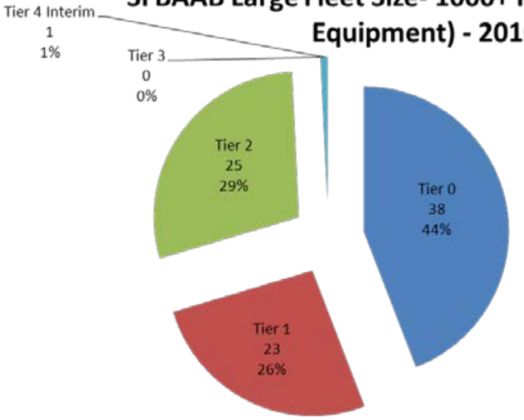
-First number shown in each pie is total pieces of equipment in that tier.

-Second number shown in each pie is the percent of total pieces of equipment in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB Large Fleet Size- 1000+ HP Bin (Pieces of Equipment) - 2010



Notes:
Total Pieces of Equipment - 86

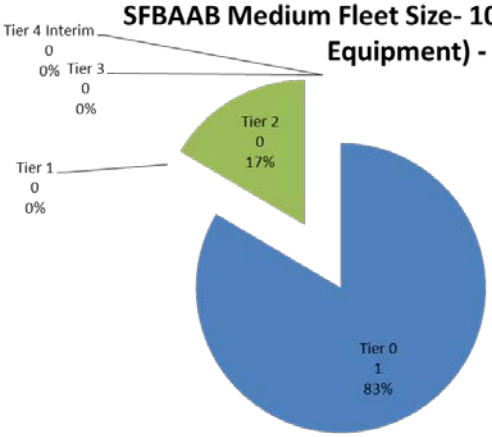
-First number shown in each pie is total pieces of equipment in that tier.

-Second number shown in each pie is the percent of total pieces of equipment in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB Medium Fleet Size- 1000+ HP Bin (Pieces of Equipment) - 2010



Notes:
Total Pieces of Equipment - 1

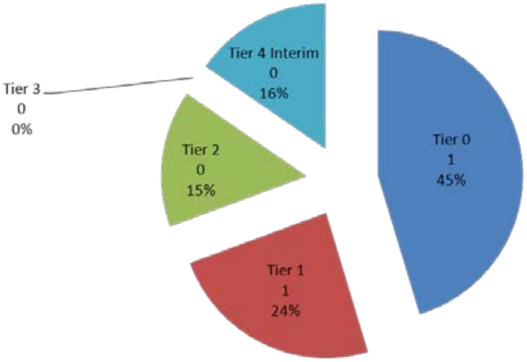
-First number shown in each pie is total pieces of equipment in that tier.

-Second number shown in each pie is the percent of total pieces of equipment in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB Small Fleet Size- 1000+ HP Bin (Pieces of Equipment) - 2010



Notes:
Total Pieces of Equipment - 3

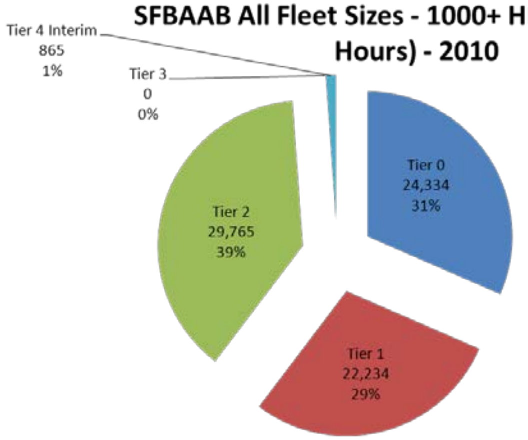
-First number shown in each pie is total pieces of equipment in that tier.

-Second number shown in each pie is the percent of total pieces of equipment in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB All Fleet Sizes - 1000+ HP Bin (Activity Hours) - 2010



Notes:
Total Activity Hours - 77,197

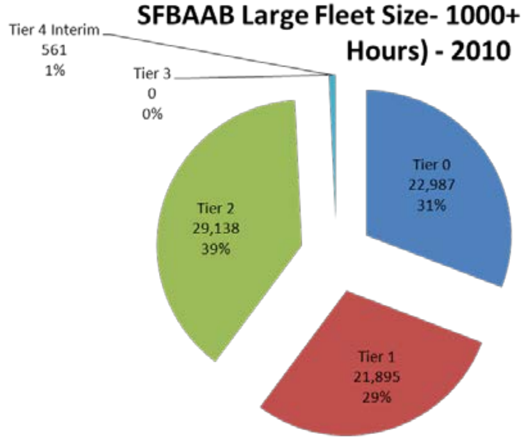
-First number shown in each pie is total activity hours in that tier.

-Second number shown in each pie is the percent of total activity hours in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB Large Fleet Size- 1000+ HP Bin (Activity Hours) - 2010



Notes:
Total Activity Hours - 74,582

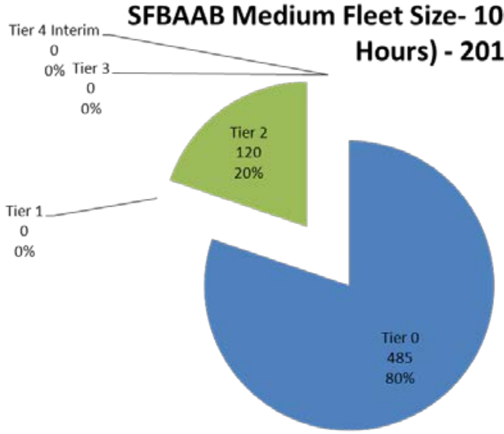
-First number shown in each pie is total activity hours in that tier.

-Second number shown in each pie is the percent of total activity hours in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB Medium Fleet Size- 1000+ HP Bin (Activity Hours) - 2010



Notes:
Total Activity Hours - 605

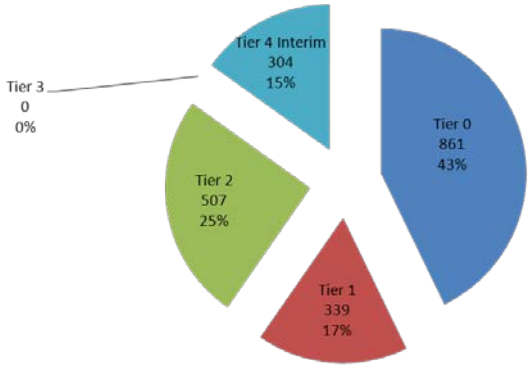
-First number shown in each pie is total activity hours in that tier.

-Second number shown in each pie is the percent of total activity hours in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB Small Fleet Size- 1000+ HP Bin (Activity Hours) - 2010



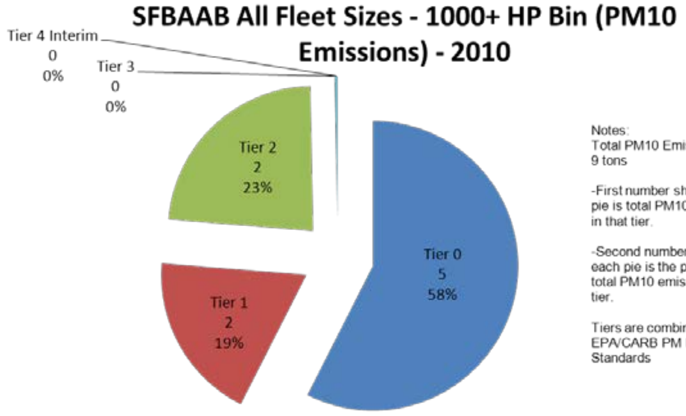
Notes:
Total Activity Hours - 2,011

-First number shown in each pie is total activity hours in that tier.

-Second number shown in each pie is the percent of total activity hours in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category


SFBAAB All Fleet Sizes - 1000+ HP Bin (PM10 Emissions) - 2010

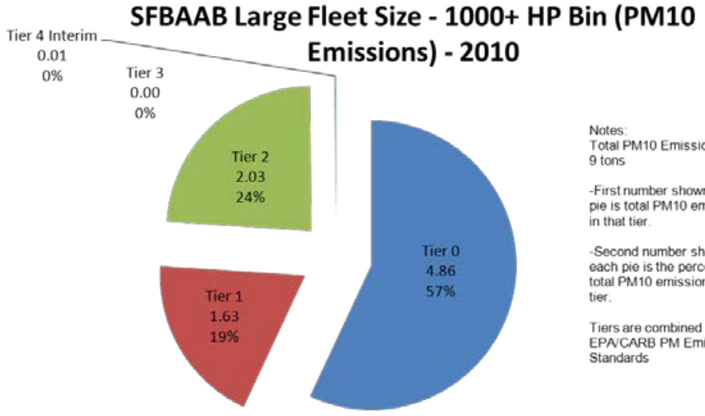
Notes:
Total PM10 Emissions - 9 tons

-First number shown in each pie is total PM10 emissions in that tier.

-Second number shown in each pie is the percent of total PM10 emissions in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category


SFBAAB Large Fleet Size - 1000+ HP Bin (PM10 Emissions) - 2010

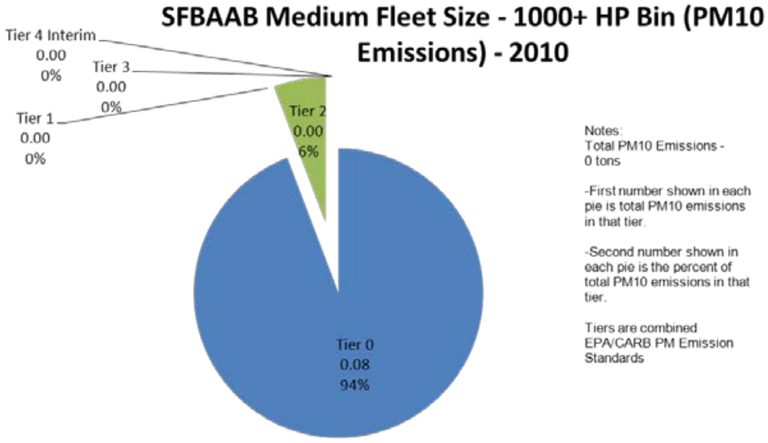
Notes:
Total PM10 Emissions - 9 tons

-First number shown in each pie is total PM10 emissions in that tier.

-Second number shown in each pie is the percent of total PM10 emissions in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category


SFBAAB Medium Fleet Size - 1000+ HP Bin (PM10 Emissions) - 2010

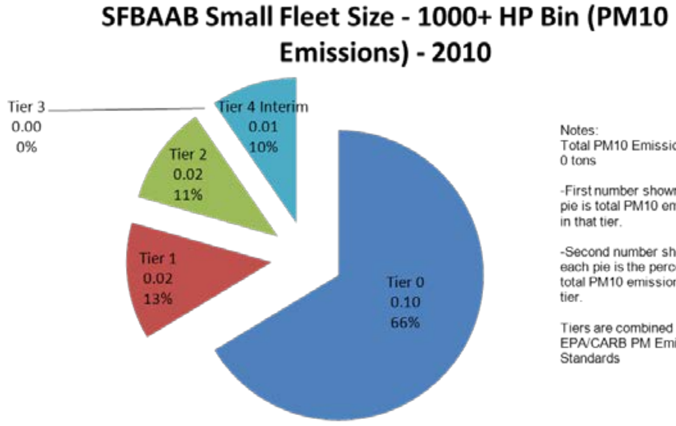
Notes:
Total PM10 Emissions - 0 tons

-First number shown in each pie is total PM10 emissions in that tier.

-Second number shown in each pie is the percent of total PM10 emissions in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category


SFBAAB Small Fleet Size - 1000+ HP Bin (PM10 Emissions) - 2010

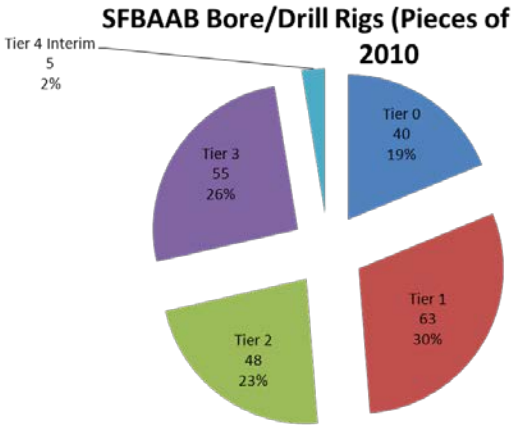
Notes:
Total PM10 Emissions - 0 tons

-First number shown in each pie is total PM10 emissions in that tier.

-Second number shown in each pie is the percent of total PM10 emissions in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category


SFBAAB Bore/Drill Rigs (Pieces of Equipment) - 2010

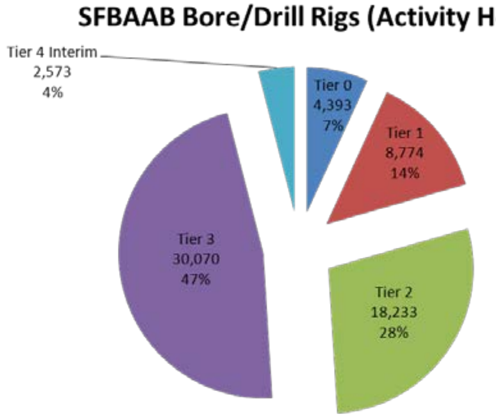
Notes:
Total Pieces of Equipment - 211

-First number shown in each pie is total pieces of equipment in that tier.

