California Environmental Protection Agency

Air Resources Board

Health Risk Assessment for the UP Intermodal Container Transfer Facility (ICTF) and Dolores Railyards

Stationary Source Division
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I. INTRODUCTION

The California Air Resources Board (ARB or Board) conducted a health risk assessment study (study) to evaluate the impacts associated with toxic air contaminants emitted in and around the Union Pacific Railroad (UP) Intermodal Container Transfer Facility (ICTF) and Dolores Railyards, located in Long Beach and the City of Carson, California. The facility includes the ICTF Railyard between East Sepulveda Boulevard and East 223rd Street and the Dolores yard along the Alameda Corridor[1] (parallel to South and North Alameda Street) to the northwest of I-405. The ICTF Railyard is about 1.8 miles long and located 4 miles north of the Port of Long Beach. The study focused on the railyard property emissions from locomotives, on-road heavy-duty trucks, off-road vehicles, and equipment used to move bulk cargo. Also evaluated were mobile and stationary sources with significant emissions within a one-mile distance from the railyards. This information was used to evaluate the potential health risks associated with diesel particulate matter emissions to those living nearby the railyards.

A. Why ARB is concerned about diesel PM emissions?

In 1998, following a 10-year scientific assessment process, ARB identified particulate matter from diesel exhaust (diesel PM) as a toxic air contaminant based on its potential to cause cancer and other adverse health problems, including respiratory illnesses, and increased risk of heart disease. Subsequent to this action, research has shown that diesel PM contributes to premature deaths[2](ARB, 2002). The diesel PM particles are very small; moreover, by mass approximately 94% of these particles are less than 2.5 microns in diameter ($PM_{2.5}$). Because of their tiny size, diesel PM particles are readily respirable and can penetrate deep into the lung and enter the bloodstream, carrying with them an array of toxins. Exposure to diesel PM is a health hazard, particularly to children whose lungs are still developing and the elderly who may have other serious health problems. Population-based studies in hundreds of cities in the U.S. and around the world demonstrate a strong link between elevated PM levels and premature deaths (Pope et al., 1995, 2002 and 2004; Krewski et al., 2000), increased hospitalizations for respiratory and cardiovascular causes, asthma and other lower respiratory symptoms, acute bronchitis, work loss days, and minor restricted activity days (ARB, 2006a).

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[1] The Alameda Corridor is a 20-mile-long rail cargo expressway linking the ports of Long Beach and Los Angeles to the transcontinental rail network near downtown Los Angeles. It is a series of bridges, underpasses, overpasses and street improvements that separate freight trains from street traffic and passenger trains, facilitating a more efficient transportation network. The project's centerpiece is the Mid-Corridor Trench, which carries freight trains in an open trench that is 10 miles long, 33 feet deep and 50 feet wide between State Route 91 in Carson and 25th Street in Los Angeles. The Construction of the Alameda Corridor began in 1997. Operations began in 2002 and are governed by the Alameda Corridor Transportation Authority. For more information on the Alameda Corridor, see http://www.acta.org/.

[2] Premature Death: as defined by U.S. Centers for Disease Control and Prevention's Years of Potential Life Lost, any life ended before age 75 is considered as premature death.

Diesel PM emissions are the dominant toxic air contaminants in and around a railyard facility. Statewide, diesel PM accounts for about 70% of the estimated potential ambient air toxic cancer risks based on an analysis conducted by ARB staff in 2000 (ARB, 2000). That analysis also indicated that residents in the South Coast Air Basin (SCAB) had higher estimates of risk than elsewhere in the State. These findings are consistent with the preliminary findings reported in a recently released draft report entitled the "*Multiple Air Toxics Exposure Study in the South Coast Air Basin (SCAQMD, 2008)".* This study reported that diesel PM emissions have decreased, but these emissions are still the major contributor to air toxics risk in the SCAB, accounting for over 80% of the total risk from air toxics in the region. The higher percentage contribution over the previously reported 70% reflects the fact that there has been a proportionally greater reduction in other air toxics, such as benzene and 1,3-butadiene. Based on scientific research findings and the dominance of diesel PM emissions, the health impacts in this railyard health risk assessment study primarily focus on the risks from the diesel PM emissions.

B. Why evaluate diesel PM emissions at the UP ICTF/Dolores Railyards?

In 2005, the ARB entered into a statewide railroad pollution reduction agreement (Agreement) with Union Pacific Railroad (UP) and BNSF Railway (BNSF). This Agreement was developed to implement near-term measures to reduce diesel PM emissions in and around railyards by approximately 20 percent.

The Agreement requires that health risk assessments be prepared for each of the 17 major or designated railyards in the State. The Agreement also requires the railyard health risk assessments to be prepared based on the experience of the UP Roseville Railyard Health Risk Assessment study in 2004 (ARB, 2004a) and the Health Assessment Guidance for Railyards and Intermodal Facilities (ARB, 2006b). The UP ICTF/Dolores Railyards is one of the designated railyards subject to the Agreement and the health risk assessment requirements.

C. What are health risk assessments?

An exposure assessment is an analysis of the amount (i.e., concentration in the air) of a pollutant that a person is exposed to in a specific time period. This information is used in a risk assessment to evaluate the potential for an air pollutant to contribute to cancer or other health effects. A health risk assessment uses mathematical models to evaluate the health impacts from exposure to certain chemical or toxic air contaminants released from a facility or found in the air. Health risk assessments provide information to estimate potential long-term cancer and non-cancer health risks. Health risk assessments do not gather information or health data on specific individuals, but are estimates for the potential health impacts on a population at large.

A health risk assessment consists of three major components: (1) the air pollution emission inventory, (2) the air dispersion modeling, and (3) an assessment of associated risks. The air pollution emission inventory provides an estimate of how air pollutants are generated from different emission sources. The air dispersion modeling incorporates the estimated emission inventory and meteorological data as inputs, and then uses a computer model to predict the distributions of air toxics in the air. Based on the modeling results, an assessment of the potential health risks from the air toxics to exposed population is performed. The results are expressed in a number of ways as summarized below.

- For potential cancer health effects, the risk is usually expressed as the number of chances in a population of a million people. The number may be stated as “10 in a million” or “10 chances per million”. The methodology used to estimate the potential cancer risks is consistent with the Tier-1 analysis of *Air Toxics Hot Spots Program Risk Assessment Guidelines* (OEHHA, 2003). A Tier-1 analysis assumes that an individual is exposed to an annual average concentration of a given pollutant continuously for 70 years. The length of time that an individual is exposed to a given air concentration is proportional to the risk. During childhood, the impact from exposure to a given air concentration is greater. Exposure durations of 30 years or 9 years may also be evaluated as supplemental information to present the range of cancer risk based on residency period.

- For non-cancer health effects, a reference exposure level (REL)[3] is used to estimate if there will be certain identified adverse health impacts, such as lung irritation, liver damage, or birth defects. These adverse health effects may happen after chronic (long-term) or acute (short-term) exposure. To calculate a non-cancer health risk, the reference exposure level (REL) is compared to the concentration that a person is exposed to and a hazard index (HI) is calculated. The higher the hazard index is above 1.0, the greater the potential for possible adverse health impacts. If the hazard index is less than 1.0, then it is an indicator that adverse effects are less likely to occur.

- For premature deaths linked to diesel PM emissions in the South Coast Air Basin, ARB staff estimated about 1,300 premature deaths per year due to diesel exhaust exposure in 2000 (ARB Research Division, and Lloyd and Cackette, 2001). The

[3] The Reference Exposure Level (REL) for diesel PM is essentially the U.S. EPA Reference Concentration first developed in the early 1990s based on histological changes in the lungs of rats. Since the identification of diesel PM as a Toxic Air Contaminant (TAC), California has evaluated the latest literature on particulate matter health effects to set the Ambient Air Quality Standard. Diesel PM is a component of particulate matter. Health effects from particulate matter in humans include illness and death from cardiovascular and respiratory disease, and exacerbation of asthma and other respiratory illnesses. Additionally, a body of literature has been published, largely after the identification of diesel PM as a TAC and adoption of the REL, which shows that diesel PM can enhance allergic responses in humans and animals. Thus, it should be noted that the REL does not reflect adverse impacts of particulate matter on cardiovascular and respiratory disease and deaths, exacerbation of asthma, and enhancement of allergic response.

total diesel PM emission from all sources in the South Coast Air Basin is about 7,750 tons per year in 2005 (ARB, 2006a). Diesel PM emissions in 2005 from the UP ICTF Railyards are estimated at about 24 tons (including 3.4 tons of off-site locomotive and heavy heavy duty truck travel within 0.5 miles from the facility), about 0.3% of total air basin emissions. In comparison with another regional major source of diesel PM emissions in the South Coast Air Basin, the combined diesel PM emissions from the Port of Los Angeles/Port of Long Beach were estimated to be about 1,760 tons per year, which resulted in an estimated 29 premature deaths annually (ARB, 2006b).

The potential cancer risk from known carcinogens estimated from the health risk assessment is expressed as the incremental number of potential cancers that could develop per million people, assuming population is exposed to the carcinogen at a defined concentration over a presumed 70-year lifetime. The ratio of potential number of cancers per million people can also be interpreted as the incremental likelihood of an individual exposed to the carcinogen developing cancer from continuous exposure over a lifetime. For example, if the cancer risk were estimated to be 100 chances per million, then the probability of an individual developing cancer would not be expected to exceed 100 chances in a million. If a population (e.g., one million people) were exposed to the same potential cancer risk (e.g., 100 chances per million), then statistics would predict that no more than 100 of those million people exposed would be likely to develop cancer from a lifetime of exposure (i.e., 70 years) to diesel PM emissions from a facility.

The health risk assessment is a complex process that is based on current knowledge and a number of assumptions. However, there is a certain extent of uncertainty associated with the process of risk assessment. The uncertainty arises from lack of data in many areas, necessitating the use of assumptions. The assumptions used in the assessment are often designed to be conservative on the side of health protection in order to avoid underestimation of risk to the public. As indicated by the OEHHA Guidelines, the Tier-1 evaluation is useful in comparing risks among a number of facilities and similar sources. Thus, the risk estimates should not be interpreted as a literal prediction of disease incidence in the affected communities but more as a tool for comparison of the relative risk between one facility and another. Therefore, risk assessment results are best used for comparing potential risks to target levels to determine the level of mitigation needed. They are also an effective tool for determining the impact a particular control strategy will have on reducing risks.

D. Who prepared the UP ICTF/Dolores Railyard health risk assessments?

Under the Agreement, ARB worked with affected local air quality management districts, counties, cities, communities, and the two railroads to develop two guideline documents for performing the health risk assessments. The two documents, entitled *Health Risk Assessment Guidance for Railyard and Intermodal Facilities* (ARB, 2006b) and *Railyard Emissions Inventory Methodology* (ARB, 2006e), provide guidelines for the identification, modeling, and evaluation of the toxic air contaminants from designated railyards throughout California. Using the guidelines, the railroads developed the emission inventories based on the year 2005 activities and performed the air dispersion modeling for all operations that occur within each of the designated railyards.

ARB staff is responsible for reviewing and approving the railroads' submittals, identifying significant sources of emissions near the railyards, modeling the impacts of those sources, and preparing the railyard health risk assessments. ARB staff is also responsible for releasing the draft HRAs to the public for comment and presenting them at community meetings. Ultimately, the information derived from the railyards HRAs is to be used to help identify the most effective mitigation measures that could be implemented to further reduce railyard emissions and public health risks.

E. How is this report structured?

The next chapter provides a summary of the UP ICTF/Dolores Railyard operations, emissions, air dispersion modeling, and health risk assessment results. The following chapters present the details of the analyses of emission inventory, air dispersion modeling, and health risk assessment. The appendices present the technical supporting documents for the analysis discussed in the main body of the report.

II. SUMMARY

The study estimated the 2005 base-year diesel PM emissions generated from the UP ICTF/Dolores Railyards, off-site operations, and off-site non-railyard emission sources. The activities and diesel PM emissions associated with facility operations, the emissions within the area with in a one-mile perimetric distance from the both railyards, and the health risk assessment are summarized as below.

A. UP ICTF and Dolores Railyards

The UP ICTF/Dolores Railyards are located in Long Beach, California, about 4 miles north of the Port of Long Beach. The facility has two railyards, (1) the ICTF intermodal yard to the east, and (2) Dolores flat switching and servicing yard to the northwest. The ICTF covers a narrow area between East Sepulveda Boulevard and East 233rd Street, just south of the I-405 freeway (see Figure II-1). The main portion of the Dolores Yard covers a narrow area approximately one-half mile in length along the Alameda Corridor[4], connected to the ICTF with a series of parallel tracks approximately 1.4 miles long on the north end and 0.9 miles long on the south end. The general land uses on the west, south, and north sides of the facility are commercial and industrial. There are three major refineries located within about one-mile of the railyard boundaries, BP Carson Refinery, ConocoPhillips Refinery, and Shell Refinery (purchased by Tesoro in 2007). A number of industrial storage facilities are located to the southwest. An overpass of the I-405 freeway passes over the south end of the Dolores Yard. Between the east side of the facility and the I-710 freeway (approximately one mile from the facility boundary) is a residential area. The nearest residences are approximately 100-400 feet from the eastern boundary of both yards. The population surrounding the railyard facility within a 3-mile radius is estimated at approximately 186,000 according to the U.S. 2000 Census Bureau's Data.

B. What are the primary facility operations at the UP ICTF/Dolores Railyards?

UP ICTF is an intermodal railyard. Activities at ICTF Railyard include receiving inbound trains from the Ports of Long Beach and Los Angeles, and other distribution facilities, loading and unloading intermodal trains, storing intermodal containers and chassis, building and departing outbound trains, and repairing freight cars and intermodal containers/chassis. Activities at the Dolores Yard include receiving inbound trains, building and departing outbound trains, locomotive flat switching, locomotive refueling, locomotive servicing, and sanding operations. UP operates yard switcher locomotives within Dolores and ICTF to support many of these activities. In addition, Pacific Harbor Lines (PHL) operates yard switchers throughout the Ports (although not generally within the boundaries of the ICTF or Dolores Yards). The PHL switchers will pull train sections

[4] See the footnote 1.

destined for on-dock handling from the south (or west) end of Dolores Yard, and push train sections that were newly built on-dock back into the south end of Dolores. The

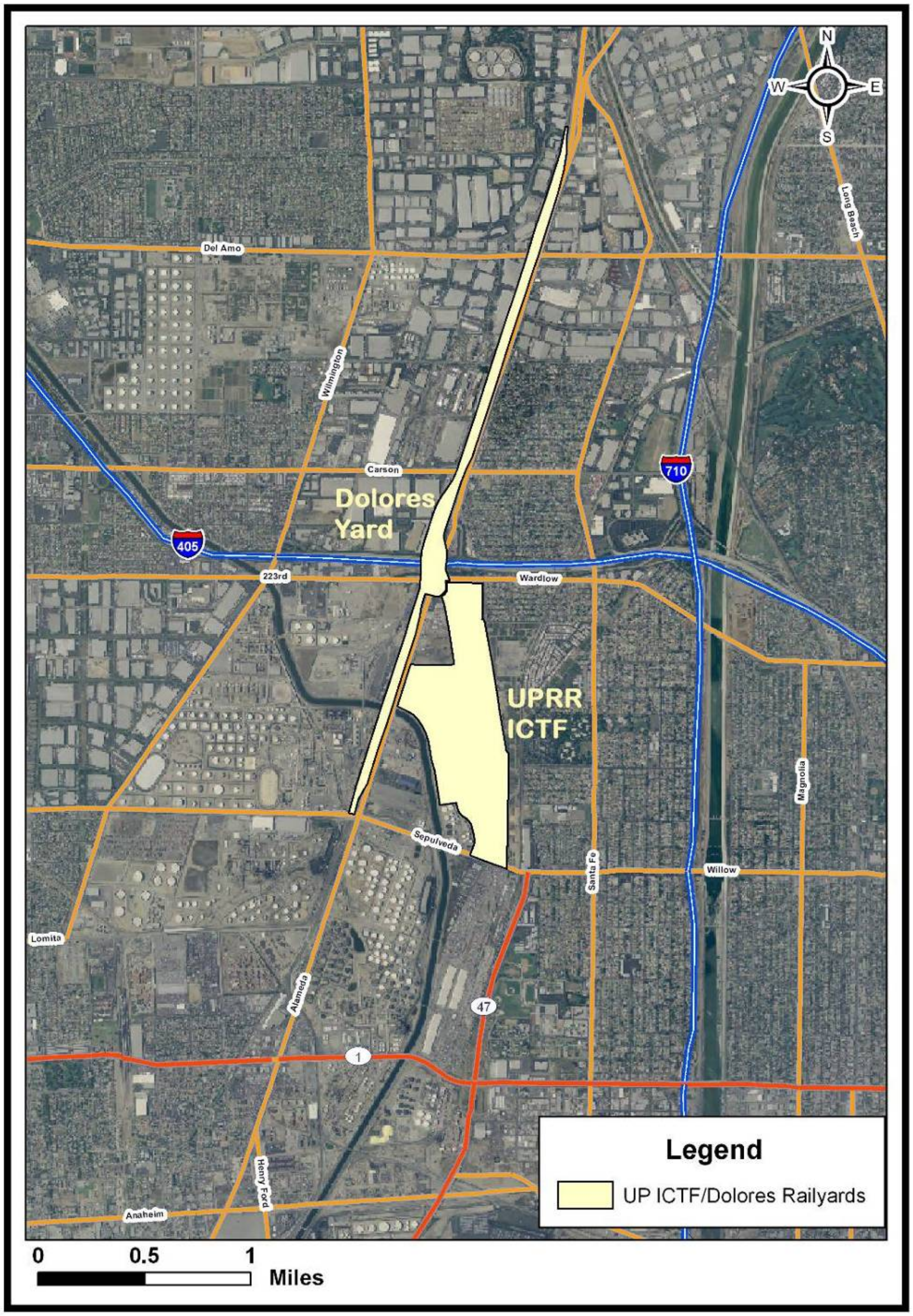


Figure II-1 The location of UP ICTF and Dolores Railyards and the neighboring areas.

PHL also operates railcar switching and pulls trains for UP and BNSF along the San Pedro Branch Line extended to the Port of Long Beach. This branch line is located about 100 yards east of the UP ICTF Railyard.

C. What are the diesel PM emissions at and near the UP ICTF/Dolores Railyards?

In 2005, the combined diesel PM emissions from the UP ICTF/Dolores Railyards on-site emissions were estimated at about 24 tons per year, including limited off-site operation-related emissions within a half-mile distance from both railyards. The limited off-site operation-related diesel PM emissions include locomotives and heavy heavy duty trucks (i.e., drayage trucks), and are estimated at about 4 tons per year within a half-mile distance of the railyards. These limited off-site operation-related emissions were included to be consistent with UP ICTF Modernization Project emission inventory. Other significant off-site non-railyard (i.e., not operation-related) mobile and stationary diesel PM emission resources within a one-mile boundary (see Figure III-3), were also included in the analysis. The off-site non-railyard mobile and stationary diesel PM emissions within one-mile were estimated at approximately 48 and 2.1 tons per year, respectively, for a total of 50 tons per year for off-site emissions within one-mile. In comparison with other railyards in the State, Table II-1 summarizes three major diesel PM source categories within all designated railyards subject to the health risk assessments under 2005 Agreement.

1. Railyard emissions

The UP ICTF/Dolores Railyard emission sources include, but are not limited to, locomotives, heavy heavy duty diesel trucks (i.e., drayage trucks), heavy duty trucks, cargo handling equipment, diesel-fueled heavy equipment and generators, and fuel storage tanks. The facility operates 24 hours per day, 365 days per year. The emissions were calculated on a source-specific and facility-wide basis for the 2005 baseline year. The methodology used to calculate the diesel PM and other toxic air contaminant emissions is based on the ARB's *Railyard Emission Inventory Methodology* (ARB, 2006e). The future growth in emissions at the UP ICTF/Dolores facility is not incorporated in the HRA emission inventory, but will be included as part of the mitigation emission reduction efforts. The locomotive emission factors used in the study are presented in Appendix D.

The facility-wide diesel PM emissions at UP ICTF and Dolores Railyards are evaluated to include the emissions within the facility and the off-site operation-related emissions within a half-mile radius from the facility boundary. The off-site operation-related emissions include activities of locomotive flat switching and drayage trucks. Among the facility-wide diesel PM emissions, locomotive operations account for approximately 42% (9.8 tons per year), the operations of drayage trucks for 32% (7.5 tons per year), the operations of cargo handling equipment for 18% (4.4 tons per year), and other diesel-fueled heavy equipment and transport refrigeration units for another 8% (1.4 tons per year) of total diesel PM emissions. The diesel PM stationary sources within the facilities were estimated less than 1% of total facility-wide emissions. The locomotive diesel PM emissions are primarily due to locomotive and railcar switching operations, comprising about 5.6 tons per year. The arriving and departing line haul locomotives activities contribute approximately 3 tons per year, and the locomotive testing and maintenance activities account for about 1.2 tons per year. The facility-wide (on-site operations and off-site operations within a half-mile from the yard boundaries) diesel PM emissions by source category are summarized in Table II-2.

Table II-1 Comparisons of diesel PM emissions (tons per year) from four major source categories within eighteen railyards.

Designated Railyards	Locomotives	Cargo Handling Equipment	On-road Trucks	Off-road and Stationary Sources	Total[§]
UP Roseville[*]	25.1[**]	N/A[‡]	N/A[‡]	N/A[‡]	**25.1**
BNSF Hobart	5.9	4.2[†]	10.1	3.7	**23.9**
UP Commerce	4.9	4.8[†]	2.0	0.4	**12.1**
UP LATC	3.2	2.7[†]	1.0	0.5	**7.3**
UP Stockton	6.5	N/A[‡]	0.2	0.2	**6.9**
UP Mira Loma	4.4	N/A[‡]	0.2	0.2	**4.9**
BNSF Richmond	3.3	0.3[†]	0.5	0.6	**4.7**
BNSF Stockton	3.6	N/A[‡]	N/A[‡]	0.02	**3.6**
BNSF Commerce Eastern	0.6	0.4	1.1	1.0	**3.1**
BNSF Sheila	2.2	N/A[‡]	N/A[‡]	0.4	**2.7**
BNSF Watson	1.9	N/A[‡]	< 0.01	0.04	**1.9**
UP ICTF/Dolores	9.8	4.4	7.5	2.0	**23.7**[¶]
UP Colton	16.3	N/A[‡]	0.2	0.05	**16.5**
UP City of Industry	5.9	2.8	2.0	0.3	**10.9**
UP Oakland	3.9	2.0	1.9	3.4	**11.2**
BNSF Barstow	*To be available in Spring 2008*				
BNSF San Bernardino	*To be available in Spring 2008*				
BNSF San Diego	*To be available in Spring 2008*				

* The UP Roseville Health Risk Assessment (ARB, 2004a) was based on 1999-2000 emission estimate, only locomotive diesel PM emissions were reported in that study.

** The actual emissions were estimated at a range of 22.1 to 25.1 tons per year.

‡ Not applicable.

§ Numbers may not add precisely due to rounding.

† After the modeling was completed, ARB received updated information on cargo handling equipment emissions. However, the resulting change in emissions was de minimis, so the modeling was not reperformed.

¶ The facility-wide total emissions also include off-site operation-related locomotive and drayage truck emissions within 0.5 miles from both railyards, 1.8 and 1.6 tons per year, respectively.

Table II-2 UP ICTF/Dolores Railyard diesel PM emissions and off-site emissions.

Diesel PM Emission Sources	**Facility-wide**[**]		**Off-site** [§]	
	Tons per Year[*]	**Percentage**	**Tons per Year**	**Percentage**
Locomotives Switch Locomotives Line Haul Locomotives Service/Maintenance	9.8 5.6 3.0 1.2	42% 24% 13% 5%	-	-
On-road HHD Trucks	7.5	32%	-	-
Cargo Handling Equipment	4.4	18%	-	-
Heavy Equipment and Transport Refrigeration Units (TRUs)	1.9	8%	-	-
Other Stationary Sources	0.06	< 1%	-	-
Off-site Mobile Sources	-	-	47.9	96%
Off-site Stationary Sources	-	-	2.1	4%
Total	23.7	100%	50	100%

[*] Numbers may not add precisely due to rounding.
[**] Including the emissions of off-site operations (facility-related) within a half-mile from the facility boundary.
[§] Diesel PM emissions of mobile and stationary sources are estimated within the one-mile boundary. However, the railyard diesel PM emissions are not included. In addition, an estimated 0.5 tons per year of diesel PM emissions from the San Pedro Branch Line (about 100 yards east of the UP ICTF Railyard within one-mile boundary) are not included in the off-site emission inventory.

Diesel PM is not the only toxic air contaminant emitted in the UP ICTF/Dolores Railyards. A small amount of toxic air contaminants are also emitted from gasoline motor vehicles and engines, and fuel storage tanks in the facility. The total amount of these toxic air contaminant emissions is estimated at about 1.4 tons per year, as compared to 24 tons per year of facility-related diesel PM emissions. However, using cancer potency weighted factor adjustment (see the details of a similar approach in the section II-C.2), these non-diesel PM toxic air contaminant emissions are about a factor of 1,200 less than the cancer potency weighted emissions of diesel PM, (i.e., 0.02 vs. 24 tons per year). Therefore, only diesel PM emissions are presented in the on-site emission analysis and health impact evaluation.

2. Surrounding sources

ARB staff evaluated significant off-site mobile and stationary sources of diesel PM emissions within a one-mile distance of the UP ICTF/Dolores Railyards. A one-mile distance was chosen because the health risk assessment study for the UP Roseville Railyard (ARB, 2004a) indicated that cancer risk associated with on-site railyard diesel PM emissions is substantially reduced beyond a one-mile distance from the railyard.

Of the total off-site non-railyard diesel PM emissions of 50 tons per year, about 48 tons, or 96%, were generated by mobile sources from traffic activities in the region, (i.e., I-405, I-710 and local roadways). This estimate was based on the Southern California Association of Governments (SCAG) Heavy Duty Truck Transportation Demand Model and the EMFAC-2007 (v2.3) model within a one-mile boundary from both railyards. The traffic flows were calculated based on roadway-specific vehicle activity data on diesel trucks and spatially allocated through the traffic network. The estimates do not include the diesel PM emissions generated from other modes such as extended idling, starts, and off-road diesel-fueled equipment outside the railyards. Individual sources such as local truck distribution centers and warehouses were not evaluated due to insufficient activity data; however, the trucking flow related to these local facilities was integrated into overall traffic volume using a county basis estimate. Because the off-site (non-railyard) mobile sources have only focused on the on-road diesel PM emissions, the exclusion of extended idling and off-road mobile sources may result in an underestimation for the off-site diesel PM emissions.

The stationary source emissions account for the other 4% of off-site non-railyard diesel PM emissions, at about 2.1 tons per year. These emissions are based on the California Emission Inventory Development and Reporting System (CEIDARS) database that contains information reported by the local air districts. These emissions are primarily from the commercial and industrial facilities. There are three major refineries located within about a one-mile perimeter from the railyard boundaries, BP Carson Refinery, ConocoPhillips Los Refinery, and Shell Refinery (purchased by Tesoro in 2007). These three refineries account for 81% of total off-site stationary diesel PM emissions. The off-site non-railyard mobile and stationary diesel PM emissions are summarized in Table II-2.