-Second number shown in each pie is the percent of total pieces of equipment in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category


SFBAAB Bore/Drill Rigs (Activity Hours) - 2010

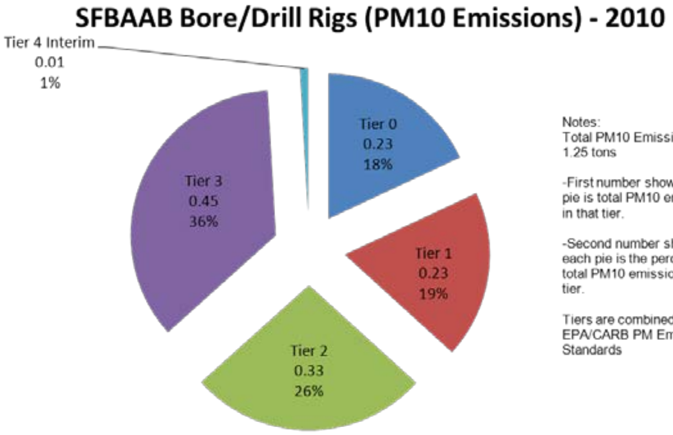
Notes:
Total Activity Hours - 64,043

-First number shown in each pie is total activity hours in that tier.

-Second number shown in each pie is the percent of total actvity hours in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category


SFBAAB Bore/Drill Rigs (PM10 Emissions) - 2010

Notes:
Total PM10 Emissions - 1.25 tons

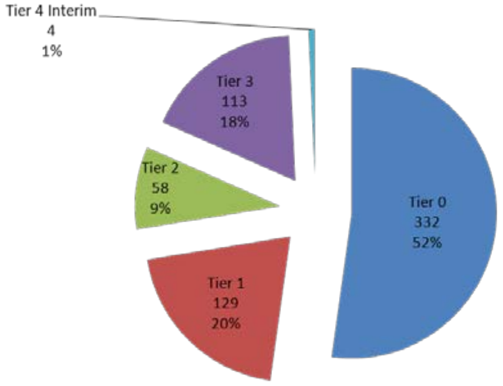
-First number shown in each pie is total PM10 emissions in that tier.

-Second number shown in each pie is the percent of total PM10 emissions in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB Cranes (Pieces of Equipment) - 2010



Notes:
Total Pieces of Equipment - 636

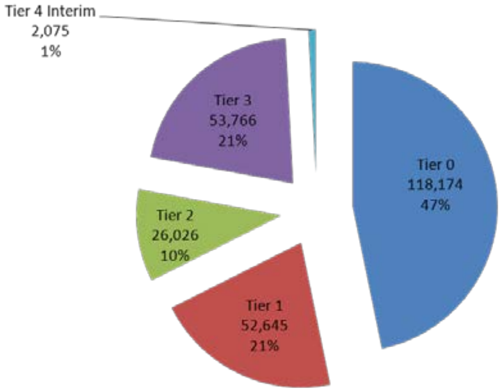
-First number shown in each pie is total pieces of equipment in that tier.

-Second number shown in each pie is the percent of total pieces of equipment in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB Cranes (Activity Hours) - 2010



Notes:
Total Activity Hours - 252,685

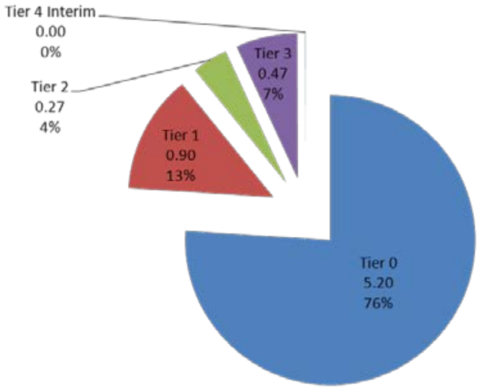
-First number shown in each pie is total actvity hours in that tier.

-Second number shown in each pie is the percent of total actvity hours in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB Cranes (PM10 Emissions) - 2010



Notes:
Total PM10 Emissions - 6.84 tons

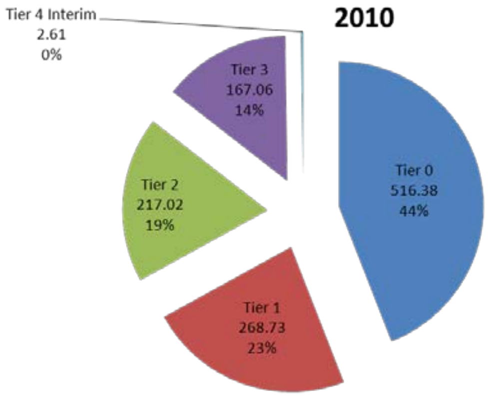
-First number shown in each pie is total PM10 emissions in that tier.

-Second number shown in each pie is the percent of total PM10 emissions in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB Crawler Tractors (Pieces of Equipment) - 2010



Notes:
Total Pieces of Equipment - 1,172

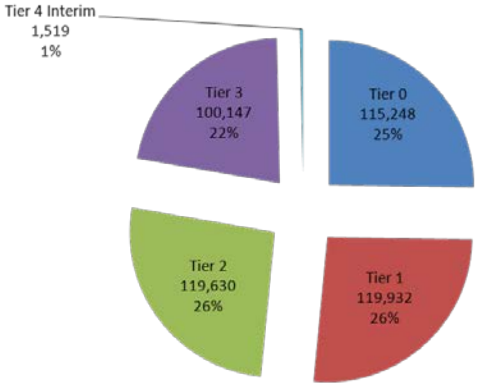
-First number shown in each pie is total pieces of equipment in that tier.

-Second number shown in each pie is the percent of total pieces of equipment in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB Crawler Tractors (Activity Hours) - 2010



Notes:
Total Activity Hours - 456,477

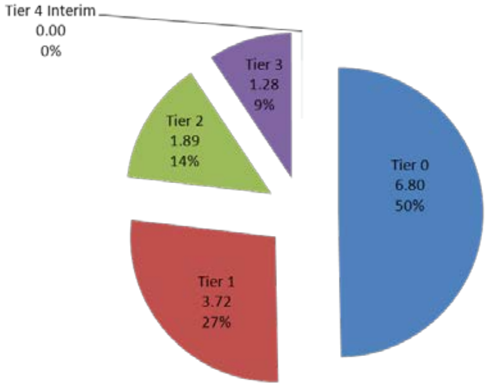
-First number shown in each pie is total activity hours in that tier.

-Second number shown in each pie is the percent of total activity hours in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB Crawler Tractors (PM10 Emissions) - 2010



Notes:
Total PM10 Emissions - 13.69 tons

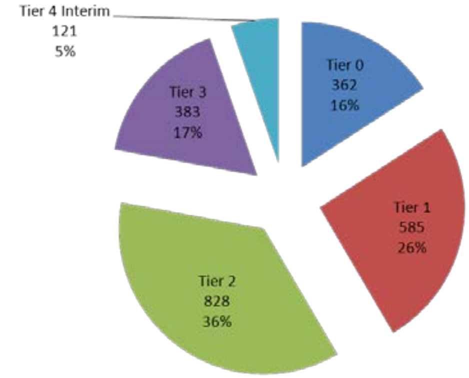
-First number shown in each pie is total PM10 emissions in that tier.

-Second number shown in each pie is the percent of total PM10 emissions in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB Excavators (Pieces of Equipment) - 2010



Notes:
Total Pieces of Equipment - 2,279

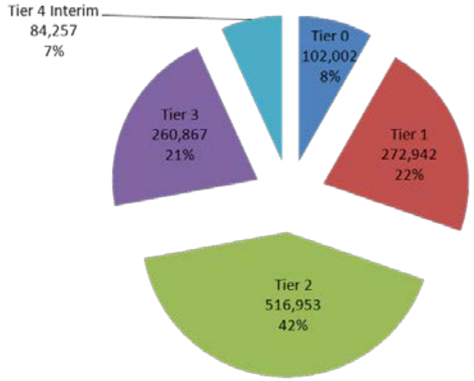
-First number shown in each pie is total pieces of equipment in that tier.

-Second number shown in each pie is the percent of total pieces of equipment in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB Excavators (Activity Hours) - 2010



Notes:
Total Activity Hours - 1,237,021

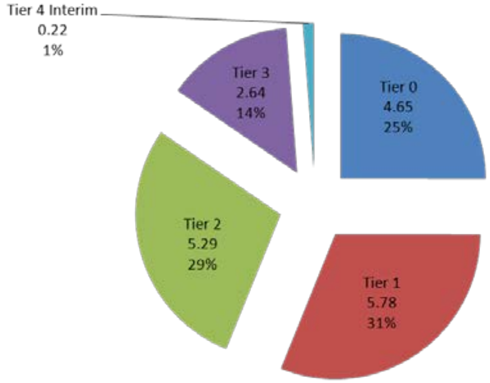
-First number shown in each pie is total activity hours in that tier.

-Second number shown in each pie is the percent of total activity hours in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB Excavators (PM10 Emissions) - 2010



Notes:
Total PM10 Emissions - 18.59 tons

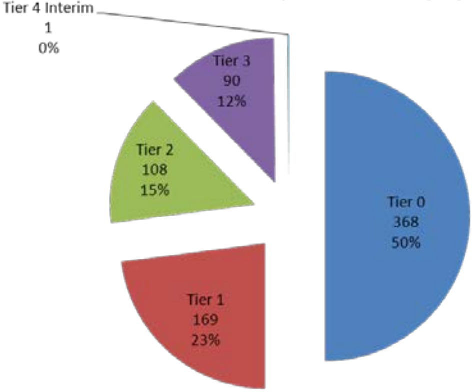
-First number shown in each pie is total PM10 emissions in that tier.

-Second number shown in each pie is the percent of total PM10 emissions in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB Graders (Pieces of Equipment) - 2010



Notes:
Total Pieces of Equipment - 737

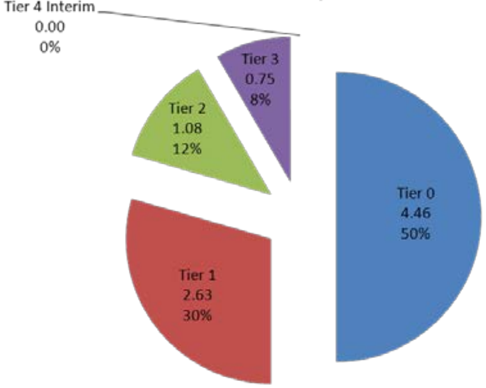
-First number shown in each pie is total pieces of equipment in that tier.

-Second number shown in each pie is the percent of total pieces of equipment in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB Graders (PM10 Emissions) - 2010



Notes:
Total PM10 Emissions - 8.93 tons

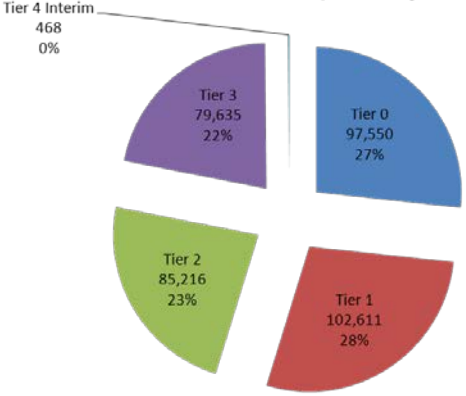
-First number shown in each pie is total PM10 emissions in that tier.

-Second number shown in each pie is the percent of total PM10 emissions in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB Graders (Activity Hours) - 2010



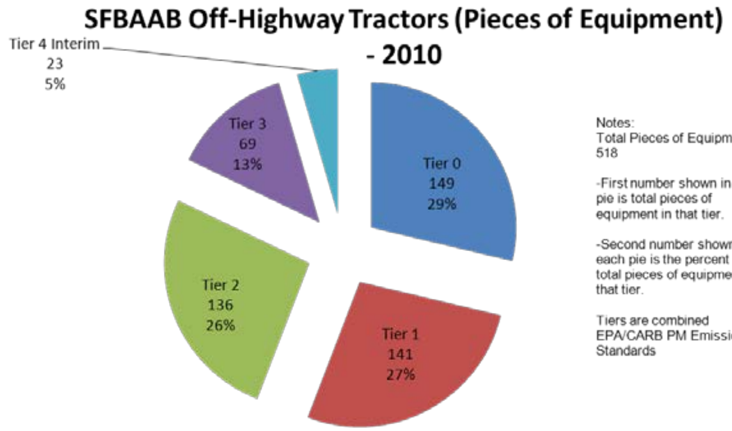
Notes:
Total Activity Hours - 365,480

-First number shown in each pie is total activity hours in that tier.

-Second number shown in each pie is the percent of total activity hours in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category



SFBAAB Off-Highway Tractors (Pieces of Equipment) - 2010

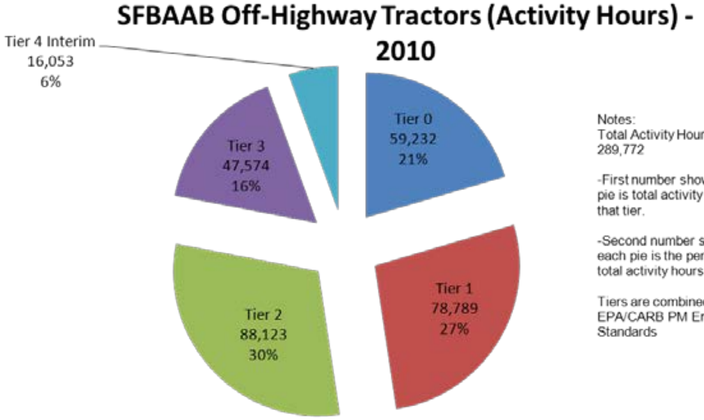
Notes:
Total Pieces of Equipment - 518

-First number shown in each pie is total pieces of equipment in that tier.