In 2000, ARB's *Risk Reduction Plan to Reduce Particulate Matter Emissions from Diesel-Fueled Engines and Vehicles* (ARB, 2000) identified diesel PM, 1,3-butadiene, benzene, carbon tetrachloride, and formaldehyde as the top five cancer risk contributors, based on ambient concentrations. These toxic air contaminants account for 95% of the statewide estimated potential cancer risk levels. This study also concluded that diesel PM contributes over 70%of the State's estimated potential cancer risk levels, which are significantly higher than other toxic air contaminants.

ARB staff also evaluated other toxic air contaminants from stationary emissions around the UP ICTF/Dolores Railyards. Among the toxic air contaminants other than diesel PM from stationary sources, benzene and formaldehyde were identified to be major contributors and estimated at about 7.9 tons per year. Benzene and formaldehyde were also identified to be major toxic air contaminants associated with the petroleum production facilities nearby.

> **Cancer potency factors (CPF)** are expressed as 95% upper confidence limit of excess cancer cases occurring in an exposed population assuming continuous lifetime exposure to a substance at a dose of one milligram per kilogram of body weight, and are expressed in units of $(mg/kg\text{-}day)^{-1}$.

The Office of Environmental Health Hazard Assessment (OEHHA) has estimated an inhalation cancer potency factor (CPF) for individual chemicals and some chemical mixtures such as whole diesel exhaust. Diesel exhaust PM contains many individual cancer causing chemicals. The individual cancer-contributing chemicals from diesel exhaust are not separately evaluated so as to avoid double counting. The compounds listed in Table II-3 from top five TACs in inventory are given a weighting factor by comparing each compound's cancer potency factor to the diesel PM cancer potency factor. This factor is multiplied by the estimated actual emissions for a given compound, which gives the potency weighted toxic emission as shown in the Table. As indicated, the cancer potency weighted toxic air contaminant emissions from stationary sources are estimated at about 0.43 tons per year. Based on the emission inventory, the potential cancer risks from these non-diesel toxic air contaminants are considerably less, by about a factor of 115 as compared to diesel PM emissions. Because of the dominance of diesel PM emissions, other toxic air contaminants from the stationary sources were not included in the analysis.

Table II-3 Cancer potency weighted toxic air contaminant emissions from significant off-site stationary sources surrounding UP ICTF/Dolores Railyards

Toxic Air Contaminant	Cancer Potency Factor	Weighted Factor	Estimated Emissions (tons/year)	Potency Weighted TAC Emissions (tons/year)
Diesel PM	1.1	1.0	50	**50**
1,3 Butadiene	0.6	0.55	0.05	**0.03**
Carbon Tetrachloride	0.15	0.14	0.001	**< 0.01**
Benzene	0.1	0.09	3.4	**0.31**
Formaldehyde	0.021	0.019	4.5	**0.09**
Non-Diesel PM Toxic Air Contaminants			8.0	**0.43**

ARB staff also estimated the potential cancer risk levels contributed by the use of gasoline in the region of South Coast Air Basin based on 2005 emission inventory, including 1,3-butadiene, benzene, formaldehyde, and acetaldehyde. These four TACs are identified as major contributors associated with the use of gasoline in the air basin. Table II-4 presents the emissions of these toxic air contaminants from gasoline-related sources, weighted by individual cancer potency factors. The potency weighted emissions from these carcinogens from all gasoline related sources are estimated at about 817 tons per year, about 11% of diesel PM emissions in the region. For gasoline-fueled vehicles only, the potency weighted emissions are estimated at about 438 tons per year, or about 6% of diesel PM emissions regionwide. The potential cancer risks associated with non-diesel PM toxic air contaminants emitted from off-site gasoline vehicular sources are substantially less than the potential cancer risks associated with diesel PM emissions and are not included in the analysis.

Table II-4 Major toxic air contaminants from gasoline-related sources in the South Coast Air Basin in 2005.

Toxic Air Contaminant	Emissions (tons per year)			
	All Sources	Potency Weighted†	Gasoline Vehicular Sources	Potency Weighted†
Diesel PM	7,746	**7,746**	—	—
1,3-Butadiene	695	**382**	420	**231**
Benzene	3,606	**325**	2,026	**182**
Formaldehyde	4,623	**92**	1,069	**21**
Acetaldehyde	1,743	**17**	314	**3**
Total (other than diesel PM)	10,668	**817**	3,829	**438**

†: Emission based on cancer potency weighted factors.

D. What are the potential cancer risks from the UP ICTF/Dolores Railyards?

As discussed previously, ARB developed *Health Risk Assessment Guidance for Railyard and Intermodal Facilities* (ARB, 2006b) to ensure that the methodologies used in railyard health risk assessments meet the requirements for the ARB/Railroad Statewide Agreement. The railyard health risk assessments follow *The Air Toxics Hot Spots Program Risk Assessment Guidelines* (OEHHA, 2003) published by the Office of Environmental and Health Hazard Assessment and is consistent with the methodology used for the UP Roseville Railyard Study (ARB, 2004a).

The U.S. EPA recently approved a new state-of-the-art air dispersion model, AERMOD (**A**merican Meteorological Society/**E**PA **R**egulatory Model Improvement Committee **MOD**EL), as a regulatory model for health risk assessments. ARB staff used the AERMOD in the railyard health risk assessments. One of the critical inputs required for the air dispersion modeling is meteorological data, such as wind direction and wind speed. These parameters determine where and how the pollutants will be transported and distributed in the air.

Three meteorological stations around the region of the UP ICTF/Dolores Railyards were evaluated for the meteorological inputs of the AERMOD modeling simulations. Based on the AERMOD meteorological data selection criteria, ARB staff determined the data collected at Saints Peter and Paul School meteorological station in Long Beach to be more representative than other stations, considering local terrain characteristics, prevailing wind field, and data completeness (see Figure IV-1).

The potential cancer risks from the diesel PM emissions generated at the UP ICTF/Dolores Railyards are estimated by risk isopleths (or contours) presented in Figures II-2 and II-3. The estimated average potential cancer risk is about 700 chances per million near the railyard property boundaries, assuming a 70-year exposure duration. The risks further decrease to 100 in a million within a one-mile distance from the railyard (see Figure II-2) then to 25 in a million within another two-mile distance (see Figure II-3). About 5 miles upwind and 8 miles downwind from the railyard boundary, the estimated cancer risks are at 10 in a million or lower.

> An **isopleth** is a line drawn on a map through all points of equal value of some measurable quantity; in this case, cancer risk.

The OEHHA Guidelines specify that, for health risk assessments, the location of the point of maximum exposure at the point of maximum impact (PMI) be reported. The PMI is defined as a location or the receptor point with the highest cancer risk level outside of the railyard boundary, with or without residential exposure. The PMI is predicted to be located next to the eastern boundary of ICTF Railyard fence line based on the highest diesel PM concentrations estimated from the modeling results outside of the facility. The PMI is downwind from the locomotive, cargo handling, and drayage truck activities, which are the dominant diesel PM emissions from the facility (see the emission spatial allocation in Appendix E).

The cancer risk at the PMI is estimated at to be about 1200 chances per million based on a 70-year exposure duration. The land use in the vicinity of the PMI is primarily zoned for industrial use. However, there may be residents living in this zoned area. In the residential zoned area, the potential cancer risk of maximally exposed individual resident (MEIR) or maximum individual cancer risk (MICR) is estimated at about 800 chances in a million, assuming a 70-year lifetime exposure.

As indicated by *Roseville Railyard Study* (ARB, 2004a), the location of the PMI may vary depending upon the settings of the model inputs and parameters, such as meteorological data set or emission allocations in the railyard. Therefore, given the estimated emissions, modeling settings, and the assumptions applied to the risk assessment, there are great uncertainties associated with the estimation of PMI and MICR. These indications of PMI and MICR should not be interpreted as a literal prediction of disease incidence but more as a tool for comparison as discussed in the

OEHHA Guidelines. In addition, the estimated point of maximum impact and maximum individual cancer risk from the dispersion model may not be replicated by air monitoring. ARB staff also conducted a comparison of cancer risks estimated at the PMI versus MICR, and the differences of facility-wide diesel PM emissions between the UP and BNSF designated railyards. The ratios of cancer risks at the PMI or MICR to the diesel PM emissions do not suggest that one railroad's facilities have statistically higher cancer risks than the other railroad's or vice versa. Rather, the differences are primarily due to emission spatial distributions from individual operations among railyards.

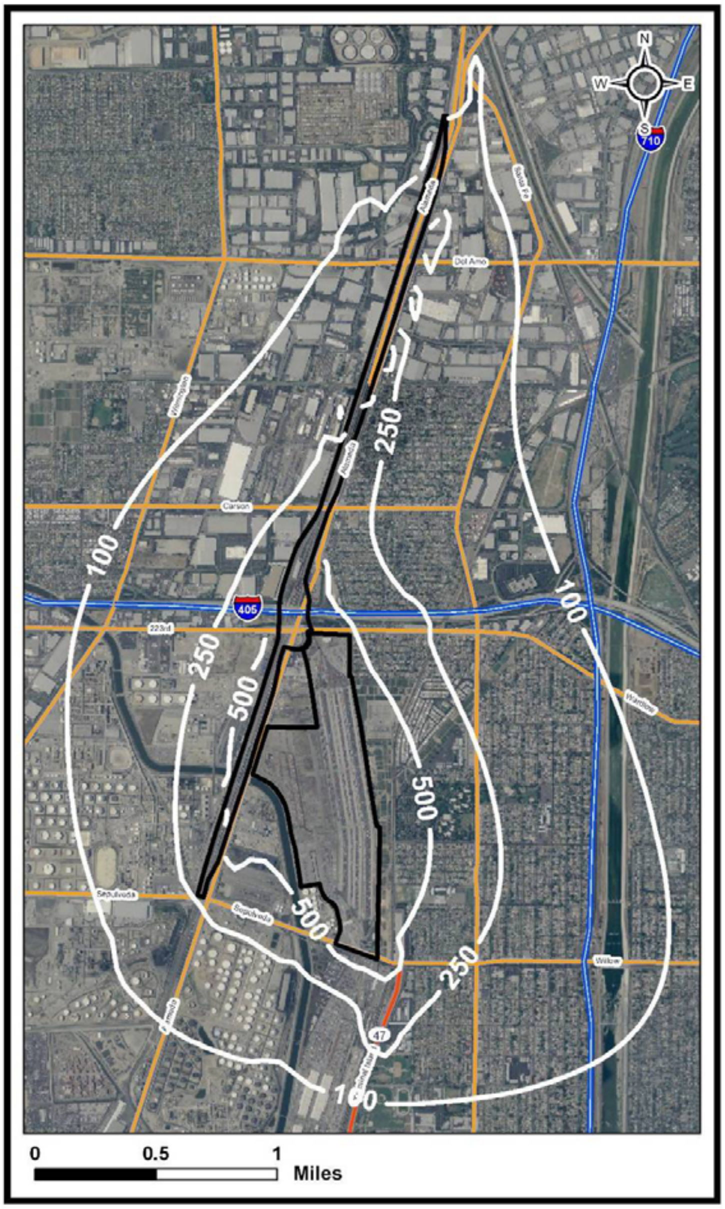


Figure II-2 Estimated adjacent area potential cancer risks (chances per million) associated with diesel PM emissions at the UP ICTF/Dolores Railyards (based on Tier-1 estimate and 80th percentile breathing rate for 70-year exposure).

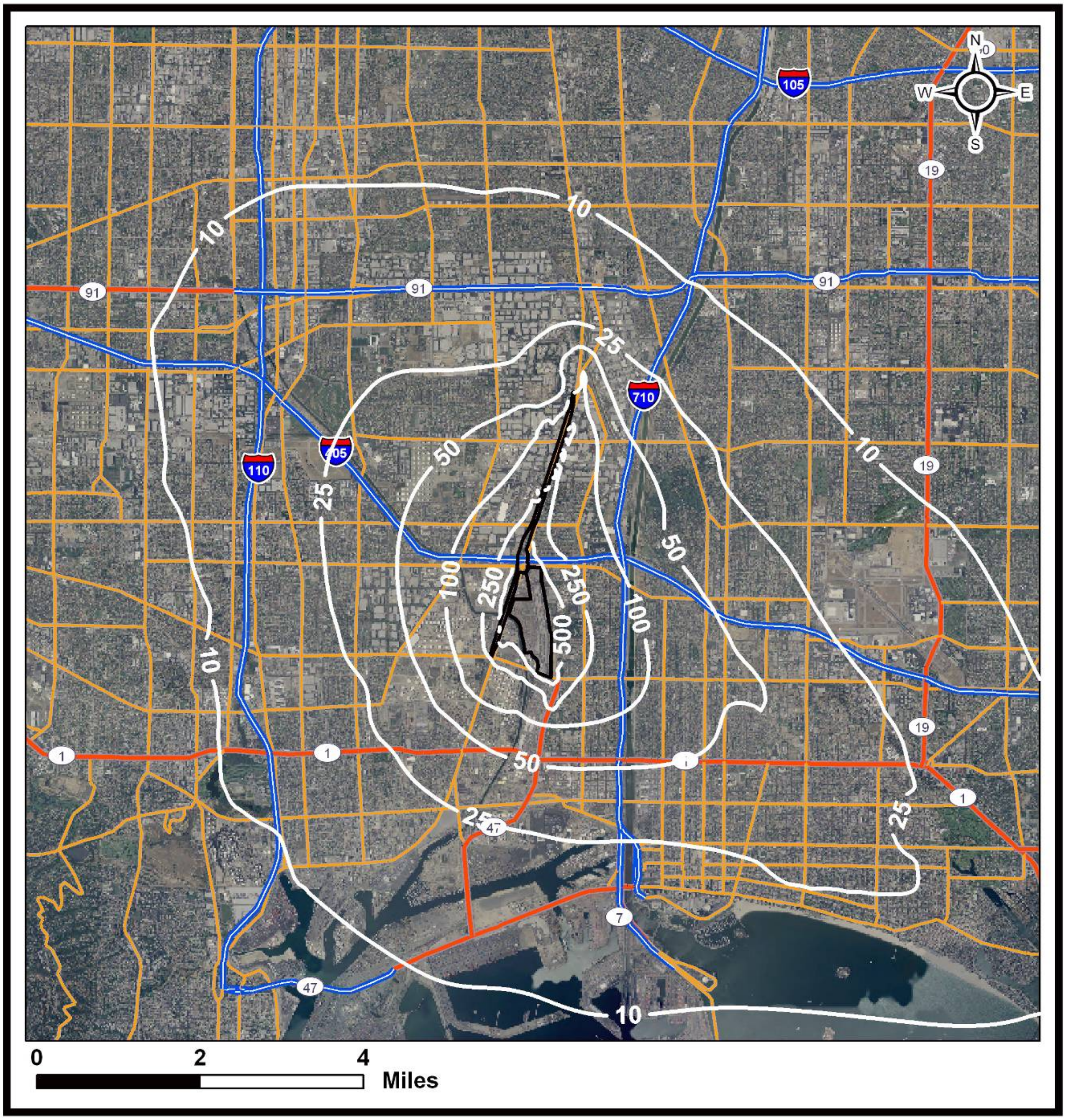


Figure II-3 Estimated potential cancer risks (chances per million) associated with diesel PM emissions at the UP ICTF/Dolores Railyards (based on Tier-1 estimate and 80th percentile breathing rate for 70-year exposure).

The residential areas near the UP ICTF/Dolores Railyards are located east of the railyard. The area with an estimated risk greater than 10 in a million encompasses approximately 54,310 acres outside the railyard facilities where about 597,500 residents live, based on the 2000 U.S. Census Bureau's data. Table II-5 presents the exposed population and area coverage size for various impacted zones of cancer risks.

Table II-5 Estimated impacted areas and exposed population associated with different potential cancer risk levels for a 70-year exposure.

Estimated Risk (chances per million)	Estimated Impacted Area (acres)	Estimated Exposed Population†
> 500	220	1,200
250 - 500	730	10,100
100 - 250	2,760	20,200
50 - 100	5,100	51,000
25 - 50	11,900	206,000
10 - 25	33,600	309,000
> 10	54,310	597,500

† The population centroid of each census block is used to avoid possible double counting.

The OEHHA Guidelines recommend a 70-year lifetime exposure duration to evaluate the potential cancer risks for residents. Shorter exposure durations of 30 years and 9 years may also be evaluated for residents and school-aged children, respectively, as a supplement. These three exposure durations – 70 years, 30 years, and 9 years – all assume exposure for 24 hours a day, and 7 days a week. It is important to note that children, for physiological as well as behavioral reasons, have higher rates of exposure than adults on a per unit body weight basis (OEHHA, 2003). To evaluate the potential cancer risks for off-site workers, the OEHHA Guidelines recommend that a 40-year exposure duration be used, assuming workers have a different breathing rate (149 L kg^{-1} day^{-1}) and exposure for an 8-hour workday, five days a week, 245 days a year.

Table II-6 shows the equivalent risk levels of 70- and 30-year exposure durations for exposed residents, and 9- and 40-year exposure durations for children and off-site workers, respectively. As Table II-6 shows, the isopleth line with a potential cancer risk level of 10 chances per million in Figure II-2 would become 4 chances per million for exposed population with a shorter residency of 30 years, 2.5 chances per million for children at the age range of 0-9 (first 9-year childhood), and 2 chances per million for off-site workers.

Table II-6 Equivalent potential cancer risk levels of 70-, 30-, 9-, and 40-year exposure durations associated with on-site railyard diesel PM emissions.

Exposure Duration (years)	Equivalent Estimated Cancer Risk Levels (chances in a million)			
70	10	25	50	100
30	4	11	21	43
9*	2.5	6.3	12.5	25
40‡	2	5	10	20

* Exposure duration for school-aged children (age 0-9).
‡ Exposure duration for off-site workers.

It is important to note that the estimated risk levels represent the potential cancer risks in addition to regional background risk from diesel PM emissions. ARB staff estimated the regional background cancer risk due to emissions of all toxic air contaminants at about 1,000 chances per million for the South Coast Air Basin in 2000 (ARB, 2006c). Figure II-3 presents a comparison of the estimated average potential cancer risks in various ranges associated with the ICTF/Dolores Railyard diesel PM emissions to the regional background risk level from all air toxic contaminants from the air basin. For example, in the cancer risk range greater than 500 chances in a million, the average risk above the regional background is 700 chances per million. Residents living in that area would have a potential cancer risk of about 1,700 chances in a million.

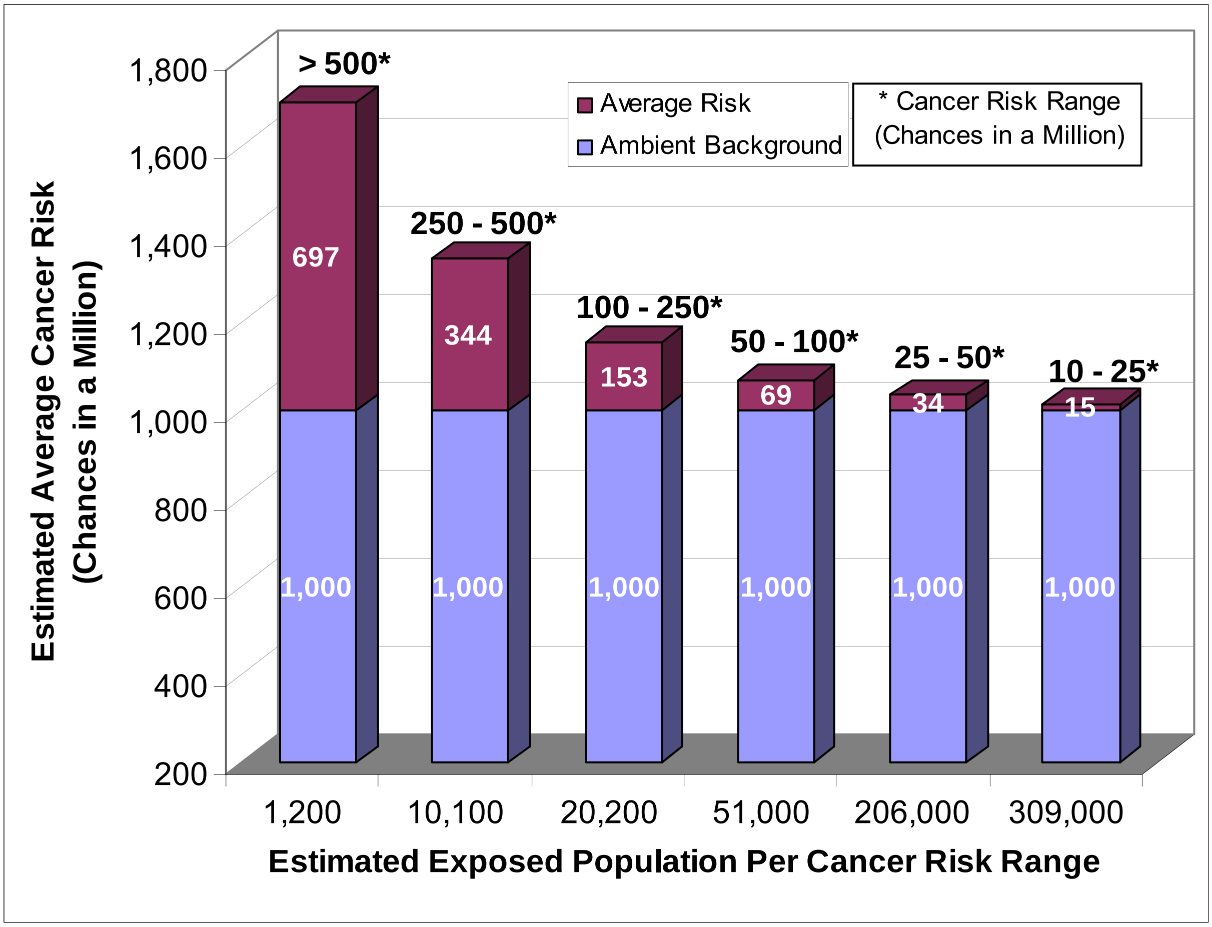


Figure II-3 Comparisons of estimated potential cancer risks associated with diesel PM emissions at the UP ICTF/Dolores Railyards to the regional background cancer risk level.

E. What are the estimated non-cancer chronic risks near the UP ICTF/Dolores Railyards?

The potential non-cancer chronic health risks due to the diesel PM emissions at the UP ICTF/Dolores Railyards are estimated as hazard indices from 0.05, about one to one 1.5 miles from the railyard facilities, to 0.5 near the UP ICTF Railyard boundary, presented in Figure II-4. The impacted zone with hazard index greater than 0.05 covers an area of about 4,900 acres. The level of 0.5 was estimated at the areas near the eastern boundary of UP ICTF Railyard. According to the OEHHA Guidelines (OEHHA, 2003), these levels (less than 1.0) indicate that the potential non-cancer chronic public health risks from diesel PM are less likely to occur.

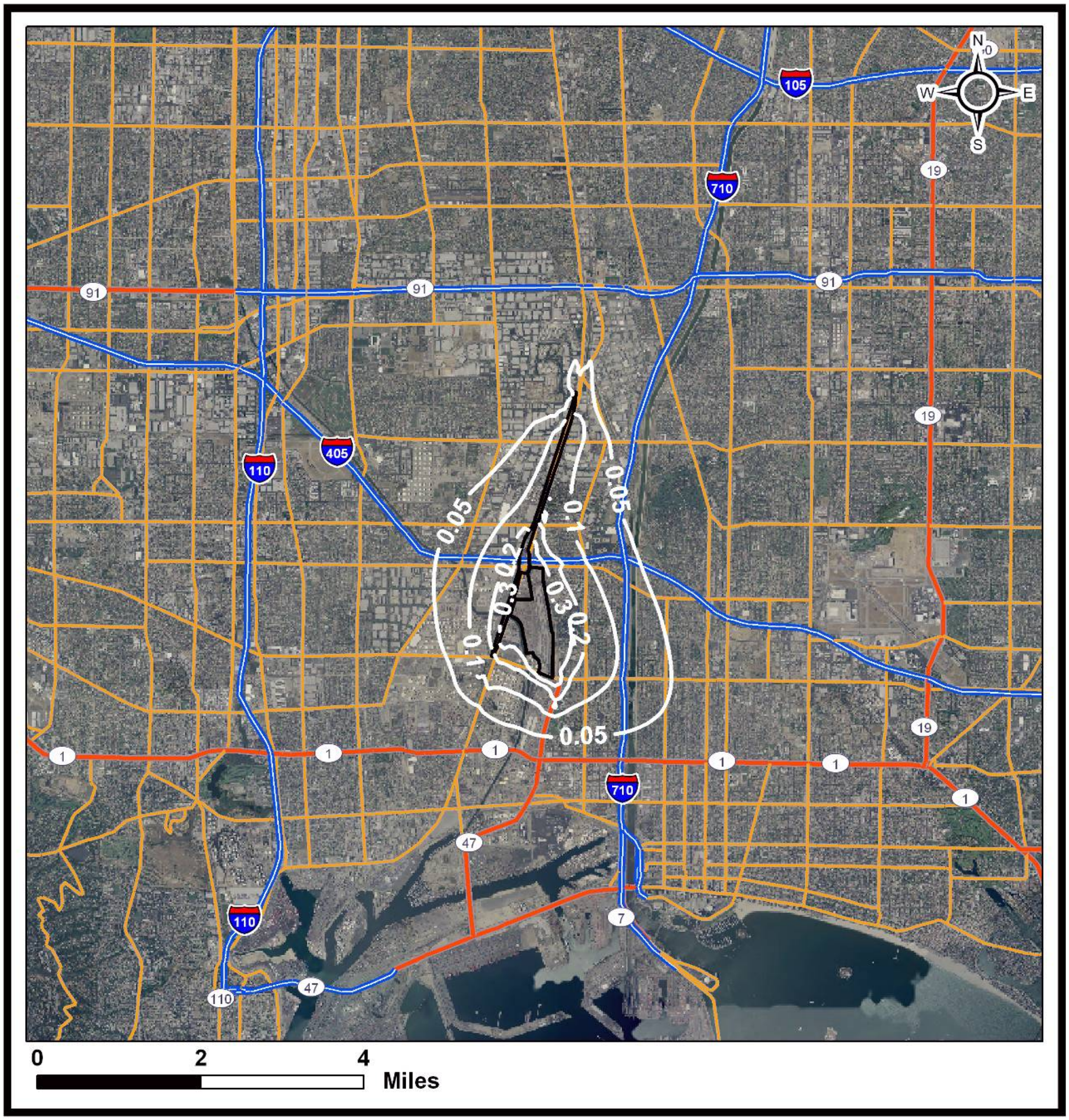


Figure II-4 Estimated non-cancer chronic risks (indicated as Hazard Indices) associated with the diesel PM emissions from the UP ICTF/Dolores Railyards.

Due to the uncertainties in the toxicological and epidemiological studies, diesel PM as a whole was not assigned a short-term acute reference exposure level. It is only the specific compounds from diesel exhaust (e.g., acrolein) that independently have potential acute effects (such as irritation of the eyes and respiratory tract) and an assigned acute reference exposure level. Acrolein is a by-product of the combustion or burning process. However, acrolein is a chemically reactive and unstable compound, and easily reacts with a variety of chemical compounds in the atmosphere. Compared to the other chemical compounds from the diesel exhaust, the concentration of acrolein has a much lower chance of reaching a distant off-site receptor. More importantly, given the multitude of activities ongoing at facilities as complex as railyards, there is a much higher level of uncertainty associated with hourly-specific emission data and hourly model-estimated peak concentrations for short-term exposure. Therefore, non-cancer acute risk is not addressed quantitatively in this study. From a risk management perspective, ARB staff believes it is reasonable to focus on diesel PM cancer risk because it is the predominant risk driver and the most effective parameter to evaluate risk reduction actions. Further, actions to reduce diesel PM will also reduce non-cancer health risks.