-Second number shown in each pie is the percent of total pieces of equipment in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category



SFBAAB Off-Highway Tractors (Activity Hours) - 2010

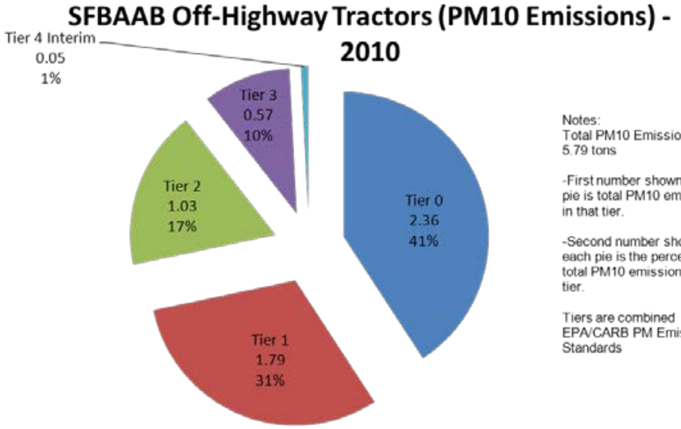
Notes:
Total Activity Hours - 289,772

-First number shown in each pie is total activity hours in that tier.

-Second number shown in each pie is the percent of total activity hours in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category



SFBAAB Off-Highway Tractors (PM10 Emissions) - 2010

Notes:
Total PM10 Emissions - 5.79 tons

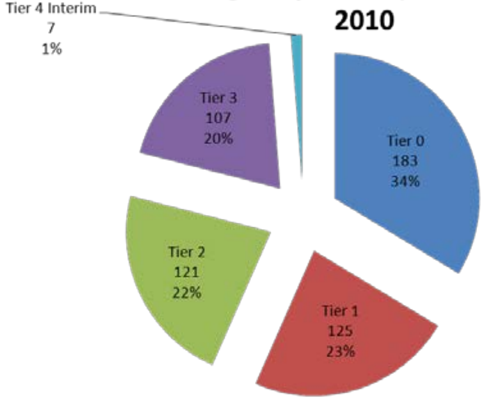
-First number shown in each pie is total PM10 emissions in that tier.

-Second number shown in each pie is the percent of total PM10 emissions in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB Off-Highway Trucks (Pieces of Equipment) - 2010



Notes:
Total Pieces of Equipment - 543

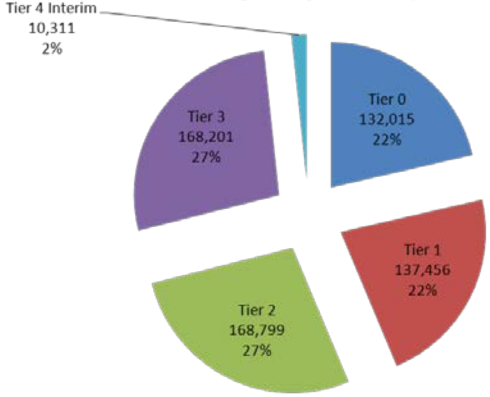
-First number shown in each pie is total pieces of equipment in that tier.

-Second number shown in each pie is the percent of total pieces of equipment in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB Off-Highway Trucks (Activity Hours) - 2010



Notes:
Total Activity Hours - 616,782

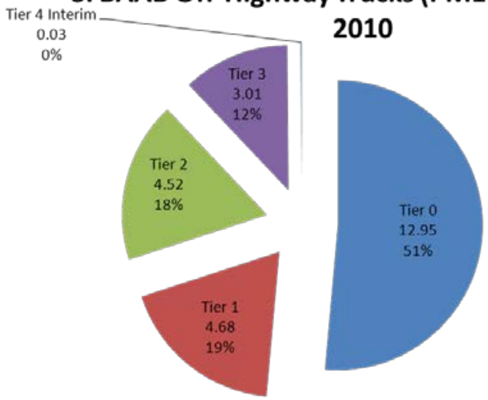
-First number shown in each pie is total activity hours in that tier.

-Second number shown in each pie is the percent of total activity hours in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB Off-Highway Trucks (PM10 Emissions) - 2010



Notes:
Total PM10 Emissions - 25.19 tons

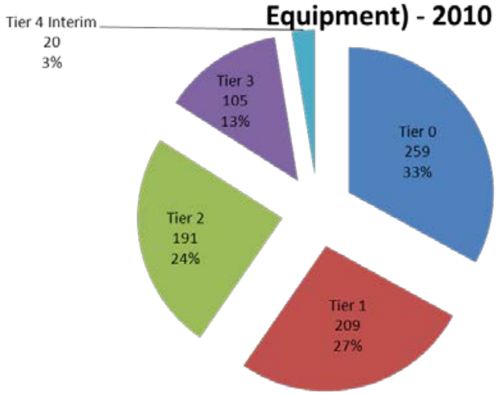
-First number shown in each pie is total PM10 emissions in that tier.

-Second number shown in each pie is the percent of total PM10 emissions in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB Other Construction Equipment (Pieces of Equipment) - 2010



Notes:
Total Pieces of Equipment - 785

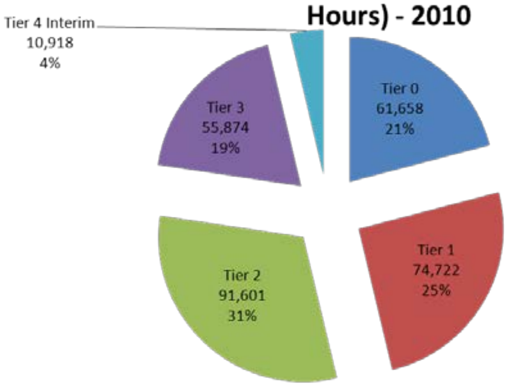
-First number shown in each pie is total pieces of equipment in that tier.

-Second number shown in each pie is the percent of total pieces of equipment in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category.

SFBAAB Other Construction Equipment (Activity Hours) - 2010



Notes:
Total Activity Hours - 294,772

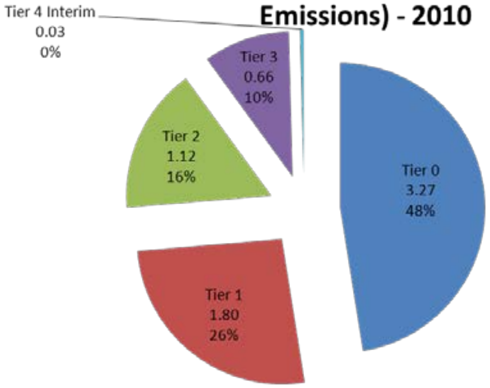
-First number shown in each pie is total activity hours in that tier.

-Second number shown in each pie is the percent of total activity hours in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category.

SFBAAB Other Construction Equipment (PM10 Emissions) - 2010



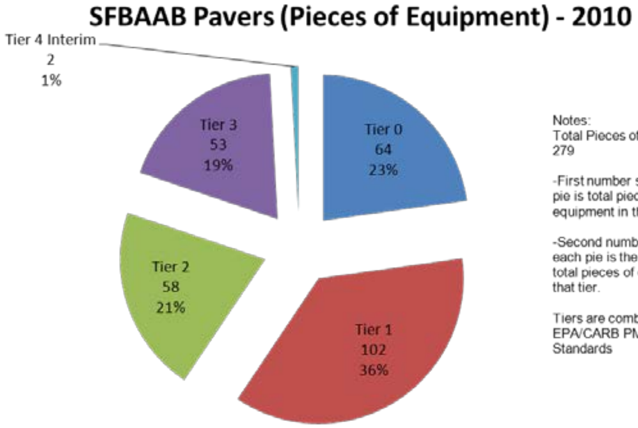
Notes:
Total PM10 Emissions - 6.88 tons

-First number shown in each pie is total PM10 emissions in that tier.

-Second number shown in each pie is the percent of total PM10 emissions in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category.


SFBAAB Pavers (Pieces of Equipment) - 2010

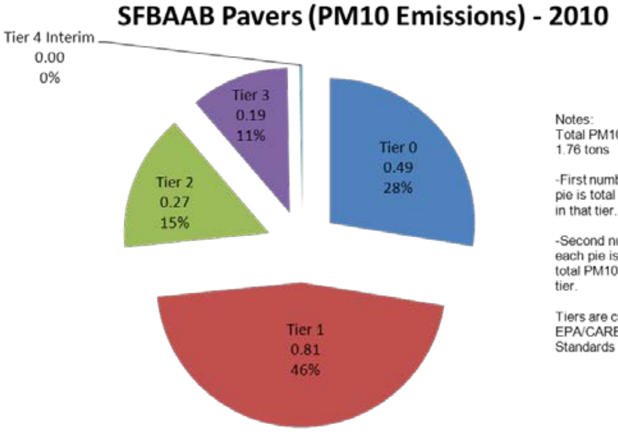
Notes:
Total Pieces of Equipment - 279

-First number shown in each pie is total pieces of equipment in that tier.

-Second number shown in each pie is the percent of total pieces of equipment in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category.


SFBAAB Pavers (PM10 Emissions) - 2010

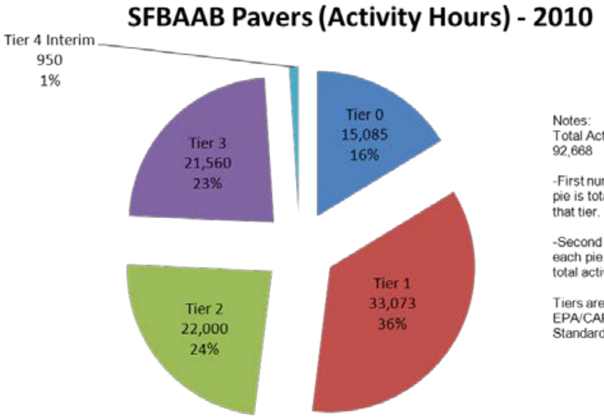
Notes:
Total PM10 Emissions - 1.76 tons

-First number shown in each pie is total PM10 emissions in that tier.

-Second number shown in each pie is the percent of total PM10 emissions in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category.


SFBAAB Pavers (Activity Hours) - 2010

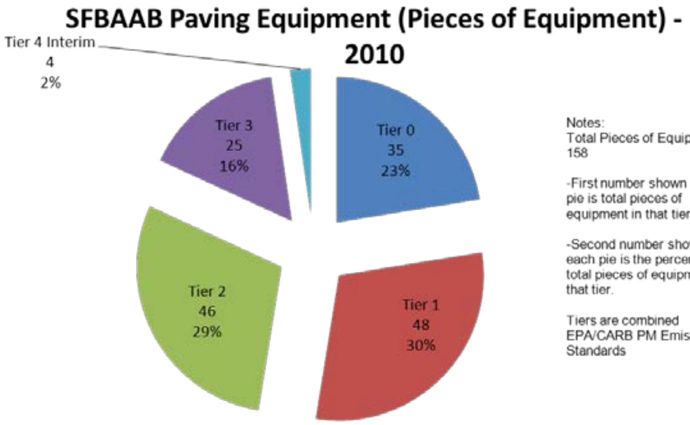
Notes:
Total Activity Hours - 92,668

-First number shown in each pie is total activity hours in that tier.

-Second number shown in each pie is the percent of total activity hours in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category.



SFBAAB Paving Equipment (Pieces of Equipment) - 2010

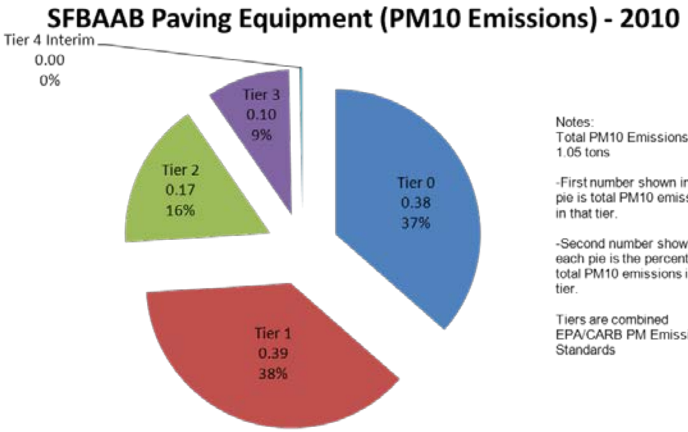
Notes:
Total Pieces of Equipment - 158

-First number shown in each pie is total pieces of equipment in that tier.

-Second number shown in each pie is the percent of total pieces of equipment in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category



SFBAAB Paving Equipment (PM10 Emissions) - 2010

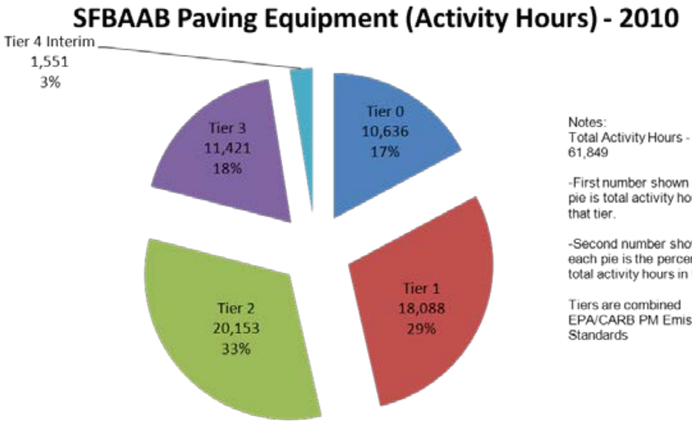
Notes:
Total PM10 Emissions - 1.05 tons

-First number shown in each pie is total PM10 emissions in that tier.

-Second number shown in each pie is the percent of total PM10 emissions in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category



SFBAAB Paving Equipment (Activity Hours) - 2010

Notes:
Total Activity Hours - 61,849

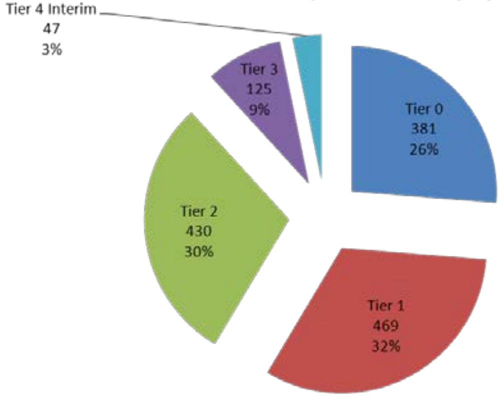
-First number shown in each pie is total activity hours in that tier.