F. What are the estimated health risks from off-site (non-railyard) emissions?

ARB staff evaluated the health impacts from off-site non-railyard diesel PM emissions near the UP ICTF/Dolores Railyards facility using the U.S. EPA AERMOD dispersion model. The off-site mobile and stationary sources located within a one-mile distance from the railyard were included in the air dispersion model simulations. The emissions consisted of about 48 tons per year from on-road diesel mobile sources and 2.1 tons per year from stationary sources. The estimated cancer risks are shown in Figure II-5. The diesel PM emissions from mobile sources were generally generated from the traffic along the I-405 and I-710, due to the high density of heavy heavy duty truck activities. As shown in the figure, the areas near both freeways have relatively higher cancer risk compared to other areas, estimated from about 400 to 700 chances per million cancer risk level.

The zone of impacts of estimated cancer risks associated with off-site diesel PM emissions is larger than that of the UP ICTF/Dolores Railyard facility-wide emissions. The impacted area for cancer risk levels greater than 10 chances per million was estimated at about 64,800 inland acres inland area coverage where a residential population of about 740,000 was reported according to the 2000 Census data. The impacted zones and exposed population are summarized in Table II-7. In comparison, the impacted inland area with cancer risk above 10 in a million is larger than the impacted area with similar risk levels from the facility-wide railyard diesel PM emissions and the associated exposed population is also higher, about by a factor of 1.2.

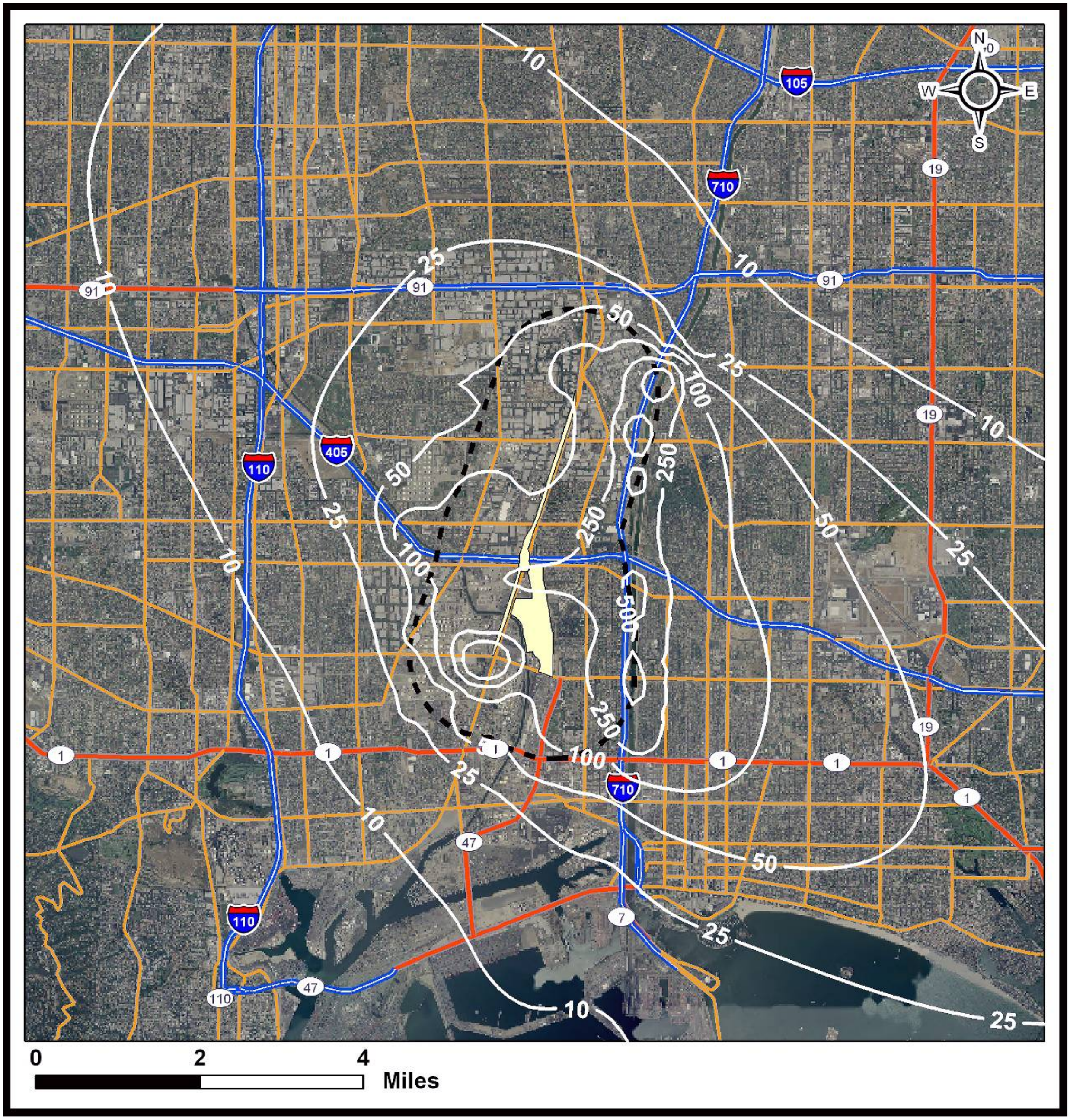


Figure II-5 Estimated cancer risks (chances per million) associated with the off-site non-railyard diesel PM emissions within the one-mile boundary around the UP ICTF/Dolores Railyards (based on Tier-1 estimate and 80th percentile breathing rate for 70-year exposure).

Table II-7 Area coverage and exposed population of impacted areas for cancer risk levels associated with the off-site diesel PM emissions (based on Tier-1 estimate and 80th percentile breathing rate for 70-year exposure).

Estimated Risk (chances per million)	Estimated Impacted Area (acres)*	Estimated Exposed Population†
> 500	500	1,300
250 - 500	2,500	25,100
100 - 250	7,000	94,400
50 - 100	9,200	145,000
25 - 50	15,600	142,000
10 - 25	30,000	331,200
> 10	64,800	739,000

* inland area only.
† The population centroid of each census block is used to avoid possible double counting.

The estimated non-cancer chronic risks (indicated as hazard indices) from the off-site non-railyard diesel PM emissions range from about 0.05 to 0.3. The hazard indices near the major off-site diesel PM emission sources, such as I-405, I-710, and refineries, are generally greater than 0.1, presented in Figure II-6. At neighboring residential areas between the Dolores Railyard and I-710, the risk levels range from 0.1 to 0.2. The residents living close to the freeways I-405 and I-710, have an estimated higher non-cancer chronic risk level compared to other neighboring areas. However, all estimated hazard indices in the region are lower than the level of 1.0. According to the OEHHA Guidelines (OEHHA, 2003), these estimated indices indicate that the potential non-cancer chronic health risks are less likely to occur.

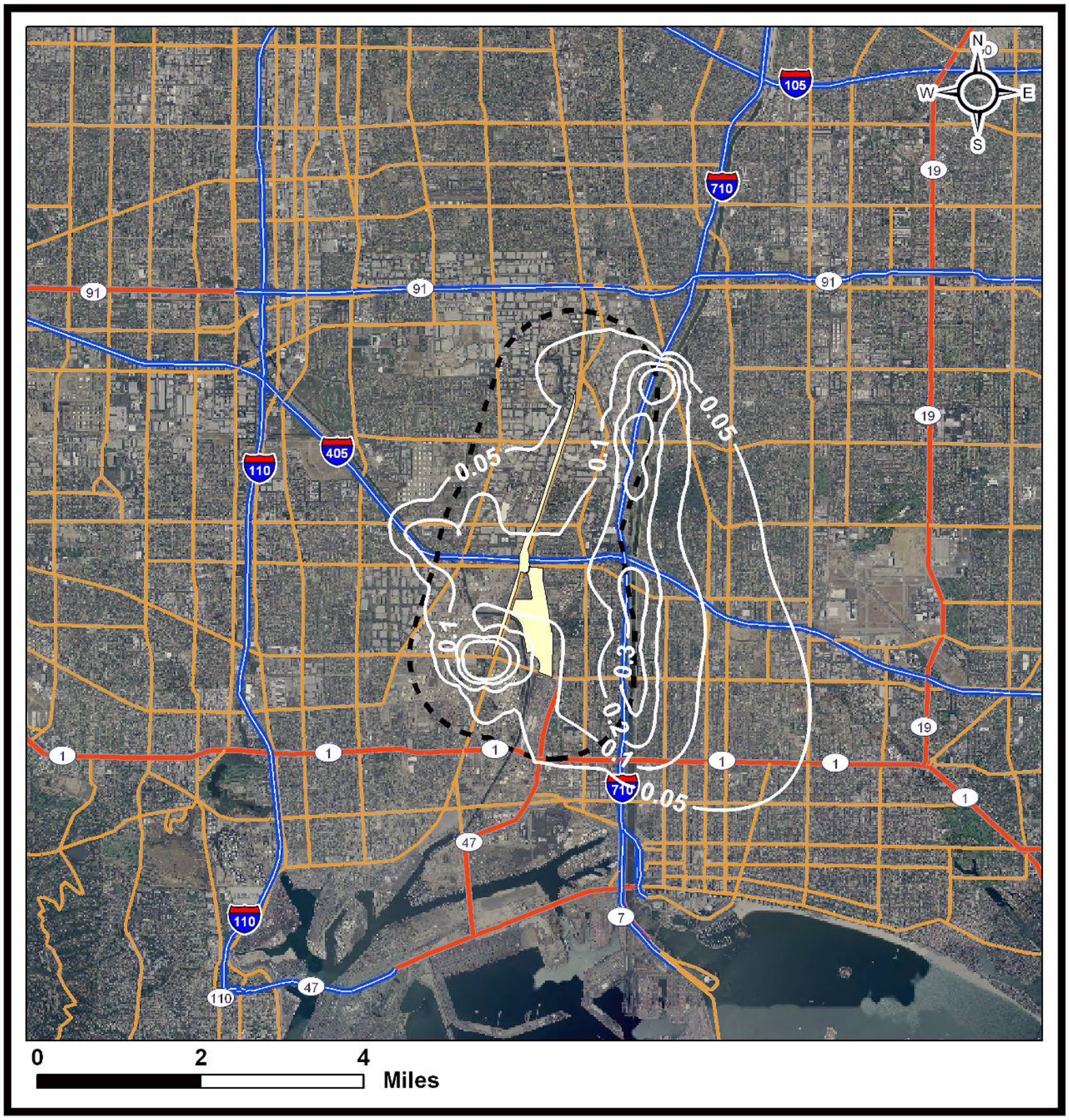


Figure II-6 Estimated non-cancer chronic risks (indicated as hazard indices) associated with the off-site non-railyard diesel PM emissions within the one-mile boundary around the UP ICTF/Dolores Railyards.

G. Can study estimates be verified by air monitoring?

Currently, there is no approved specific measurement technique for directly monitoring diesel PM emissions in the ambient air. This does not preclude the use of an ambient monitoring program to measure general air quality trends in a region. Since cancer risk is based on an annual average concentration, a minimum of one year of intensive monitoring data would generally be needed.

H. What activities are underway to reduce diesel particulate matter emissions and public health risks?

The Air Resources Board (ARB) has developed a comprehensive approach to reduce locomotive and railyard emissions through a combination of voluntary agreements, ARB and United States Environmental Protection Agency (U.S. EPA) regulations, funding programs, and early replacement of California's line haul and yard locomotive fleets. The information presented below summarizes California's key locomotive and rail yard air pollution control measures and strategies.

South Coast Locomotive NO_x Fleet Average Agreement (1998): Signed in 1998 between ARB and both Union Pacific Railroad (UP) and BNSF Railway (BNSF), it requires the locomotive fleets that operate in the South Coast Air Quality Management District (SCAQMD) to meet, on average, U.S. EPA's Tier 2 locomotive emissions standards by 2010. Tier 2 locomotives became commercially available in 2005 and provide a 65% reduction in oxides of nitrogen (NOx) and 50% reduction in diesel particulate matter (PM) emissions. This Agreement will provide locomotive fleet benefits in southern California 20 years earlier than the rest of the country.

Statewide Railroad Agreement (2005): ARB and both UP and BNSF signed a voluntary statewide agreement in 2005 which does not change any federal, state, or local authorities to regulate railroads. The Agreement has resulted in measures that have achieved a 20% reduction in locomotive diesel PM emissions in and around rail yards since its adoption in June 2005. The measures in the Agreement include:

- Phasing-out of non-essential idling on all locomotives without idle reduction devices (60 minute limit – fully implemented);
- Installing idling devices on 99% of the 450 California-based locomotives by June 30, 2008 (15 minute limit – 95% implemented);
- Identifying and expeditiously repairing locomotives with excessive smoke and ensure that at least 99% of the locomotives operating in California pass smoke inspections (fully implemented);
- Requiring all locomotives that fuel in the state use at least 80% federal or California ultra low sulfur (15 parts per million) diesel fuel by January 1, 2007, (six years prior to federal requirement) (fully implemented);

- Preparing new health risk assessments for 16 major railyards, based on the UP Roseville Railyard health risk assessment (completed in 2004) and Office of Environmental Health Hazard Assessment (OEHHA) guidelines; (nine of 16 finalized in November 2007); and
- Identifying and implementing future feasible mitigation measures based on the results of the railyard health risk assessments.

ARB Diesel Fuel Regulations Extended to Intrastate Locomotives (2007): This regulation, approved in 2004, requires intrastate locomotives that operate 90% of the time in the state to use only California ultra low sulfur (15 parts per million) diesel fuel. CARB diesel's lower aromatics provide on average a 6% reduction in NO_x and 14% reduction in diesel PM emissions as compared to U.S. EPA ultra low sulfur on-road diesel fuel. ARB staff estimates that there are 250 intrastate locomotives currently operating in the South Coast Air Basin, and CARB diesel fuel will reduce these locomotive emissions by up to 30 tons per year for diesel PM and 300 tons per year for NO_x. The regulation took effect on January 1, 2007.

ARB Cargo Handling Equipment Regulations (2007): This regulation, approved in 2005, requires the control of emissions from more than 4,000 pieces of mobile cargo handling equipment, such as yard trucks and forklifts that operate at ports and intermodal rail yards. Impletion of this regulation will reduce diesel PM by approximately 40% in 2010 and 65% in 2015, and NO_x emissions by approximately 25% in 2010 and 50% in 2015. This regulation is expected to reduce diesel PM and NO_x emissions by up to 80% by 2020. The regulation took effect on January 1, 2007.

Heavy Duty Diesel New Trucks Regulations: ARB and the U.S. EPA both have adopted emission standards for 2007 and subsequent model year heavy-duty diesel engines. These standards represent a 90% reduction of NO_x emissions, 72% reduction of non-methane hydrocarbon emissions, and a 90% reduction of PM emissions compared to the 2004 model-year emission standards. The ARB adopted similar emission standards and test procedures to reduce emissions from 2007 and subsequent model year heavy-duty diesel engines and vehicles. These stringent emission standards will reduce NO_x and diesel PM emissions statewide from on-road heavy diesel trucks by approximately 50 and 3 tons per day, respectively, in 2010; by 140 and 6 tons per day, respectively, in 2015; and by 210 and 8 tons per day, respectively, in 2020.

ARB Statewide Diesel Truck and Bus Regulation: The ARB is developing a regulation to reduce diesel PM, NO_x and green house gas emissions from on-road heavy-duty diesel-fueled vehicles. This measure will cover long and short haul truck-tractors, construction related trucks, wholesale and retail goods transport trucks, tanker trucks, package and household goods transport trucks, and most other diesel-powered trucks and buses with a gross vehicle weight rating of 14,000 pounds or greater (shuttle buses of all sizes will also be included). The goals of this effort are: (a) by 2014, emissions are to be no higher than a 2007 model year engine with a diesel particulate filter, and (b) by 2021, emissions are to be no higher than a 2010 model year engine. With the implementation of the proposed measure, California's emissions from this sector could be reduced by about 70%, and NO_x emissions by up to 35% in 2014. This measure is scheduled for ARB Board consideration in October 2008.

ARB Regulation to Control Emissions from In-Use on-Road Diesel-Fueled Heavy-Duty Drayage Trucks at Ports and Intermodal Railyard Facilities: The ARB developed a port truck fleet modernization program that will reduce diesel PM by 86% by 2010, and NO_x by 56% by 2014, as compared to the 2007 baseline. There are an estimated 20,000 port trucks operating at California ports and intermodal railyards. These trucks are a significant source of air pollution, with about 3 tons per day of diesel PM and 61 tons per day of NO_x in 2007. Drayage trucks also often operate in close proximity to communities. This regulation will result in significant reductions in exposure and potential cancer risks to residents that live near ports, railyards, and the major roadways. The ARB approved the regulation in December 2007.

ARB Tier 4 Off-Road Diesel-Fueled New Engine Emission Standards: In 2004, the ARB and U.S. EPA adopted a fourth phase of emission standards (Tier 4). New off-road engines are now required to meet aftertreatment-based exhaust standards for particulate matter (PM) and NO_x starting in 2011. The Tier 4 standards will achieve over a 90% reduction over current levels by 2020, putting off-road engines on a virtual emission par with on-road heavy duty engines.

Transport Refrigeration Unit (TRU) Airborne Toxics Control Measure (ATCM): This airborne toxics control measure is applicable to refrigeration systems powered by integral internal combustion engines designed to control the environment of temperature sensitive products that are transported in trucks, trailers, railcars, and shipping containers. Transport refrigeration units may be capable of both cooling and heating. Estimates show that diesel PM emissions for transport refrigeration units and transport refrigeration unit gen-set engines will be reduced by approximately 65% in 2010 and 92% in 2020. California's air quality will also experience benefits from reduced NO_x and HC emissions. The transport refrigeration unit airborne toxics control measure is designed to use a phased approach over about 15 years to reduce the diesel PM emissions from in-use transport refrigeration unit and transport refrigeration unit generator set engines that operate in California. The TRU ATCM was approved on February 26, 2004 and became effective on December 10, 2004. Compliance dates for meeting in-use performance standards are phased in, beginning December 31, 2008, and extending out in time.

U.S. EPA Locomotive Emission Standards: Under the Federal Clean Air Act, U.S. EPA has sole authority to adopt and enforce locomotive emission standards. Under U.S. EPA's rules, this preemption also extends to the remanufacturing of existing locomotives. In April 2007, U.S. EPA released a proposed locomotive rulemaking that would reduce Tier 0 locomotive NO_x emissions by 20% and Tier 0-3 remanufacture and new standards to reduce PM only by 50%. The ARB is relying on U.S. EPA to expeditiously require the introduction of the next generation or Tier 4 locomotive emission standards that requires Tier 4 locomotives built with diesel particulate filters and selective catalytic reduction. Combined, these exhaust aftertreatment devices are expected to provide up to a 90% reduction in NO_x and PM emissions beginning in 2015-2017. The final U.S. EPA locomotive regulations are scheduled for approval in early 2008.

ARB Goods Movement Emission Reduction Plan (GMERP): Approved in 2006, this plan forecasts goods movement emissions growth and impacts. It contains a comprehensive list of proposed strategies to reduce emissions from ships, trains, and trucks and to maintain and improve upon air quality. The strategies in the plan, if fully implemented, would reduce locomotive NO_x and diesel PM emissions by up to 85% by 2020.

California Yard Locomotive Replacement Program: One locomotive strategy being pursued is to replace California's older yard locomotives that operate in and around railyards statewide. Yard locomotives represent about five percent of the statewide locomotive NO_x and diesel PM emissions, but often occur in railyards located in densely populated urban centers. Multiple non-road engine (gen-set) and electric-hybrid yard locomotives have demonstrated they can reduce NO_x and diesel PM emissions by up to 90% as compared to existing locomotives. By 2008, UP had deployed 60 gen-set and 12 electric hybrid yard locomotives in southern California. BNSF has been operating four liquefied natural gas (LNG) yard locomotives in downtown Los Angeles since the mid-1990s. UP and BNSF have ordered more gen-set locomotives for use in northern California in 2008.

III. SUMMARY OF UP ICTF/DOLORES RAILYARDS ACTIVITY AND EMISSIONS

UP ICTF Railyard is an intermodal container transfer facility located in both the cities of Long Beach and Carson, California, about 4 miles north from the Port of Long Beach and 16 miles south from City of Los Angeles. The Dolores Railyard, located in City of Carson, is a locomotive flat switching, mechanical service and maintenance yard connected to the ICTF. For the year 2005, the combined diesel PM emissions from the UP ICTF/Dolores Railyards (on-site and off-site operation emissions) and off-site non-railyard emission sources within a one-mile perimetric distance from the railyards were estimated at about 74 tons per year. The estimated off-site diesel PM emissions from mobile sources (not generally related to the railyards' activities) are about 48 tons per year, or about 65% of the total combined emissions. Off-site stationary sources contribute 2.1 tons per year of diesel PM emissions or 3% of the total combined on-site and off-site emissions. The UP ICTF/Dolores Railyard diesel PM emissions are estimated at about 24 tons per year, accounting for about 32% of the total combined on-site and off-site diesel PM emissions.

A. UP ICTF/Dolores Railyard facility

The UP ICTF Railyard is located at Sepulveda Boulevard and East 223rd Street, Long Beach, California. As shown in Figure II-1, the railyard facility is surrounded by commercial, industrial to the west and south, and residential areas next to the railyards to the east. The ICTF facility also is bordered by Interstate-405 (I-405) to the north, Alameda Corridor[5] to the west, Sepulveda Boulevard to the south, and Interstate-710 (I-710) to the east about 1.5 miles from the yard. The Port of Long Beach is about 4 miles from the ICTF Railyard. The Dolores Railyard is along the Alameda Corridor and connected to the ICTF to the northwest with the overpass of I-405. The general land uses on the west, south, and north sides of the yards are industrial and commercial. There are refinery facilities and petroleum terminals to the west and south. There are three major refineries located about one-mile of the railyard boundaries, BP Carson Refinery, ConocoPhillips Refinery, and Shell Refinery (purchased by Tesoro in 2007). The nearest residences are located to the east side of the ICTF Railyard.

B. UP ICTF/Dolores Railyard operations

The UP ICTF is an intermodal container facility. Intermodal containers are received, sorted, and distributed from the facility. Intermodal containers may arrive at the facility by truck to be loaded onto trains for transport to distant destinations, or arrive by train and unloaded onto chassis for transport by truck to local destinations. Cargo containers and chassis are also temporarily stored at the Yard. Facilities at the Yards include classification tracks, a gate complex for inbound and outbound intermodal truck traffic, intermodal loading and unloading tracks, and various buildings and facilities supporting railroad and contractor operations.

[5] See footnote 1.

The Dolores Yard serves two primary operations: flat switching and locomotive servicing. At a flat switching area, incoming and outbound train sections are stored in different track segments, and separated from and connected to other sections to build new trains. Dolores serves three separated types of trains: (1) manifest (i.e., mixed) freight trains that are handled within the Dolores Yards, (2) intermodal trains that are handled at ICTF, and (3) intermodal and other trains are handled at on-dock facilities within the Ports of Los Angeles and Long Beach.

The Dolores Yard is also a locomotive servicing facility, which includes a service track and a locomotive shop, to provide support to ICTF and other yards in the L.A. Basin. Operations include both basic service (refueling, sanding, cleaning, etc.) and major planned and unscheduled maintenance for locomotives serving Dolores, ICTF, and the on-dock facilities in the Ports. Other facilities and equipment at the Yard include a sand tower, diesel fuel storage tanks, various oil storage tanks, and a wastewater treatment plant.

Activities at the ICTF/Dolores Railyards include locomotive line haul arrivals and departures, locomotive switching (i.e., movement of locomotives and rail cars within the yard), cargo handling operations, heavy heavy duty truck movements, locomotive service and maintenance, diesel-fueled heavy equipment, transportation refrigeration units and refrigerated rail cars, and stationary sources (e.g., emergency diesel-powered generators, portable air compressors, and etc.). Locomotives, cargo handling equipment, and container trucks (i.e., drayage trucks) are the three major operations at UP ICTF/Dolores Railyards. Figure III-1, III-2, III-3, and III-4 present the schematic locations of these activities at the facility. The off-site activities of truck travels related to facility operations within a half-mile radius from the railyards are also presented. The details of the railyard operation activities are described in the *Toxic Air Contaminant Emission Inventory and Dispersion Modeling Report for the ICTF and Dolores Railyards, Long Beach, California* (Sierra Research, 2007)

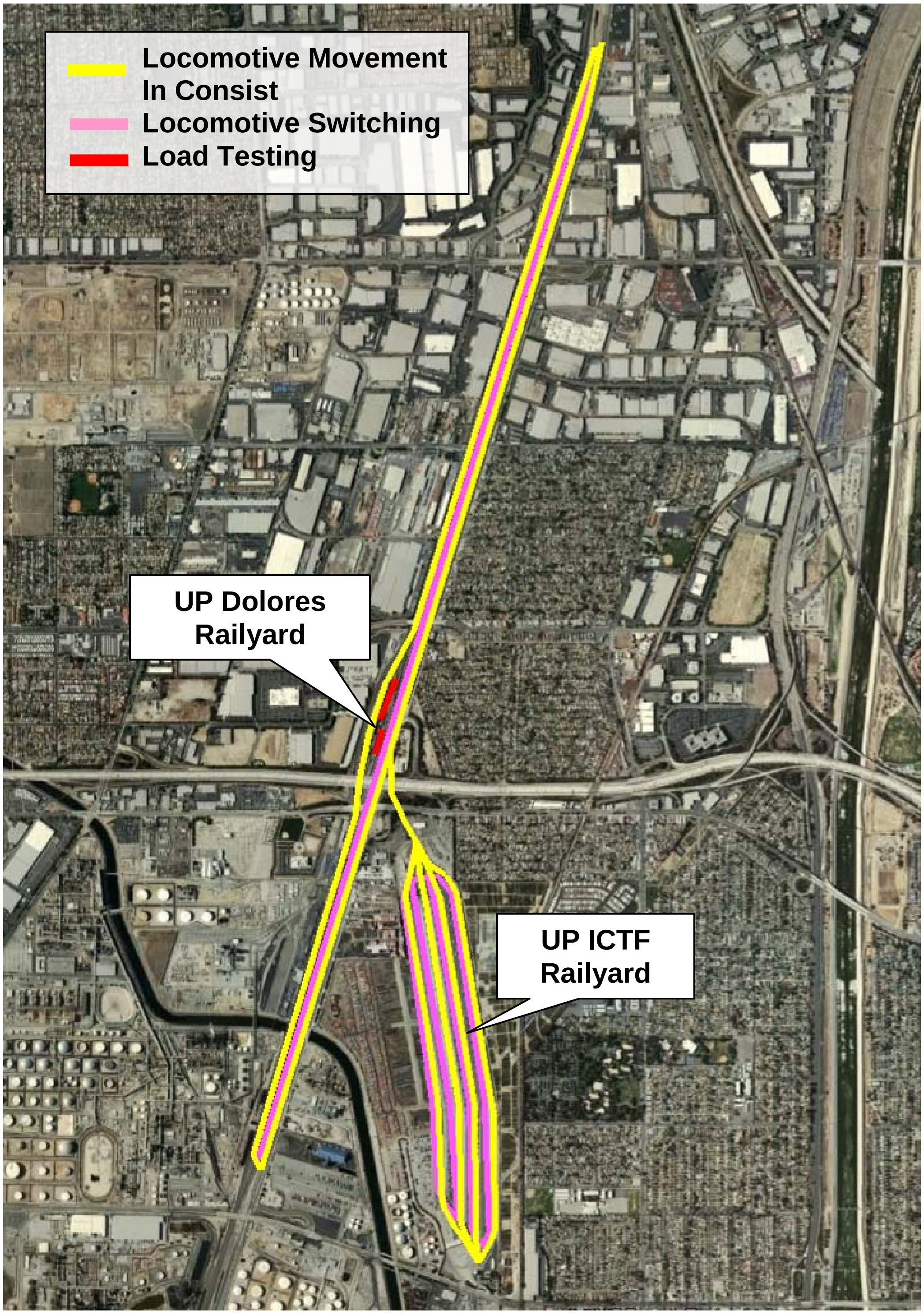


Figure III-1 Locomotive movements in consist, switching, and load testing operations at the UP ICTF/Dolores Railyards.