-Second number shown in each pie is the percent of total activity hours in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB Rollers (Pieces of Equipment) - 2010



Notes:
Total Pieces of Equipment - 1,452

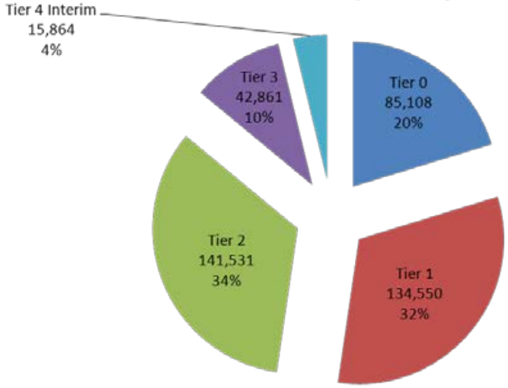
-First number shown in each pie is total pieces of equipment in that tier.

-Second number shown in each pie is the percent of total pieces of equipment in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB Rollers (Activity Hours) - 2010



Notes:
Total Activity Hours - 419,915

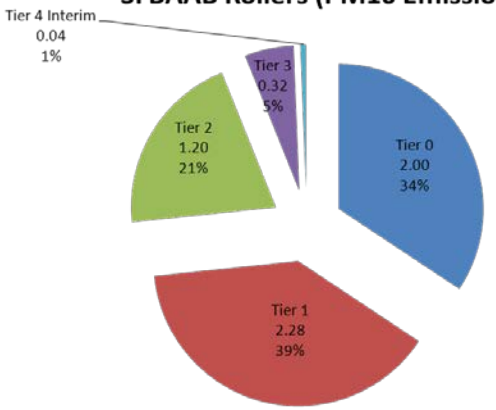
-First number shown in each pie is total activity hours in that tier.

-Second number shown in each pie is the percent of total activity hours in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB Rollers (PM10 Emissions) - 2010



Notes:
Total PM10 Emissions - 5.84 tons

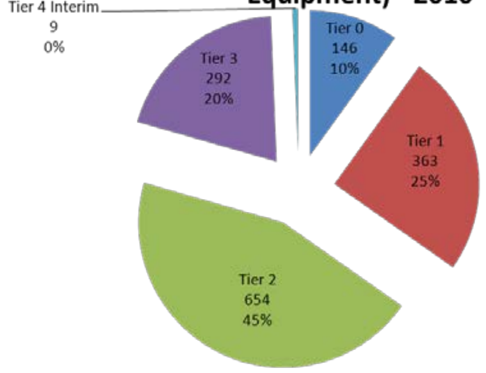
-First number shown in each pie is total PM10 emissions in that tier.

-Second number shown in each pie is the percent of total PM10 emissions in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB Rough Terrain Forklifts (Pieces of Equipment) - 2010



Notes:
Total Pieces of Equipment - 1,464

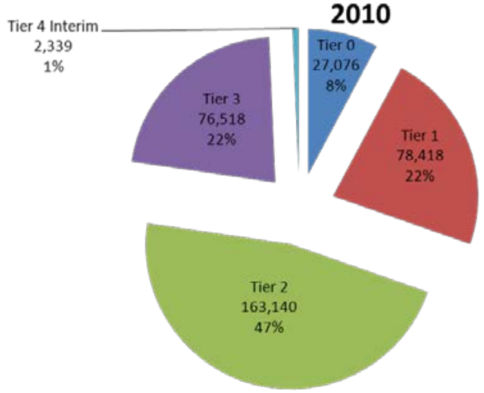
-First number shown in each pie is total pieces of equipment in that tier.

-Second number shown in each pie is the percent of total pieces of equipment in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB Rough Terrain Forklifts (Activity Hours) - 2010



Notes:
Total Activity Hours - 347,490

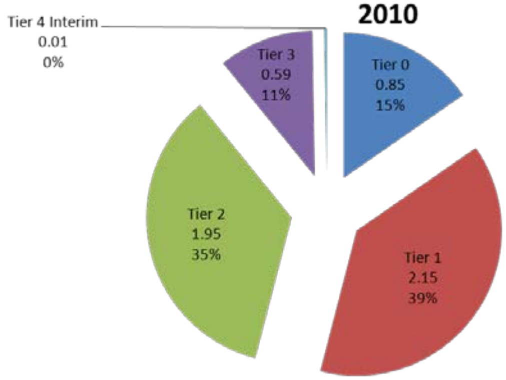
-First number shown in each pie is total activity hours in that tier.

-Second number shown in each pie is the percent of total activity hours in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB Rough Terrain Forklifts (PM10 Emissions) - 2010



Notes:
Total PM10 Emissions - 5.55 tons

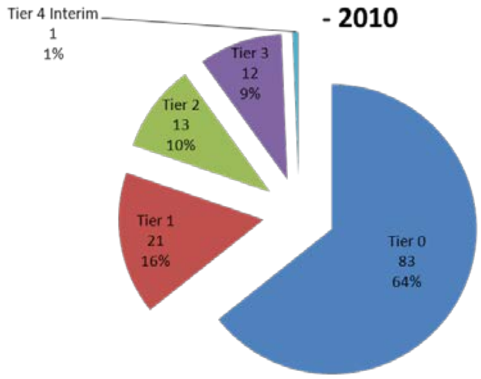
-First number shown in each pie is total PM10 emissions in that tier.

-Second number shown in each pie is the percent of total PM10 emissions in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB Rubber Tired Dozers (Pieces of Equipment) - 2010



Notes:
Total Pieces of Equipment - 129

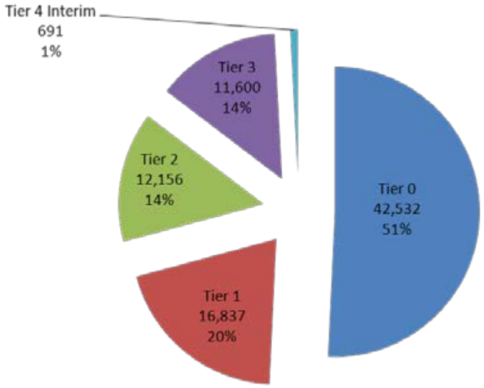
-First number shown in each pie is total pieces of equipment in that tier.

-Second number shown in each pie is the percent of total pieces of equipment in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012. http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB Rubber Tired Dozers (Activity Hours) - 2010



Notes:
Total Activity Hours - 83,816

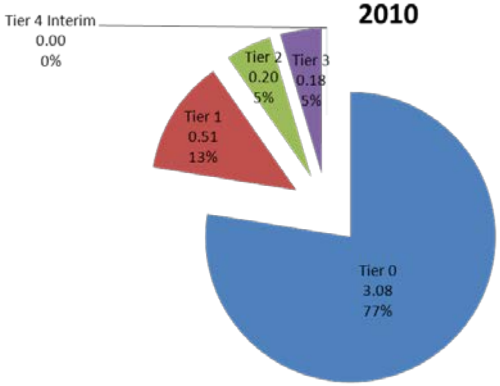
-First number shown in each pie is total activity hours in that tier.

-Second number shown in each pie is the percent of total activity hours in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012. http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB Rubber Tired Dozers (PM10 Emissions) - 2010



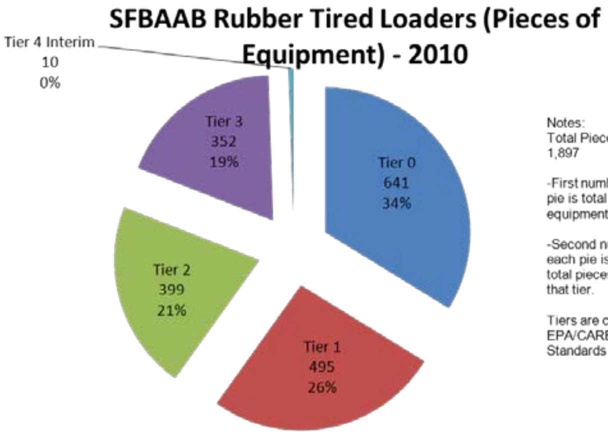
Notes:
Total PM10 Emissions - 3.97 tons

-First number shown in each pie is total PM10 emissions in that tier.

-Second number shown in each pie is the percent of total PM10 emissions in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012. http://www.arb.ca.gov/msei/categories.htm#inuse_or_category



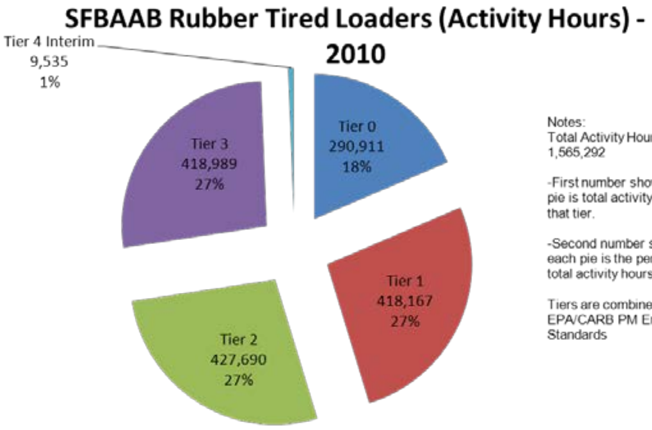
Notes:
Total Pieces of Equipment - 1,897

-First number shown in each pie is total pieces of equipment in that tier.

-Second number shown in each pie is the percent of total pieces of equipment in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category



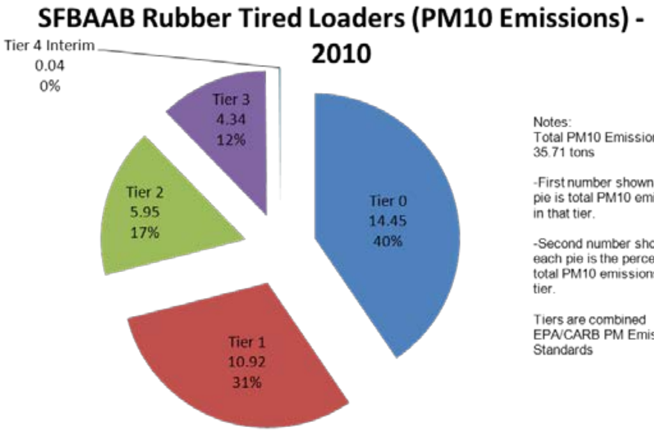
Notes:
Total Activity Hours - 1,565,292

-First number shown in each pie is total activity hours in that tier.

-Second number shown in each pie is the percent of total activity hours in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category



Notes:
Total PM10 Emissions - 35.71 tons

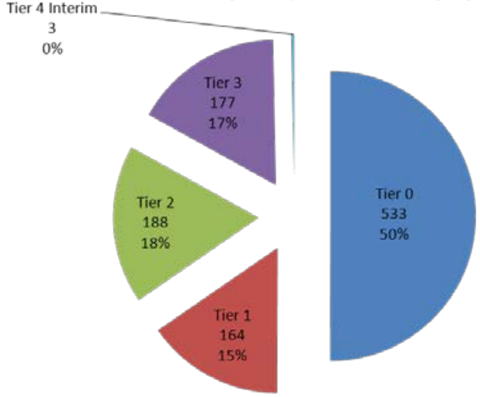
-First number shown in each pie is total PM10 emissions in that tier.

-Second number shown in each pie is the percent of total PM10 emissions in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB Scrapers (Pieces of Equipment) - 2010



Notes:
Total Pieces of Equipment - 1,065

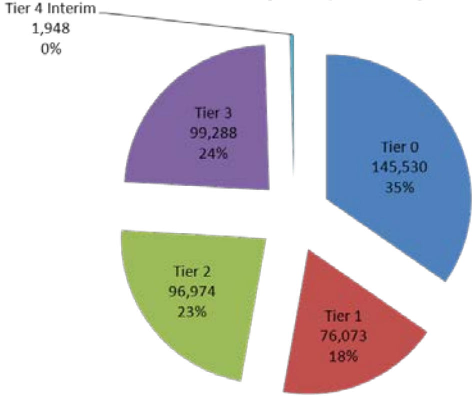
-First number shown in each pie is total pieces of equipment in that tier.

-Second number shown in each pie is the percent of total pieces of equipment in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category.

SFBAAB Scrapers (Activity Hours) - 2010



Notes:
Total Activity Hours - 419,812

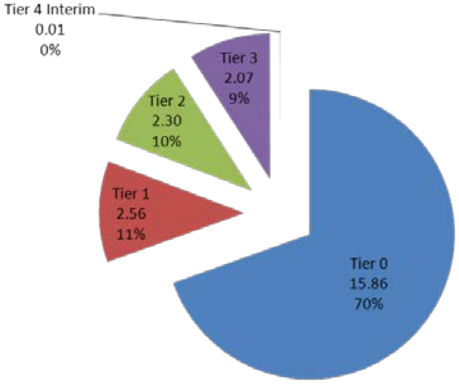
-First number shown in each pie is total activity hours in that tier.

-Second number shown in each pie is the percent of total activity hours in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category.

SFBAAB Scrapers (PM10 Emissions) - 2010



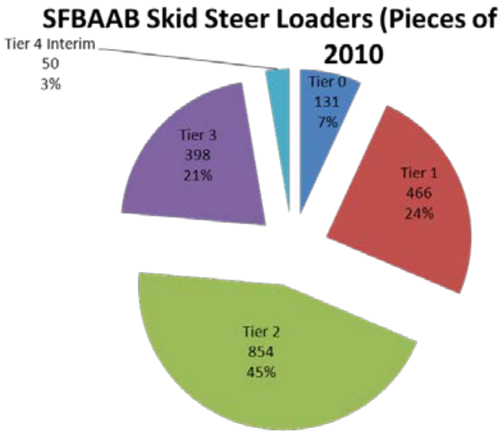
Notes:
Total PM10 Emissions - 22.80 tons

-First number shown in each pie is total PM10 emissions in that tier.

-Second number shown in each pie is the percent of total PM10 emissions in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category.