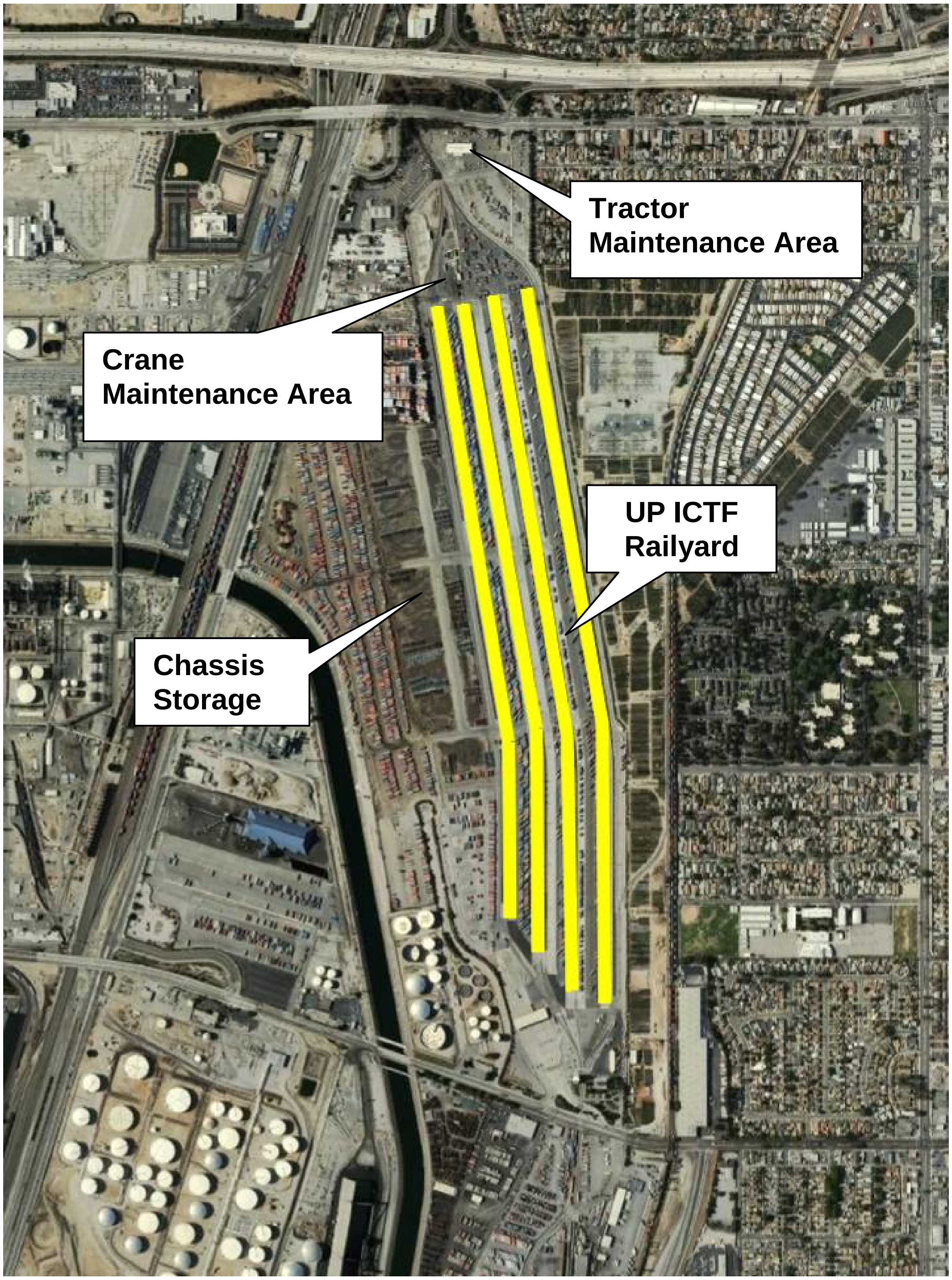


Figure III-2 Activity of cargo handling equipment (solid lines) at the UP ICTF Railyard.

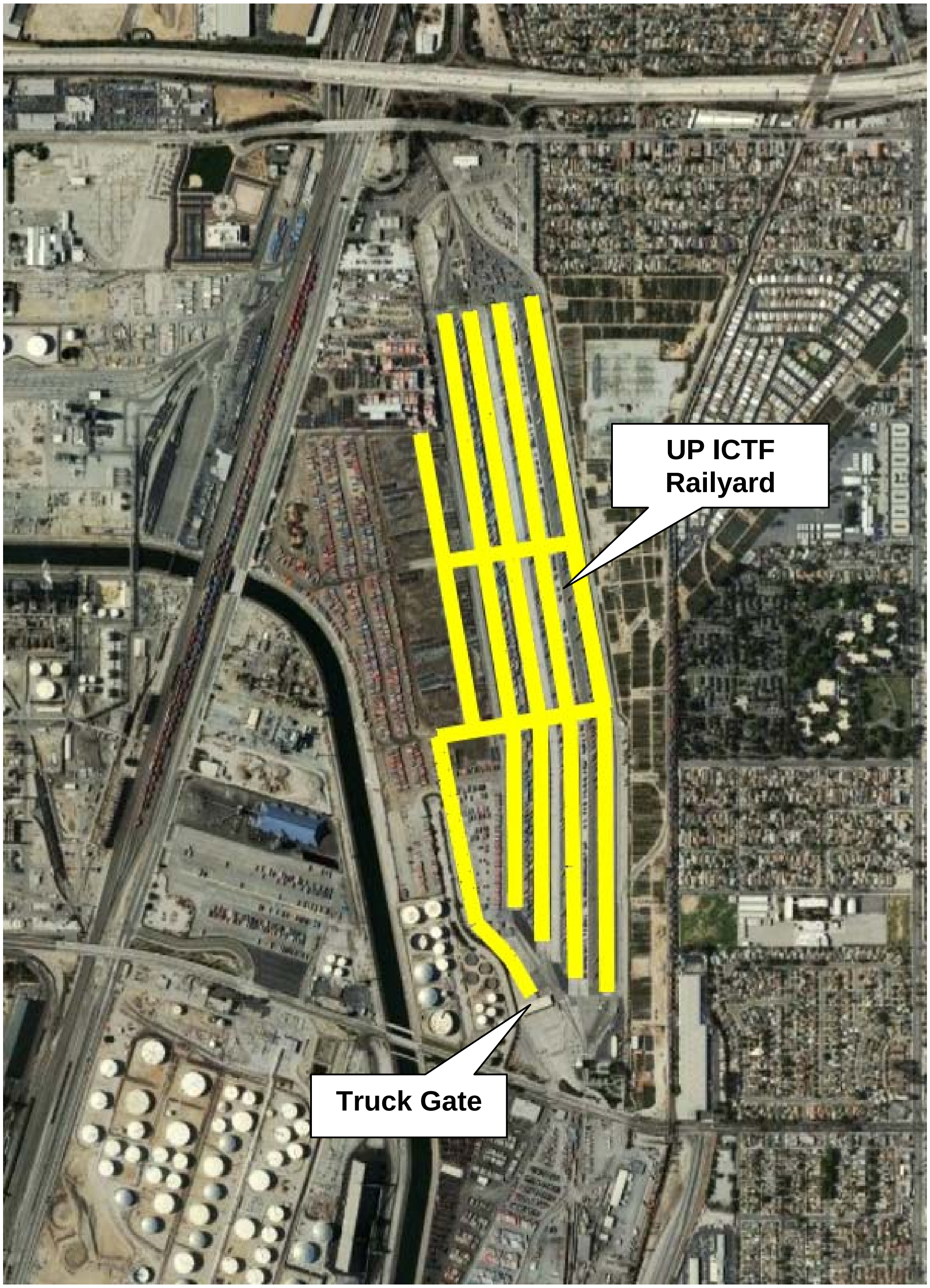


Figure III-3 On-site heavy heavy duty truck (i.e., drayage trucks) operations (solid lines) at the UP ICTF Railyard.

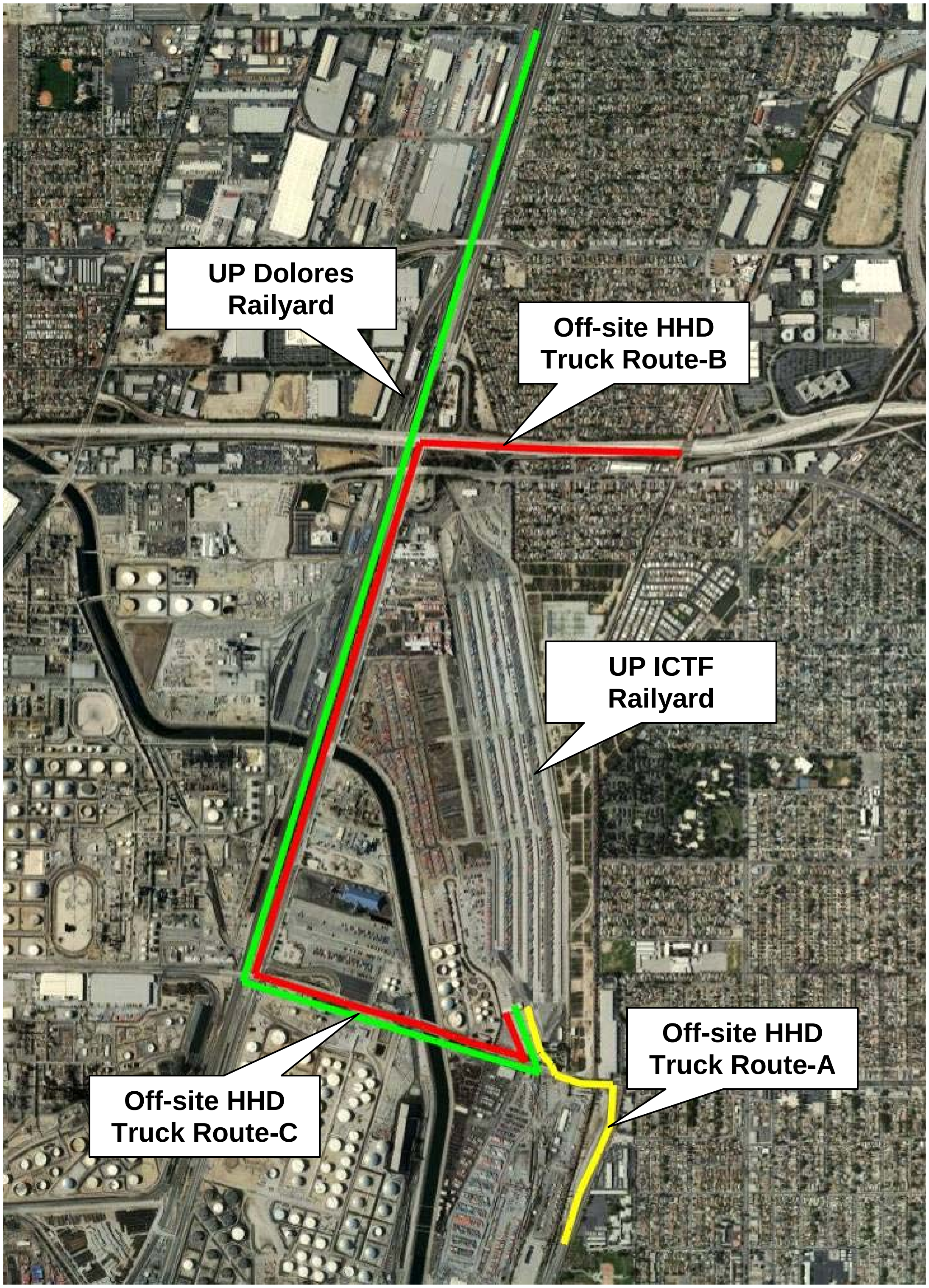


Figure III-4 Off-site operations of heavy heavy duty trucks (i.e., drayage trucks) by routes.

C. UP ICTF/Dolores Railyards emission inventory summary

The Union Pacific Railroad (UP) provided the activity data for the ICTF/Dolores railyards. This data was used to prepare the railyard emissions inventory. The methodology used to calculate the diesel PM and other toxic air contaminant emissions is based on ARB's *Railyard Emission Inventory Methodology* (ARB, 2006e) and ARB emission factor models, EMFAC-2007 (v2.3) and OFFROAD-2007. Detailed calculation methodologies and emission factors are included in the emission inventory report (Sierra Research, 2007).

Emission sources at the UP ICTF/Dolores railyards include, but are not limited to, locomotives, heavy-heavy duty (HHD) diesel-fueled trucks, cargo handling equipment (CHE), heavy equipment, transport refrigeration units (TRUs) and refrigerated rail cars, and fuel storage tanks. Emissions were calculated on a source-specific and facility-wide basis for the 2005 calendar year. In addition, at the request of the Ports of Los Angeles and Long Beach in the context of the UP ICTF Modernization Project, the emissions from locomotives and drayage trucks related to UP ICTF, and operating within 0.5 miles from the facility, were also included in emission inventory and dispersion modeling analysis. The facility-wide diesel PM emissions are summarized in Table III-1 by source categories. As indicated in Table III-1, locomotives are the largest source of diesel PM emissions at the UP ICTF/Dolores Railyards, contributing about 42% of total facility-wide diesel PM emissions in 2005, followed by on-road heavy heavy duty trucks (i.e., drayage trucks) (7.5 tons per year, 32%), cargo handling equipment (4.4 tons per year, 18%), heavy diesel-fueled equipment, TRUs, refrigerator rail cars (1.9 tons per year, 8%), and other stationary sources (less than 1%).