SFBAAB Skid Steer Loaders (Pieces of Equipment) - 2010

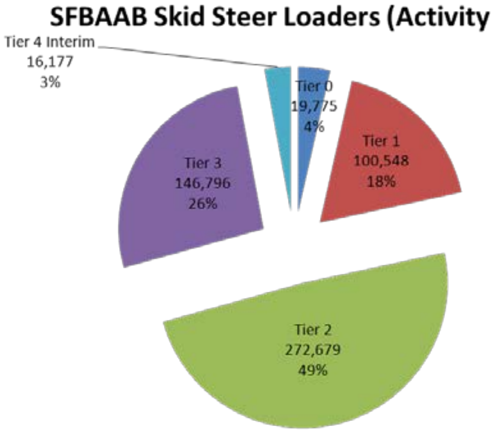
Notes:
Total Pieces of Equipment - 1,898

-First number shown in each pie is total pieces of equipment in that tier.

-Second number shown in each pie is the percent of total pieces of equipment in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category



SFBAAB Skid Steer Loaders (Activity Hours) - 2010

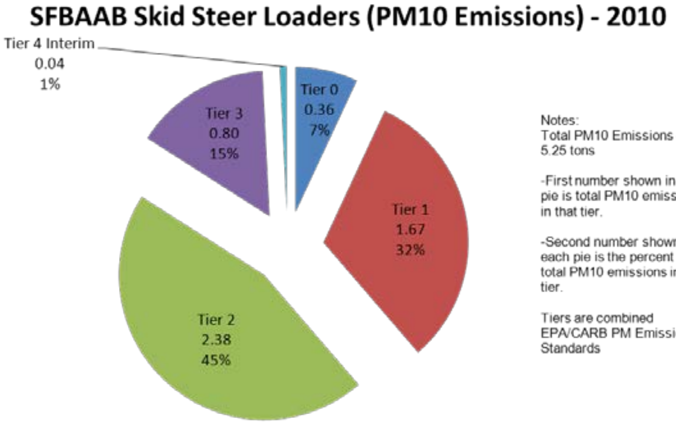
Notes:
Total Activity Hours - 555,975

-First number shown in each pie is total activity hours in that tier.

-Second number shown in each pie is the percent of total activity hours in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category



SFBAAB Skid Steer Loaders (PM10 Emissions) - 2010

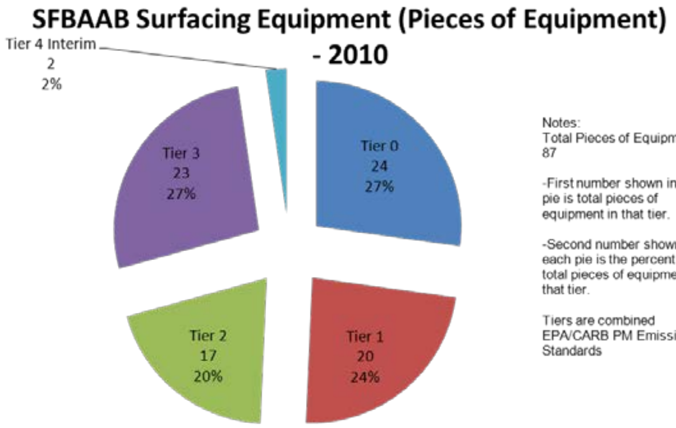
Notes:
Total PM10 Emissions - 5.25 tons

-First number shown in each pie is total PM10 emissions in that tier.

-Second number shown in each pie is the percent of total PM10 emissions in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category



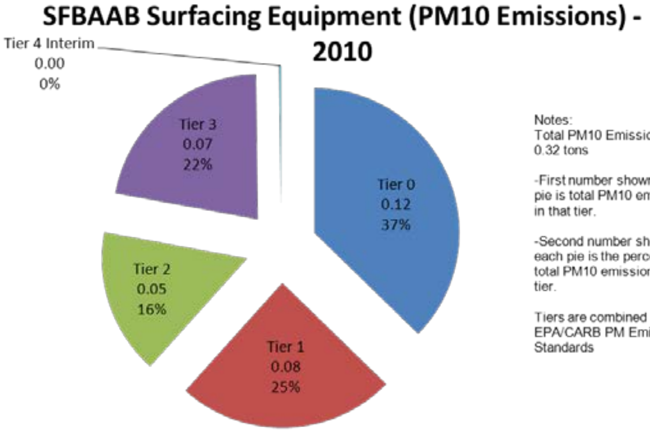
Notes:
Total Pieces of Equipment - 87

-First number shown in each pie is total pieces of equipment in that tier.

-Second number shown in each pie is the percent of total pieces of equipment in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category



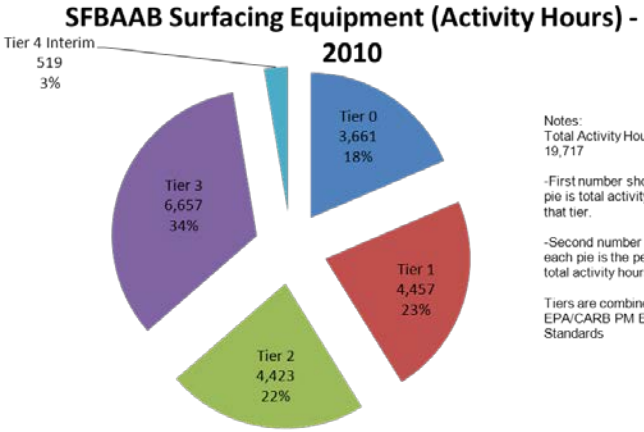
Notes:
Total PM10 Emissions - 0.32 tons

-First number shown in each pie is total PM10 emissions in that tier.

-Second number shown in each pie is the percent of total PM10 emissions in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category



Notes:
Total Activity Hours - 19,717

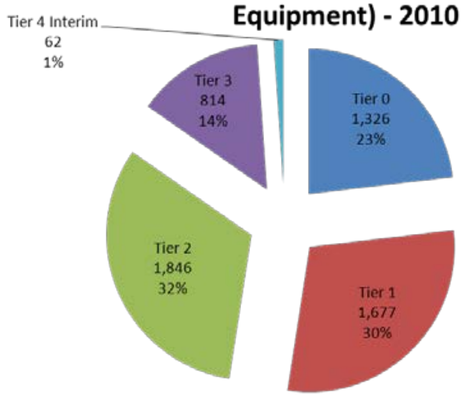
-First number shown in each pie is total activity hours in that tier.

-Second number shown in each pie is the percent of total activity hours in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB Tractors/Loaders/Backhoes (Pieces of Equipment) - 2010



Notes:
Total Pieces of Equipment - 5,724

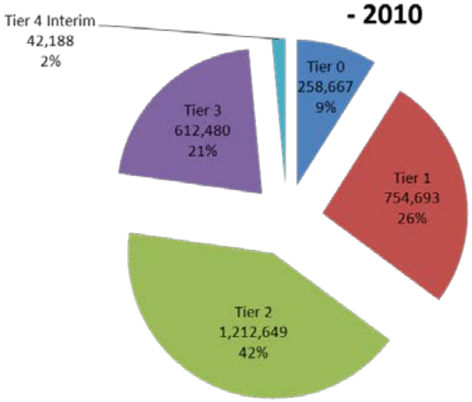
-First number shown in each pie is total pieces of equipment in that tier.

-Second number shown in each pie is the percent of total pieces of equipment in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category.

SFBAAB Tractors/Loaders/Backhoes (Activity Hours) - 2010



Notes:
Total Activity Hours- 2,880,678

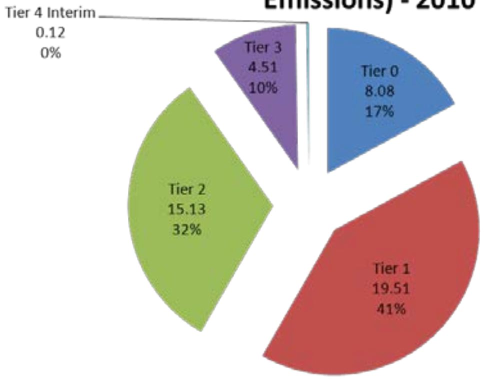
-First number shown in each pie is total activity hours in that tier.

-Second number shown in each pie is the percent of total activity hours in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB Tractors/Loaders/Backhoes (PM10 Emissions) - 2010



Notes:
Total PM10 Emissions - 47.35 tons

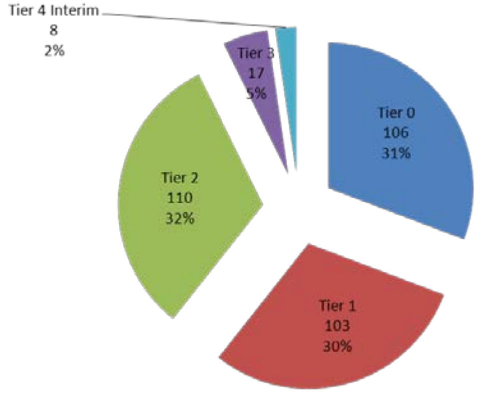
-First number shown in each pie is total PM10 emissions in that tier.

-Second number shown in each pie is the percent of total PM10 emissions in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category.

SFBAAB Trenchers (Pieces of Equipment) - 2010



Notes:
Total Pieces of Equipment - 344

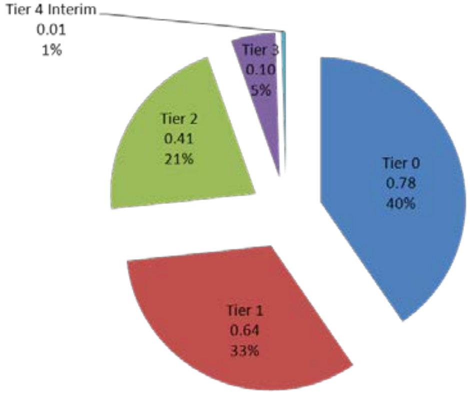
-First number shown in each pie is total pieces of equipment in that tier.

-Second number shown in each pie is the percent of total pieces of equipment in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB Trenchers (PM10 Emissions) - 2010



Notes:
Total PM10 Emissions - 1.93 tons

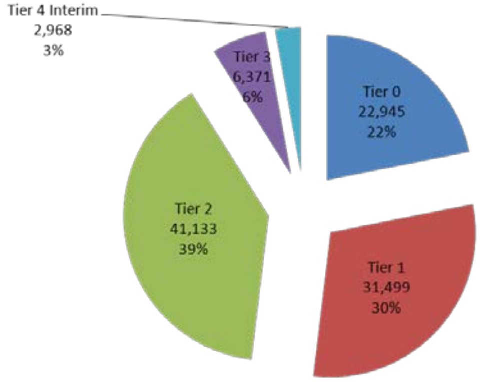
-First number shown in each pie is total PM10 emissions in that tier.

-Second number shown in each pie is the percent of total PM10 emissions in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

SFBAAB Trenchers (Activity Hours) - 2010



Notes:
Total Activity Hours - 104,917

-First number shown in each pie is total activity hours in that tier.

-Second number shown in each pie is the percent of total activity hours in that tier.

Tiers are combined EPA/CARB PM Emission Standards

Source: California Air Resources Board, "In-Use Off-Road Equipment, 2011 Inventory Model," Query accessed online, April 2, 2012, http://www.arb.ca.gov/msei/categories.htm#inuse_or_category

Appendix D – Definitions Used in Best Management Practices

Alternative Fuels – means alternative fuels including natural gas or biodiesel, which is a fuel comprised of mono-alkyl esters of long chain fatty acids derived from vegetable oils or animal fats, meeting the requirements of American Society for Testing and Materials D 6751. However, biodiesel must be proven to be sourced from sustainable feedstocks including waste grease, fats, or oils and under certain circumstances, farmed oils that can be proven to be sustainable.

Alternative Sources of Power – means utility-based electric power or other power sources other than portable diesel engines.

ARB – means the California Air Resources Board

Certification Statement – the statement provided in Appendix C.

Construction Activities – means performing all work required for a construction permit.

Construction Permit – means a permit specified in Section 106A.3.2.6 of the San Francisco Building Code.

Construction Phase – means a particular construction activity over a certain period of time. Construction phases may include, but not limited to, demolition, grading, trenching, building construction, and paving. Construction phases may occur at the same time.

Construction Site – means the location of the construction activities.

Environmental Review Officer – means the role described in Section 31.05 of the San Francisco Administrative Code.

Equipment – means off-road and on-road equipment.

Equipment Type – means a description of the off-road equipment. This off-road equipment includes bore/drill rigs, cranes, crawler tractors, excavators, graders, off-highway tractors, off-highway trucks, other construction equipment, pavers, paving equipment, rollers, rough terrain forklifts, rubber tired dozers, rubber tired loaders, scrapers, skid steer loaders, surfacing equipment, tractors/loaders/backhoes, and trenchers.

Off-Road Engines – means nonroad engines as defined in 40 Code of Federal Regulations, Section 89.2.

Off-Road Equipment – means equipment with off-road engines greater than twenty-five (25) horsepower and operating for more than twenty (20) total hours over the entire duration of construction activities.

On-Road Equipment – means heavy-duty vehicles as defined in 40 Code of Federal Regulations, Section 86.1803-01.

Portable Diesel Engines – means portable as defined in 71 California Code of Regulations, Section 93116.2.

Posted at the perimeter of the construction site – means one sign on each portion of the construction site facing a public right-of-way.

Project Sponsor – means a person applying for a construction permit or, if a permit for the work is not required from the Department of Building Inspection, the owner of the property where the construction activities will take place.

Sensitive land use - means dwellings or buildings housing or occupied by sensitive receptors (children, adults, and seniors) and include: residential dwellings, schools, daycares, hospitals and senior care facilities.

Tier 2 off-road emission standards – means the Tier 2 new engine emission standards in Title 13, California Code of Regulation, section 2423(b)(1)(A) and/or Title 40, Code of Federal Regulations, Part 89.112(a).

Verified Diesel Emission Control Strategy (VDECS) – means a verified diesel emission control strategy, designed primarily for the reduction of diesel particulate matter emissions, which has been verified by ARB pursuant to "Verification Procedures, Warranty and In-Use Strategies to Control Emission from Diesel Engines," Title 13, California Code of Regulations, sections 2700-2710. VDECS can be verified to achieve Level 1 diesel particulate matter reductions (at least 25 percent), Level 2 diesel particulate matter reductions (at least 50 percent), or Level 3 diesel particulate matter reductions (at least 85 percent).

USEPA – means the United States Environmental Protection Agency

Appendix E – Certification Statement

I hereby certify that:

1. The off-road equipment identified in the Plan meets the requirements of letter e) in the Plan.
2. Any discrepancy to the above requirements will be reported to the Environmental Review Officer immediately.
3. All of the requirements in the Plan will be followed. Any deviation will be determined to be out of compliance with the conditions of project approval. Construction activities must cease until the ERO and the construction contractor have agreed upon actions to meet the above requirements.

I understand that my off-road equipment is subject to random and scheduled inspection to verify the requirements of the Plan.

I certify to the best of my knowledge that I will comply with the items listed above and that I am legally authorized signatory or designee for the Applicant.

Signature	Title
Print Name	Date
Company Name	Phone Number

Company Address

Appendix F – Other Jurisdictions: Summary of Best Management Practices

A review of Best management practices (BMPs) from other entities were used in formulating recommending BMPs for reducing exposure of sensitive populations to diesel particulate matter (DPM) emissions from construction-related equipment in the City and County of San Francisco. The following presents a list of other entities BMPs. The list is in no particular order and is not intended to be an exhaustive list, as other entities were also researched, but reflects some of the BMPs that were considered in formulating the recommended BMPs. Usually the text is copied over verbatim from the original source without providing any context.[1] Website links to the original source and full text of the BMPs are provided as footnotes if a reader wants to obtain more context.

1. SACRAMENTO METROPOLITAN AIR QUALITY MANAGEMENT DISTRICT (SMAQMD): CONSTRUCTION AIR QUALITY MITIGATION PLAN PROTOCOL – SEPTEMBER 2010[2]

When the air quality analysis demonstrates that a proposed project's construction emissions may exceed SMAQMD's 85 pounds per day nitrogen oxides (NOx) threshold of significance, the jurisdiction will apply "all feasible mitigation" to the project as required by the California Environmental Quality Act (CEQA).

Project construction emission sources considered in the air quality analysis include: fuel combustion from mobile heavy-duty diesel and gasoline powered equipment, portable auxiliary equipment, material haul trucks, worker commute trips, soil disturbance, demolition activities, paving and architectural coating applications.

The mitigation measures listed below are included in the environmental document and project approvals, and become part of the mitigation monitoring and reporting program (MMRP). Prior to construction the project sponsor provides the construction equipment list

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[1] Some text has been changed to avoid duplicative abbreviations or confusion between terms used by different entities.

[2] http://www.airquality.org/ceqa/mitigation.shtml

for District review, and if applicable, haul truck information. The SMAQMD will work with the sponsor to confirm that the emissions are reduced to less than significant levels. If not, the SMAQMD works with sponsor to develop a construction equipment list for which the construction emissions would be below the threshold. Once this is demonstrated, the SMAQMD sends a letter to the proponent and/or construction company and the jurisdiction confirming the fleet meets the mitigation requirements.

1.1 Feasible Mitigation

Onsite

On-Site Construction Mitigation targets emission reductions from off-road construction equipment. The standard construction mitigation language (aka, Enhanced Exhaust Control Practices) is provided below.

Category 1: Reducing NOx emissions from off-road diesel powered equipment

The project shall provide a plan for approval by [DERA, City of x, SMAQMD, etc] demonstrating that the heavy-duty (> 50 horsepower) off-road vehicles to be used in the construction project, including owned, leased and subcontractor vehicles, will achieve a project wide fleet-average 20 percent NOx reduction and 45 percent particulate reduction compared to the most recent California Air Resources Board (ARB) fleet average at time of construction; and

The project representative shall submit [to DERA, City of x, SMAQMD, etc.] a comprehensive inventory of all off-road construction equipment, equal to or greater than 50 horsepower, that will be used an aggregate of 40 or more hours during any portion of the construction project. The inventory shall include the horsepower rating, engine production year, and projected hours of use or fuel throughput for each piece of equipment. The inventory shall be updated and submitted monthly throughout the duration of the project, except that an inventory shall not be required for any 30-day period in which no construction activity occurs. At least 48 hours prior to the use of subject heavy-duty off-road equipment, the project representative shall provide SMAQMD with the anticipated construction timeline including start date, and name and phone number of the project manager and on-site foreman.

Category 2: Controlling visible emissions from off-road diesel powered equipment

The project shall ensure that emissions from all off-road diesel powered equipment used on the project site do not exceed 40 percent opacity for more than three minutes in any one hour. Any equipment found to exceed 40 percent opacity (or Ringelmann 2.0) shall be repaired immediately, and [DERA, City of x, SMAQMD, etc.] shall be notified within 48 hours of identification of non-compliant equipment. A visual survey of all in-operation equipment shall be made at least weekly, and a monthly summary of the visual survey results shall be submitted throughout the duration of the project, except that the monthly summary shall not be required for any 30-day period in which no construction activity occurs. The monthly summary shall include the quantity and type of vehicles surveyed as well as the dates of each survey. The SMAQMD and/or other officials may conduct periodic site inspections to determine compliance. Nothing in this section shall supersede- other SMAQMD or state rules or regulations.

and/or:

If at the time of construction, the SMAQMD has adopted a regulation applicable to construction emissions, compliance with the regulation may completely or partially replace this mitigation. Consultation with SMAQMD prior to construction will be necessary to make this determination.

Some projects require large amounts of material hauling, i.e. demolition, levee work. If material hauling emissions are a significant portion of the daily NOx emissions, a jurisdiction should require mitigation for haul trucks on this type of project. One mitigation strategy is to require the use of trucks with newer model year engines to reduce NOx emissions.

Offsite

Off-Site Construction Mitigation Fee

If the projected construction related emissions for a project are not reduced to the SMAQMD's threshold of significance (85 pounds/day of NOX) by the application of the standard on-site construction mitigation for off-road equipment and mitigation requiring newer model year engines in haul trucks then an off-site construction mitigation fee should be applied.

The SMAQMD has developed a fee calculation spreadsheet which is available for use by jurisdictions. The fee calculation takes into account the excess construction emissions, the number of days those emissions occur, the cost to reduce emissions, and the administrative cost for the SMAQMD to run the mitigation program.[3] This fee is used by the SMAQMD to fund emission reduction programs in the air basin, such as the SMAQMD's Heavy Duty Incentive Program through which select owners of heavy duty equipment in Sacramento County can repower or retrofit their old engines with cleaner engines or technologies.

2. SAN LUIS OBISPO COUNTY AIR POLLUTION CONTROL DISTRICT (SLOAPCD): CONSTRUCTION ACTIVITY MANAGEMENT PLAN GUIDELINES – DECEMBER 2009[4]

A Construction Activity Management Plan (CAMP) may be required by the SLOAPCD for construction projects that will result in significant particulate matter (PM) and/or NOx emission impacts, such as potentially high emissions of fugitive dust or NOx, or emissions in areas where potential nuisance concerns are present. The purpose of the CAMP is to specifically define the mitigation measures that will be employed as the project moves forward, in order to ensure all requirements are accounted for in the project budget, included in the contractor bid specifications, and are fully implemented throughout project construction. The CAMP is a comprehensive mitigation plan and will need to specifically identify all of the mitigation measures to be implemented for the project. The following is a list of potential mitigation measures to include in the CAMP. The CAMP must be submitted to the SLOAPCD for approval prior to the start of the project.

Sensitive Receptors (NOx and PM)

Document the proximity of the project to the nearest sensitive receptor (e.g. residence, school, daycare, hospital or senior center). Tailor the mitigation measures to provide adequate protection to any nearby sensitive receptors. (e.g. of mitigation measures: Locate

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[3] As of May 2012, the current acceptable cost to reduce one ton of emissions is $16,640 (based on the cost effectiveness formula established in California's Carl Moyer Incentive Program).

[4] http://www.slocleanair.org/business/regulations.php

construction staging areas away from sensitive receptors such that exhaust and other construction emissions do not enter the fresh air intakes to buildings, air conditioners, and windows).

Mitigation Monitoring (NOx and PM)

A person or persons must be designated to monitor the CAMP implementation and be responsible for compliance (name and telephone number provided to the SLOAPCD). Their duties shall include holidays and weekend periods when work may not be in progress. Depending on the site location, a certified visible emissions monitor may be required.

Construction Equipment Emission Reductions (NOx and PM)

To mitigate air quality impacts from the emissions of construction equipment engines, the SLOAPCD has project proponents apply various emission reduction methods depending on the magnitude of the project. Below are the methods used:

Standard Control Measures for Construction Equipment

The standard mitigation measures for reducing NOx, reactive organic gases (ROG), and DPM emissions from construction equipment are listed below:

- Maintain all construction equipment in proper tune according to manufacturer’s specifications;
- Fuel all off-road and portable diesel powered equipment with ARB certified motor vehicle diesel fuel (non-taxed version suitable for use off-road);
- Use diesel construction equipment meeting ARB's Tier 2 certified engines or cleaner off-road heavy-duty diesel engines, and comply with the State off-Road Regulation;
- Use on-road heavy-duty trucks that meet the ARB’s 2007 or cleaner certification standard for on-road heavy-duty diesel engines, and comply with the State On-Road Regulation;
- Construction or trucking companies with fleets that that do not have engines in their fleet that meet the engine standards identified in the above two

measures (e.g. captive or NOx exempt area fleets) may be eligible by proving alternative compliance;

- All on and off-road diesel equipment shall not idle for more than 5 minutes. Signs shall be posted in the designated queuing areas and or job sites to remind drivers and operators of the 5 minute idling limit;
- Diesel idling within 1,000 feet of sensitive receptors is not permitted;
- Staging and queuing areas shall not be located within 1,000 feet of sensitive receptors;
- Electrify equipment when feasible;
- Substitute gasoline-powered in place of diesel-powered equipment, where feasible; and,
- Use alternatively fueled construction equipment on-site where feasible, such as compressed natural gas (CNG), liquefied natural gas (LNG), propane or biodiesel.

Best Available Control Technology (BACT) for Construction Equipment

If the estimated construction phase ozone precursor emissions from the actual fleet for a given Phase are expected to exceed the SLOAPCD's threshold of significances after the standard mitigation measures are factored into the estimation, then BACT needs to be implemented to further reduce these impacts. The BACT measures can include:

- Further reducing emissions by expanding use of Tier 3 and Tier 4 off-road and 2010 on-road compliant engines;
- Repowering equipment with the cleanest engines available; and
- Installing ARB verified diesel emission control strategies (VDECS).
- Implementing a design measure to minimize emissions from on and off-road equipment associated with the construction phase. This measure should include but not be limited to the following elements:

- Tabulation of on and off-road construction equipment (type, age, horsepower, engine model year and miles and/or hours of operation);
- Calculate daily worst case emissions and the quarterly emissions that include the overlapping segments of construction phases
- Equipment Scheduling (NOx and PM)
  - Schedule activities to minimize the amount of large construction equipment operating simultaneously during any given time period;
  - Locate staging areas at least 1,000 feet away from sensitive receptors;
  - Where feasible:
    - Limit the amount of cut and fill to 2,000 cubic yards per day;
    - Limit the length of the construction work-day period; and,
    - Phase construction activities.
- On-road Truck Management (NOx and PM)
  - Schedule construction truck trips during non-peak hours to reduce peak hour emissions;
  - Locate staging areas at least 1,000 feet away from sensitive receptors;
  - Proposed truck routes should be evaluated to define routing patterns with the least impact to residential communities and sensitive receptors and identify these receptors in the truck route map;
  - To the extent feasible, construction truck trips should be scheduled during non-peak hours to reduce peak hour emissions; and
  - Trucks and vehicles should be kept with the engine off when not in use, to reduce vehicle emissions. Signs shall be placed in queuing areas to remind drivers to limit idling to no longer than 5 minutes.

Offsite Mitigation for Construction Equipment

If the estimated construction phase ozone precursor emissions from the actual fleet for a given Phase are expected to exceed the SLOAPCD's 6 tons/quarter threshold of significance after the standard and BACT measures are factored into the estimation, then off-site mitigation is appropriate. The current (May 2012) mitigation rate is $16,000 per ton of ozone precursor emission (NOx + ROG) over the SLOAPCD threshold evaluated over the length of the expected exceedance. The applicant may use these funds to implement SLOAPCD approved emission reduction projects near the project site or may pay that funding level plus a 15% administration fee to the SLOAPCD for the SLOAPCD to implement emission reduction projects in close proximity to the project. The applicant shall provide this funding at least two (2) months prior to the start of the project to help facilitate emission offsets that are real-time as possible.

Construction Worker Trips (NOx)

Implement an SLOAPCD approved Trip Reduction Program to reduce construction worker commute trips, which includes carpool matching, vanpooling, transit use, etc. Monitor worker use of alternative transportation throughout the project to ensure compliance.

Complaint Response (NOx and PM)

The CAMP should include a section that addresses complaints and complaint handling. At a minimum this section shall include the following:

- Complete contact information (Title, Phone, Physical Address) for the person(s) responsible for addressing and resolving all complaints regarding the construction activity.
- A hotline telephone number shall be established and publicized to help facilitate rapid complaint identification and resolution. In addition, Prop 65 notification with regard to toxic diesel emissions shall to be made.
- An action plan section shall be outlined that includes additional measures or modifications to existing mitigation measures in the event of complaints.
- All complaints shall be reported immediately to the SLOAPCD.

3. SAN JOAQUIN VALLEY AIR POLLUTION CONTROL DISTRICT (SJVAPCD): GUIDE FOR ASSESSING AND MITIGATING AIR QUALITY IMPACTS (GUIDELINES) – JANUARY 2002[5]

The discussion of construction impacts and mitigation measures in these Guidelines focuses primarily on PM10 emissions from fugitive dust sources. However, Lead Agencies seeking to reduce emissions from construction equipment exhaust should also consider the mitigation measures in Table F-1 (below). The SJVAPCD recognizes that these measures are difficult to implement due to poor availability of alternative fueled equipment and the challenge of monitoring these activities (as of January 2002).

TABLE F-1. SJVAPCD CONSTRUCTION EQUIPMENT MITIGATION MEASURES

Emission Source	Mitigation Measure
Heavy duty equipment (scrapers, graders, trenchers, earth movers, etc.)	Use of alternative fueled or catalyst equipped diesel construction equipment
	Minimize idling time (e.g., 10 minute maximum)
	Limit the hours of operation of heavy duty equipment and/or the amount of equipment in use
	Replace fossil-fueled equipment with electrically driven equivalents (provided they are not run via a portable generator set)
	Curtail construction during periods of high ambient pollutant concentrations; this may include ceasing of construction activity during the peak-hour of vehicular traffic on adjacent roadways
	Implement activity management (e.g. rescheduling activities to reduce short-term impacts)

4. THE NORTHEAST DIESEL COLLABORATIVE (NEDC): DIESEL EMISSION CONTROLS IN CONSTRUCTION PROJECTS MODEL CONTRACT SPECIFICATION – DECEMBER 2010[6]

NEDC is a regionally coordinated initiative to reduce diesel emissions, improve public health, and promote clean diesel technology. Members of NEDC include United States Environmental Protection Agency (USEPA) Regions 1 and 2, the environmental agencies of the eight northeastern states and Puerto Rico, Northeast States for Coordinated Air Use Management, MJ Bradley and Associates, AJW, Inc. and Corning, Inc.

NEDC recommends that contracts for all construction projects require the diesel control measures outlined below. As the public health risks from exposure to diesel exhaust are of paramount concern, institutions, municipalities, agencies and private contractors that want a phased adoption of contract requirements could focus *initially* on projects including, but not limited to, those located (1) in urban areas, (2) within 500 feet of a school, hospital,

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[5] http://www.valleyair.org/transportation/ceqa_idx.htm

[6] http://northeastdiesel.org/pdf/NEDC-Construction-Contract-Spec.pdf

daycare facility, elderly housing, convalescent facility, or similar facility, (3) in poor air quality areas, (4) in densely populated areas or (5) in any other areas which receive a disproportionate quantity of air pollution from diesel fleets.

Model Contract Specification

1. Diesel Emission Control Technology[7]

   a. Diesel Onroad Vehicles

   All diesel onroad vehicles on site for more than 10 total days must have either (1) engines that meet USEPA 2007 onroad emissions standards or (2) emission control technology verified by USEPA or the ARB to reduce PM emissions by a minimum of 85%.[8]

   b. Diesel Generators

      i. All diesel generators on site for more than 10 total days must be equipped with emission control technology verified by USEPA or ARB to reduce PM emissions by a minimum of 85%.

   c. Diesel Nonroad Construction Equipment

      i. All nonroad diesel engines on site must be Tier 2 or higher. Tier 0 and Tier 1 engines[9] are not allowed on site.

      ii. All diesel nonroad construction equipment on site for more than 10 total days must have either (1) engines meeting USEPA Tier 4 nonroad emission standards or (2) emission control technology verified by USEPA or ARB for use with nonroad engines to reduce PM emissions by a minimum of 85% for engines 50 horsepower (hp) and greater and by a minimum of 20% for engines less than 50 hp.

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[7] Diesel emission control technology requirements apply to all equipment onsite powered by diesel engines, whether owned, leased or rented by the contractor.

[8] In all instances "verified" means verified for use with the specific onroad, nonroad, or generator engine.

[9] Machines with engines which have been repowered by Tier 2 engines, or engines upgraded from Tier 0 or 1 to Tier 2 using original equipment manufacturers approved conversion kit and certified by the original equipment manufacturer to Tier 2 standard performance are acceptable.

d. Upon confirming that the diesel vehicle, construction equipment, or generator has either an engine meeting Tier 4 non road emissions standards or emission control technology, as specified above, installed and functioning, the developer will issue a compliance sticker. All diesel vehicles, construction equipment, and generators on site shall display the compliance sticker in a visible, external location as designated by the developer.

e. Emission control technology shall be operated, maintained, and serviced as recommended by the emission control technology manufacturer.

f. All diesel vehicles, construction equipment, and generators on site shall be fueled with ultra-low sulfur diesel fuel (ULSD) or a biodiesel blend[10] approved by the original engine manufacturer with sulfur content of 15 parts per million or less.

2. Idling Requirements

a. During periods of inactivity, idling of diesel onroad vehicles and nonroad equipment shall be minimized and shall not exceed the time allowed under state and local laws.[11] In the absence of state or local idling regulations, idling shall not exceed three minutes in any sixty-minute period.

b. Exemptions, if any, from state or local idling laws are specified by those laws, which shall be enforced on site. In locations without prevailing state or local idling regulations, idling for more than three minutes over a sixty-minute period is permitted only under the following circumstances:

i. When an onroad diesel vehicle or nonroad construction equipment is forced to remain motionless because of traffic conditions or mechanical difficulties over which the operator has no control;

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[10] Biodiesel blends are only to be used in conjunction with the technologies which have been verified for use with biodiesel blends and are subject to the following requirements http://www.arb.ca.gov/diesel/verdev/reg/biodieselcompliance.pdf.

[11] Idling regulations for the Northeast states are available on the NEDC website at www.northeastdiesel.org.

ii. To bring the onroad diesel vehicle, nonroad construction equipment, or generator to the manufacturer's recommended operating temperature;

iii. When there are regulations requiring temperature control for driver or passenger comfort and there are no auxiliary power sources available to provide temperature control;

iv. When it is necessary to operate auxiliary equipment that is located in or on the diesel vehicle or construction equipment, to accomplish the intended use of the vehicle or equipment (for example, cranes and cement mixers);

v. When the onroad diesel vehicle, nonroad construction equipment, or generator is being repaired, if idling is necessary for such repair; and/or

vi. When the onroad diesel vehicle, nonroad construction equipment, or generator is queued for inspection, if idling is necessary for such inspection.

3. Exemptions[12]

i. Onroad diesel vehicles, nonroad construction equipment, and generators on site for 10 working days or less over the life of the project need not install emission control technology. This equipment must be included on the equipment list submitted by the contractor and approved by the developer.

ii. Until December 31, 2012, if the contractor can prove to the developer's satisfaction that a piece of nonroad construction equipment planned for use on site had been retrofitted with emission control technology verified by USEPA or ARB for use with nonroad engines to reduce PM emissions by a minimum of 20% prior to the award of this contract and provided that the emission control technology is in working order and within its

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[12] Exemptions in this section apply only to emission control technology requirements and do not in anyway exempt the contactor from meeting the requirement that all engines onsite must be Tier 2 or higher as specified in section 1.c.

useful life, the contractor need not install additional or alternative emission control technology on the specified piece of nonroad construction equipment.

iii. If the contractor can prove to the developer’s satisfaction that for a particular class of onroad diesel vehicle, nonroad construction equipment, or generator, (1) no alternative equipment with a Tier 4 engine is available, (2) it is not technically feasible to meet the control level specified above with a verified device, or (3) installing the control device would create a safety hazard or impaired visibility for the operator, then the contractor may, with the developer’s written approval, drop down to a lower level of control.

iv. The developer’s representative may create an exemption when there is a compelling emergency need to use diesel vehicles or engines that do not meet the contract conditions for emission controls. An example would be the need for rescue vehicles or other equipment to prevent or remedy harm to human beings or nearby property. Meeting contract deadlines, failure to rent equipment in a timely manner, planned unavailability, or lack of advance planning are not considered compelling emergencies.

v. The developer may provide an exemption lasting no more than 30 days to a contractor, if the contractor can prove with valid documentation and to the developer's satisfaction that the appropriate emission control equipment has been ordered in a timely manner after the bid was awarded, but has yet to be installed due to delays attributable to the equipment manufacturer and beyond the control of the contractor. The contractor must install the retrofit as soon as practicable once it has been delivered, and shall submit proof thereof when installation is complete. Provided, however, that such exemption shall not be available to a contractor who already owns an equivalent piece of equipment that meets the engine requirements for the project, as the contractor may use that piece of equipment.

4. Additional Diesel Requirements

a. Construction shall not proceed until the contractor submits a certified list of all diesel vehicles, construction equipment, and generators to be used on site. The list shall include the following[13]:

i. Contractor and subcontractor name and address, plus contact person responsible for the vehicles or equipment.

ii. Equipment type, equipment manufacturer, equipment serial number, engine manufacturer, engine model year, engine certification (Tier rating), horsepower, engine serial number, and expected fuel usage and hours of operation.

iii. For the emission control technology installed: technology type, serial number, make, model, manufacturer, USEPA/ARB verification number/level, and installation date and hour-meter reading on installation date.

iv. The Certification Statement[14] signed and printed on the contractor's letterhead.

b. If the contractor subsequently needs to bring on site equipment not on the list, the contractor shall submit written notification within 24 hours that attests the equipment complies with all contract conditions and provide information asked for in 4(a).

c. All diesel equipment shall comply with all pertinent local, state, and federal regulations relative to exhaust emission controls and safety.

d. The contractor shall establish generator sites and truck-staging zones for vehicles waiting to load or unload material on site. Such zones shall be located where diesel emissions have the least impact on abutters, the general public, and

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[13] USEPA's Construction Fleet Inventory Guide is a useful tool in identifying the information required: http://www.epa.gov/cleandiesel/documents/420b10025.pdf.

[14] The NEDC Model Certification Statement can be found in Appendix A to the Model.

especially sensitive receptors such as hospitals, schools, daycare facilities, elderly housing, and convalescent facilities.

5. Reporting

   a. The contractor shall submit to the developer's representative a monthly report that, for each onroad diesel vehicle, nonroad construction equipment, or generator onsite, includes:

      i. Hour-meter readings on arrival on-site, the first and last day of every month, and on off-site date

      ii. Any problems with the equipment or emission controls.

      iii. Certified copies of fuel deliveries for the time period that identify:

         1. Source of supply

         2. Quantity of fuel

         3. Quality of fuel, including sulfur content (percent by weight).

6. Compliance

All onroad diesel vehicles, nonroad construction equipment, and generators must be compliant with these provisions whenever they are present on the project site. The contractor's compliance with this notice shall not be grounds for claims as outlined in Section ____. *[developer inserts reference to appropriate section in its standard contract]*

7. Non-Compliance

   a. If any onroad diesel vehicle, nonroad construction equipment, or generator is found to be in non-compliance with the contract terms, the equipment will be immediately removed from the job site and *[developer inserts penalties consistent with others specified in contract]*.

   b. Once the contractor has brought previously non-compliant machinery into compliance, the developer's representative shall promptly issue the contractor a written acknowledgment of compliance.

5. LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY (LACMTA): GREEN CONSTRUCTION POLICY – JULY 2011[15]

LACMTA's Green Construction Policy provides requirements for 1) identifying and mitigating air emission impacts on human health, environment, and climate of on-road and off-road construction equipment and generators used in their construction and development activities; 2) implementing appropriate BMPs to complement equipment mitigations; and 3) implementing strategies to ensure compliance with this policy.

5.1 Construction Equipment

Construction Equipment (excluding On-Road Equipment)

1) Construction equipment shall incorporate, where feasible, emissions-reducing technology such as hybrid drives and specific fuel economy standards.

2) Idling shall be restricted to a maximum of 5 minutes, except as provided in the exceptions to the applicable ARB regulations regarding idling.

3) Equipment Engine Specifications:

    a. Prior to December 31, 2011: All off-road diesel-powered construction equipment greater than 50 horsepower (hp) shall meet Tier-2 off-road emission standards at a minimum. In addition, all construction equipment greater than 50 hp shall be retrofitted with a ARB-verified Level 3 Diesel Emissions Control Device system (DECS).

    b. From January 1, 2012, to December 31, 2014: All off-road diesel-powered construction equipment greater than 50 hp shall meet Tier-3 off-road emission standards at a minimum. In addition, all construction equipment greater than 50 hp shall be retrofitted with a ARB Level 3 VDECS. Any emissions control device used by the Contractor shall achieve emissions reductions that are no less than what could be achieved by a Level 3 diesel emissions control strategy for a similarly sized engine as defined by ARB regulations.

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[15] http://www.metro.net/board/Items/2011/06_June/20110615EMACItem10.pdf

c. From January 1, 2015 and onwards: All off-road diesel-powered construction equipment greater than 50 hp shall meet Tier-4 off-road emission standards at a minimum. In addition, if not already supplied with a factory-equipped diesel particulate filter, all construction equipment shall be outfitted with BACT devices certified by ARB. Any emissions control device used by the Contractor shall achieve emissions reductions that are no less than what could be achieved by a Level 3 diesel emissions control strategy for a similarly sized engine as defined by ARB regulations.

On-Road Equipment

1) Trucks or equipment hauling material such as debris or any fill material shall be fully covered while operating at, to and from the LACMTA construction project.

2) Idling shall be restricted to a maximum of 5 minutes, except as provided in the exceptions to the applicable ARB regulations regarding idling.

3) USEPA Standards:

a) Prior to December 31, 2013: All on-road heavy-duty diesel trucks or equipment with a gross vehicle weight rating (GVWR) of 19,500 pounds or greater shall meet or exceed the USEPA 2007 on-road emission standards for PM (0.01 g/bhp-hr); or shall be equipped with a ARB verified Level 3 diesel particulate filter.

b) From January 1, 2014 and onwards: All on-road heavy-duty diesel trucks or equipment with a GVWR of 19,500 pounds or greater shall comply with USEPA 2007 on-road emission standards for PM and NO (0.01 g/bhp-hr and at least 1.2 g/bhp-hr, respectively).

Generators

Every effort shall be made to utilize grid-based electric power at any construction site, where feasible. Where access to the power grid is not available, on-site generators must:

1) Meet a 0.01 gram per brake-horsepower-hour standard for PM, or

2) Be equipped with BACT for PM emissions reductions.

Exceptions

These on-road and off-road construction equipment and generator requirements shall apply unless any of the following circumstances exist and the Contractor provides a written finding consistent with project contract requirements that:

1) The Contractor intends to meet the requirements of this policy as to a particular vehicle or piece of equipment by leasing or short-term rental, and the Contractor has attempted in good faith and due diligence to lease the vehicle or equipment that would comply with this policy, but that vehicle or equipment is not available for lease or short-term rental within 200 miles of the project site, and the Contractor has submitted documentation to LACMTA showing that the requirements of this Exception provision apply.

2) The Contractor has been awarded funding by SCAQMD or another agency that would provide some or all of the cost to retrofit, repower, or purchase a piece of equipment or vehicle, but the funding has not yet been provided due to circumstances beyond the Contractor's control, and the Contractor has attempted in good faith and due diligence to lease or short-term rent the equipment or vehicle that would comply with this policy, but that equipment or vehicle is not available for lease or short-term rental within 200 miles of the project site, and the Contractor has submitted documentation to LACMTA showing that the requirements of this Exception provision apply.

3) Contractor has ordered a piece of equipment or vehicle to be used on the construction project in compliance with this policy at least 60 days before that equipment or vehicle is needed at the project site, but that equipment or vehicle has not yet arrived due to circumstances beyond the Contractor's control, and the Contractor has attempted in good faith and due diligence to lease or short-term rent a piece of equipment or vehicle to meet the requirements of this policy, but that equipment or vehicle is not available for lease or short-term rental within 200 miles of the project, and the Contractor has submitted documentation to LACMTA showing that the requirements of this Exception provision apply.

4) Construction-related diesel equipment or vehicle will be used on an LACMTA construction project site for fewer than 10 calendar days per calendar year. The Contractor shall not consecutively use different equipment or vehicles that perform

the same or a substantially similar function in an attempt to use this Exception to circumvent the intent of this policy.

In any of the situations described above, the Contractor shall provide the next cleanest piece of equipment or vehicle as provided by the step down schedules in Table F-2 for Off-Road Equipment and Table F-3 for On-Road Equipment.

TABLE F-2. OFF-ROAD COMPLIANCE STEP DOWN SCHEDULE*

Compliance Alternative	Engine Standard	ARB VDECS
1	Tier4	N/A**
2	Tier3	Level 3
3	Tier 2	Level 3
4	Tier 1	Level 3
5	Tier 2	Level 2
6	Tier 2	Level 1
7	Tier 2	Uncontrolled
8	Tier 1	Level 2

Equipment less than Tier 1, Level 2 shall not be permitted.

TABLE F-3. ON-ROAD COMPLIANCE STEP DOWN SCHEDULE*

Compliance Alternative	Engine Model Year	ARB VDECS
1	2010	N/A
2	2007	N/A**
3	2004	Level3
4	1998	Level3
5	2004	Uncontrolled
6	1998	Uncontrolled

Equipment with a model year earlier than Model Year 1998 shall not be permitted.

*How to use Table F-2 and Table F-3. For example, if Compliance Alternative #3 is required by this policy but a Contractor cannot obtain an off-road vehicle that meets the Tier 2 engine standard that is equipped with a Level 3 VDECS (Compliance Alternative #3 in Table F-2) and meets one of the above exceptions, then the Contractor shall use a vehicle that meets the next compliance alternative (Compliance Alternative #4) which is a Tier 1 engine standard equipped with a Level 3 VDECS.

**Tier 4 or 2007 Model Year equipment not already supplied with a factory-equipped diesel particulate filter shall be outfitted with Level 3 VDECS.

5.2 BEST MANAGEMENT PRACTICES

In addition to equipment requirements, the Best Management Practices (BMPs) listed below are imposed on all construction projects that performed on LACMTA properties and rights-of-way. BMPs shall include, at a minimum:

1) Use of diesel particulate traps or best available control technology, as feasible;

2) Maintain equipment according to manufacturers' specifications;

3) Restrict idling of construction equipment and on-road heavy-duty trucks to a maximum of 5 minutes when not in use, except as provided in the exceptions to the applicable ARB regulations regarding idling for off-road and on-road equipment;

4) Maintain a buffer zone that is a minimum of 1,000 feet between truck traffic and sensitive receptors, where feasible;

5) Where applicable and feasible, work with local jurisdictions to improve traffic flow by signal synchronization;

6) If feasible and as allowed by local jurisdictions, configure construction parking to minimize traffic interference;

7) Enforce truck parking restrictions, where applicable;

8) Prepare haul routes that conform to local requirements to minimize traversing through congested streets or near sensitive receptor areas;

9) Provide dedicated turn lanes for movement of construction trucks and equipment on- and off-site, as feasible;

1 0) Schedule construction activities that affect traffic flow on the arterial system to off-peak hours to the extent practicable;

11) Use electric power in lieu of diesel power where available; and

12) Traffic speeds on all unpaved roads to be 15 mph or less.

6. THE PORT OF LOS ANGELES (THE PORT): LOS ANGELES HARBOR DEPARTMENT SUSTAINABLE CONSTRUCTION GUIDELINES (GUIDELINES) FOR REDUCING AIR EMISSIONS – FEBRUARY 2008[16]

These measures are expected to reduce DPM, GHGs, and criteria air pollutants. The Port is committed to developing and implementing planning, design, and construction practices that minimize air pollutants to the extent feasible for all future projects.

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[16] http://www.portoflosangeles.org/Board/2008/February/022108_item10_trans.pdf

The intent of the Guidelines is to facilitate the integration of sustainable concepts and practices into all capital projects at the Port, and to phase-in the implementation of these procedures in a practical yet aggressive manner. Following approval, these guidelines will be made a part of all construction specifications advertised for bids.

Significant features of these Guidelines include, but are not limited to:

- On-road heavy-duty trucks shall comply with USEPA 2004 on-road emission standards for PM10 and NOx and shall be equipped with a ARB verified Level 3 device. Emission standards will be raised to USEPA 2007 on-road emission standards for PM10 and NOx by January 1, 2012.
- Construction equipment (excluding on-road trucks, derrick barges, and harbor craft) shall meet Tier-2 emission off-road standards. The requirement will be raised to Tier 3 by January 1, 2012, and Tier 4 by January 1, 2015. In addition, construction equipment shall be retrofitted with a ARB certified Level 3 diesel emissions control device.
- Additional Best Management Practices, based on BACT, will be required on construction equipment (including onroad trucks) to further reduce air emissions. The above measures shall be met unless a piece of specialized equipment is unavailable within the State of California (including through a leasing agreement); a contractor has applied for necessary incentive funds to put controls on a piece of equipment but the application or funding process is not yet complete; or a contractor has ordered a control device for a piece of equipment but that order has not been completed by the manufacturer and the contractor is unable to lease the device from a dealer within 200 miles of the project.

7. FEATHER RIVER AIR QUALITY MANAGEMENT DISTRICT (FRAQMD): INDIRECT SOURCE REVIEW GUIDELINES – JUNE 2010[17]

The following are mitigation measures that can be used to reduce the impact to sensitive receptors from off-road diesel equipment:

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[17] http://www.fraqmd.org/CEQA%20Planning.html

- Install diesel particulate filters or implement other ARB VDECS on all construction equipment to further reduce DPM emissions beyond the 45% reduction required by the FRAQMD's Best Available Mitigation Measures for Construction Phase;
- Use equipment during times when receptors are not present (e.g., when school is not in session or during non-school hours; or when office buildings are unoccupied);
- Establish staging areas for the construction equipment that are as distant as possible from offsite receptors;
- Establish an electricity supply to the construction site and use electric powered equipment instead of diesel-powered equipment or generators, where feasible;
- Use haul trucks with on-road engines instead of off-road engines even for on-site hauling;
- Equip nearby buildings with High Efficiency Particle Arresting (HEPA) filter systems at all mechanical air intake points to the building to reduce the levels of DPM that enter the buildings; and/or
- Temporarily relocate receptors during construction activity.

Lead agencies should consider the applicability and feasibility of each measure on a project by project basis. The FRAQMD also encourages lead agencies to develop additional measures.

8. NATURAL RESOURCES DEFENSE COUNCIL (NRDC): GOLD STANDARD FOR CLEAN CONSTRUCTION – 2012

CEQA Standards for Clean Construction

All CEQA projects should meet the following standards for construction to minimize air quality, public health and climate impacts.

Construction Equipment

Equipment[18] greater than 25 horsepower must:

(1) Meet current emission standards[19] *and*

(2) Be equipped with BACT[20] for emissions reductions of PM and NOx, *or*

(3) Use an alternative fuel.[21]

Diesel Trucks

On-road trucks used at construction sites, such as dump trucks, must:

(1) Meet current emission standards, *or*

(2) Be equipped with BACT[22] for emissions reductions of PM and NOx, *and*

(3) Any trucks hauling materials such as debris or fill, must be fully covered while operating off-site (i.e. in transit to or from the site).

Generators

Where access to the power grid is limited, on-site generators must:

(1) Meet the equivalent current off-road standards for NOx , *and*

(2) Meet a 0.01 gram per brake-horesepower-hour standard for PM, *or*

(3) Be equipped with BACT for emissions reductions of PM.

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[18] Equipment refers to vehicles such as excavators, backhoes, bulldozers propelled by an off-road diesel internal combustion engine.

[19] These standards are described in Division 3 Chapter 9, Article 4, Section 2423(b)(1)(A) of Title 13 of the California Code of Regulations, as amended. An explanation of current and past engine standards can also be accessed at http://www.dieselnet.com/standards/. Currently all new equipment are meeting the USEPA Tier II standards and most equipment also meets Tier III standards (all 100HP to 750HP equipment). Note that Tier IV standards would automatically meet the BACT requirement.

[20] Here BACT refers to the most effective VDECS, which is a device, system or strategy that is verified pursuant to Division 3 Chapter 14 of Title 13 of the California Code of Regulations to achieve the highest level of pollution control from an off-road vehicle.

[21] This could include natural gas or biodiesel, which is a fuel comprised of mono-alkyl esters of long chain fatty acids derived from vegetable oils or animal fats, meeting the requirements of ASTM D 6751. However, biodiesel must be proven to be sourced from sustainable feedstocks including waste grease, fats or oil and under certain circumstances, farmed oils that can be proven to be sustainable.

[22] Here BACT also refers to most effective VDECS as defined by the ARB.

Special Precautions Near Sensitive Sites

All equipment operating on construction sites within 1,000 feet of a sensitive receptor site (such as schools, daycares, playgrounds and hospitals)[23] would either:

(1) Meet USEPA Tier IV emission standards *or*

(2) Install ARB Verified "Level 3" controls (85% or better PM reductions), and

(3) Notify each of those sites of the project, in writing, at least 30 days before construction activities begin.[24]

Recommendations to Limit Global Warming Pollution from Construction:

(1) Prohibit all non-essential idling of equipment and vehicles onsite.

(2) Use the lowest carbon fuels possible (such as biodiesel or other alternative fuels).

(3) Electrify operations to the extent possible. Where access to the power grid is possible, this should be established instead of using stationary or mobile power generators. All cranes, forklifts and equipment that can be electrified, should be.

(4) All constructed buildings should meet the Leadership in Energy and Environmental Design (LEED) Green Building Rating System™ including the use of locally sourced materials, where possible.[25]

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[23] Sensitive sites are defined and described in the ARB Air Quality and Land Use Planning Guidelines, 2005; http://www.arb.ca.gov/ch/landuse.htm.

[24] Notification shall include the name of the project, location, extent (acreage, number of pieces of equipment operating and duration), any special considerations (such as contaminated waste removal or other hazards), and contact information for a community liaison who can answer any questions.

[25] For information on LEED standards, see the U.S. Green Building Council: http://www.usgbc.org/DisplayPage.aspx?CategoryID=19

9. BAY AREA AIR QUALITY MANAGEMENT DISTRICT (BAAQMD): CEQA AIR QUALITY GUIDELINES – MAY 2012[26]

BAAQMD recommends implementing the *Basic Construction Mitigation Measures* for all construction projects, and if necessary, the *Additional Construction Mitigation Measures*, listed below to mitigate construction impacts.

Basic Construction Mitigation Measures

6. Idling times shall be minimized either by shutting equipment off when not in use or reducing the maximum idling time to 5 minutes (as required by the California airborne toxics control measure Title 13, Section 2485 of California Code of Regulations [CCR]). Clear signage shall be provided for construction workers at all access points.
7. All construction equipment shall be maintained and properly tuned in accordance with manufacturer's specifications. All equipment shall be checked by a certified visible emissions evaluator.

Additional Construction Mitigation Measures

9. Minimizing the idling time of diesel powered construction equipment to two minutes.
10. The project shall develop a plan demonstrating that the off-road equipment (more than 50 horsepower) to be used in the construction project (i.e., owned, leased, and subcontractor vehicles) would achieve a project wide fleet-average 20 percent NOX reduction and 45 percent PM reduction compared to the most recent ARB fleet average. Acceptable options for reducing emissions include the use of late model engines, low-emission diesel products, alternative fuels, engine retrofit technology, after-treatment products, add-on devices such as particulate filters, and/or other options as such become available.
12. Requiring that all construction equipment, diesel trucks, and generators be equipped with Best Available Control Technology for emission reductions of NOx and PM.
13. Requiring all contractors use equipment that meets ARB's most recent certification standard for off-road heavy duty diesel engines.

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[26] http://www.baaqmd.gov/Divisions/Planning-and-Research/CEQA-GUIDELINES/Updated-CEQA-Guidelines.aspx