Table III-1 Summary of facility-wide diesel PM emissions at the UP ICTF/Dolores Railyards and within a half-mile off-site operation boundary.

Facility-wide Source Types	Tons per year*	Percentage
Locomotives	9.8	42 %
Switch Locomotives	5.6	24%
Line Haul Locomotives	3.0	13%
Service/Maintenance	1.2	5%
On-Road HHD Trucks	7.5	32 %
Cargo Handling Equipment	4.4	18 %
Heavy Equipment and Transport Refrigeration Units (TRUs)	1.9	8 %
Other and Stationary Sources	< 0.06	< 1%
Total	23.7**	100 %

* Numbers may not add precisely due to rounding. ** Including off-site operations, 1.8 tons from flat switching and 1.6 tons from HHD trucks within 0.5 miles from railyards.

1. Locomotive emissions

Locomotive operations at the Yards fall into two basic categories: road power and yard operations. "Road power" units are locomotives used on inbound and outbound freight trains and are generally larger and higher horsepower units (3,000 to 6,000 hp). Locomotives used for operations within a railyard are called switcher locomotives and are generally low horsepower units (1,500 to 3,000 hp). Locomotive activities at the UP ICTF/Dolores Railyards are generally divided into three emissions categories: (1) line haul locomotive movements in consist, (2) locomotive switching or yard operations, and (3) locomotive services and maintenance (i.e., refueling, sanding, load testing and etc.). All mechanical service and maintenance operations occur only at the Dolores Yard service tracks and shop. The emissions from main locomotive operations were further divided into subcategories to describe the emission modes and spatial allocation, such as locomotive arrivals and departures, idling, locomotives in-consist, and flat switching. `

The locomotive operations data used to estimate emissions include the number of engines serviced, and the typical time in notch setting for those engines receiving services. Temporal emission profiles were estimated for each activity based on hourly locomotive counts. The profiles developed account for hourly, daily and seasonal temporal variation and are reflected in air dispersion modeling to capture operation variation. Table III-2 presents the summary of diesel PM emissions from locomotive operation activities. As shown in Table III-2, the majority of locomotive activities are locomotive switching and yard operations, representing about 57% (5.6 ton per year) of total locomotive diesel PM emissions. The line haul locomotives account for about one-third (3.0 tons per year) of the locomotive diesel PM emissions. These emissions are associated with hauling through trains on the main line, pulling arriving trains into the yard, and departing trains out of the yard. The locomotive service and maintenance activities at the Dolores Railyard accounts for about 12% (1.2 tons per year) of the diesel PM emissions.

Table III-2 Diesel PM emissions by locomotive operation activity.

Facility-wide Operation Activity	**Tons per Year**	**Percentage**
Switch Locomotives Conducting Yard Operations	5.6	57 %
Arrival/Departure Line Haul Locomotives	3.0	31 %
Locomotive Service/Maintenance	1.2	12 %
Total	9.8	100 %

According to UP, the UP interstate locomotives were fueled outside of California before they entered the California borders. However, data for the detailed diesel deliveries within and outside of California were not available in 2005. Trains arriving and terminating at California railyards (with the exception of local trains) were assumed to have used fuel produced outside of California, and arrive with remaining fuel in their tanks at 10% of capacity. On arrival, locomotives were refueled with California diesel fuel, resulting in a mixture of 90% CARB and 10% non-CARB fuel. This mixture is representative of fuel on departing trains as well as trains undergoing load testing (if conducted at a specific yard). For through trains by-passing UP railyards, an average composition of 50-50 split was applied to account for CARB-EPA and non-California diesel fuel used. Therefore, UP estimated different fuel sulfur levels based on the average fractions of California fuel being used as follows: 221 ppmw for yard operations, 463 ppmw for arriving and departing trains, 1,430 ppmw for through trains, and 2,639 ppmw for terminating trains. The locomotive diesel PM emission factors used in this study are presented in Appendix D, and the details of fuel sulfur content adjustment are documented in the emission inventory report (Sierra Research, 2007).

The ARB has developed an integrated approach to reduce statewide locomotive emissions through a combination of voluntary agreements, ARB and U.S. EPA regulations, incentive funding programs, and early replacement of California's line haul and yard locomotive fleets. The detailed approach is discussed in Chapter II. In the future, the UP ICTF/Dolores Railyards will benefit from these mitigation measures as diesel PM emissions from locomotives are gradually reduced as the locomotive fleets turnover.

2. On-road Heavy Heavy Duty (HHD) Trucks

On-road heavy heavy duty (HHD) trucks, known as drayage trucks, receive or deliver containers to and from the UP ICTF Railyard. In 2005, the estimated number of truck trips (in-gate and out-gate), based on gate count data, was 940,000. The emissions calculated are based on the emission factors from the EMFAC-2007 (v2.3) model with the BURDEN output option and assume an average drayage truck speed of 15 miles per hour. Idling emissions were calculated using EMFAC model with "emfac" output option. The trucks operating within 0.5 miles of the ICTF facility, known as a portion of the off-site operations, were evaluated, and the associated emissions were also incorporated into the facility-wide inventory.

On-road diesel trucks contributed about 32% of the total facility-wise diesel PM emissions, at about 7.5 tons per year in 2005. As indicated in Table III-3, about 79% of the on-road diesel truck PM emissions are from on-site operations, and about 21% from off-site operations within a half-mile radius from the railyards (see Figure III-4).

An ARB regulation to modernize port and intermodal railyard drayage trucks is estimated to reduced diesel PM emissions by 86% by 2010, and NO_x by 56% by 2014, as compared to the 2007 baseline.

In January 2001, the U.S. EPA promulgated a Final Rule for emission standards for 2007 and subsequent model year heavy-duty diesel engines (66 FR 5002, January 18, 2001). These emission standards represent a 90% reduction of oxides of nitrogen emissions, 72 percent reduction of non-methane hydrocarbon emissions, and 90% reduction of particulate matter emissions compared to the 2004 model year emission standards. Starting in 2007, the UP ICTF/Dolores Railyards will benefit from these measures as diesel PM emissions from heavy-duty diesel fueled trucks are gradually reduced as the truck fleets turnover.

Table III-3 Diesel PM emissions by on-road truck operations.

On-road Truck Operations	**Tons per Year**	**Percentage**
On-road HHD Trucks (on-site)	5.93	79 %
On-road HHD Trucks (off-site operations)*	1.56	21 %
Total	7.5	100 %

* Emissions from off-site HHD truck routes shown in Figure III-4.

3. Cargo Handling Equipment

Cargo handling equipment (CHE) is the third largest emission source among the facility-wide diesel PM emissions, and occur only at the UP ICTF Railyard (see Figure III-2). The diesel PM emissions from cargo handling equipment was estimated at 4.4 tons in year 2005, equivalent to about 18% of the total diesel PM emissions from the facility-wide inventory.

Cargo handling equipment is used to move intermodal freight and containers at the UP ICTF Railyard. Five types of equipment were included in CHE: yard hostlers, rubber-tired gantry (RTG) cranes, chassis stackers, forklifts, and top picks.

- Yard hostlers are also known as yard trucks. It is the most common type of cargo handling equipment. A yard hostler is very similar to an on-road truck tractor, but is designed to move cargo containers within the railyard.
- Rubber-tired gantry (RTG) cranes are very large cargo container handlers that have lifting equipment mounted on a cross-beam supported on vertical legs which run on rubber tires.
- Chassis stackers are used to stack the truck chassis.
- Forklifts are industry trucks used to hoist and transport materials by means of one or more steel forks inserted under the load.

- Top picks are also known as top handlers. Top picks are another common type of cargo handling equipment. It is a large truck-like vehicle with an overhead beam which locks onto the top of containers in a single stack.

The CHE diesel PM emissions in the UP ICTF Railyard were estimated using the ARB OFFROAD-2007 model. As shown in Table III-4, about 68% of the CHE diesel PM emissions were due to the yard hostlers, at about 3.0 tons per year. The RTG cranes generated about 20% of the total CHE diesel PM emissions (0.9 tons per year). The remaining of the CHE diesel PM emissions are from top picks, accounting for 11% or 0.5 tons per year, followed by the forklifts, less than 1% of total CHE diesel PM emissions. Additional details of calculations and estimations are reported in *Toxic Air Contaminant Emissions Inventory and Dispersion Modeling Report for the Dolores and ICTF Railyards, Long Beach, California* (Sierra Research, 2007).

Table III-4 Diesel PM emissions by cargo handling equipment.

Equipment types	Diesel PM emissions	
	Tons per year	Percent of total
Yard Hostlers	3.0	68%
RTG Cranes	0.9	20%
Top Picks	0.5	11%
Forklifts	0.01	<1%
Total	4.4	100%

In December 2005, ARB adopted a new regulation for cargo handling equipment to reduce diesel PM and NO_x emissions beginning in 2007. This regulation will provide up to 80% diesel PM control or better from the best available control technology by 2020. Therefore, starting in 2007, the UP ICTF Railyard will benefit from these mitigation measures as diesel PM emissions from cargo handling equipment are gradually reduced as the equipment fleets turnover.

4. Heavy equipment and vehicles

There are three main types of diesel-fueled equipment operated at the site: (1) heavy equipment used for non-cargo-related activities, (2) transport refrigeration units and refrigerator rail cars, and (3) heavy heavy duty diesel-fuel-delivery trucks. Emissions from heavy equipment operating at yards are based on the number and type of equipment, equipment model year, equipment horsepower, and the annual hours of operations. Emissions from TRUs and refrigerated rail cars are based on average size of the units, the average number of units in the yard, and the hours of operation for each units. HHD diesel-fuel-delivery trucks deliver diesel fuel, oil, and detergent for cleaning locomotives to the Dolores Yard, and gasoline, diesel fuel, and oil to the ICTF Yard. Emissions were estimated based on the ARB's EMFAC-2007 (v2.3) and OFFROAD-2007 models and specific emissions factors from types of equipment, annual hours of operation, vehicle miles traveled (VMT) and/or load factors. The details of activity data for the heavy and off-road equipment are documented in the emission inventory report (Sierra Research, 2007).

Table III-5 summarizes the diesel PM emissions of heavy equipment and vehicles at both railyards. The TRUs are estimated to be approximately 1.5 tons per year, followed by heavy equipment and vehicles with about 0.4 tons per year of diesel PM emissions. The diesel fuel delivery trucks contribute less than 1% of diesel PM emissions.

Table III-5 Diesel PM emissions of off-road and heavy equipment.

Heavy and off-Road Equipment	Tons per Year	Percentage
Transport Refrigeration Units/Refrigerator Rail Cars	1.51	79%
Heavy Equipment and Vehicles	0.38	20%
Diesel Fuel-Delivery Trucks	< 0.01	< 1%
Total	1.89	100%

In November 2004, ARB adopted a new regulation: *Airborne Toxic Control Measure (ATCM) for In-Use Diesel-Fueled Transport Refrigeration Units (TRUs), TRU Generator Sets and Facilities where TRUs Operate*. This regulation applies to all TRUs in California, including those coming into California from out-of-state. It requires in-use TRU and TRU generator set engines to meet specific diesel PM emissions that vary by horsepower range and engine model year, starting December 31, 2008 for engine model years 2001 or older. ARB staff estimates that diesel PM emissions for TRUs and TRU generator set engines will be reduced by approximately 65% by 2010 and 92% by 2020. Starting in 2009, the UP ICTF/Dolores Railyards will benefit from these mitigation measures as diesel PM emissions from TRUs are gradually reduced as their fleets turnover.

5. Stationary sources

The diesel PM emissions from stationary sources at the UP ICTF/Dolores Railyards include diesel-fueled IC (internal combustion) engines used for emergency generators and air compressors. The total diesel PM emissions from stationary sources at facilities were estimated at about 0.06 tons per year in 2005.

6. Other Toxic Air Contaminant Emissions

The total volatile organic compound (VOC) emissions generated from various sources were estimated at about 1.4 tons per year in the UP ICTF/Dolores Railyards. Among the VOC gases, relatively small amount of toxic air contaminant emissions were identified and estimated at about 0.02 tons or 40 pounds per year, including benzene, formaldehyde, 1,3-butadiene, acetaldehyde, chloroform, and methyl chloride. In comparison with the diesel PM emissions generated at the facility, these toxic air contaminants are estimated at about 0.1% of total estimated diesel PM emissions in the railyards. The potential cancer risks contributed by these toxic air contaminants are found to be considerably lower than the diesel PM emissions, about a factor of 1,200 less, based on cancer potency weighted factor adjustment discussed in Chapter II. Because of the dominance of diesel PM emissions, these gaseous toxic air contaminants are not included in the health impact evaluation in this study.

D. Off-site non-railyard emission inventory

ARB staff analyzed the significant off-site emission sources based on two categories: mobile and stationary. The off-site emissions, i.e., mobile and stationary, were estimated for the sources within a one-mile distance from the UP ICTF and Dolores Railyards (see Figure III-5).

1. Mobile Sources

For the off-site mobile sources, the analysis focused on on-road heavy duty diesel trucks, as they are the primary source of diesel PM from the on-road vehicle fleet. ARB staff estimated mobile emissions based on roadway specific vehicle activity data and allocated them to individual roadway links. All roadway links within a one-mile distance from the boundaries of the ICTF and Dolores Railyards are included in the analysis. The estimates do not include the diesel PM emissions generated from other modes of operations, such as extended idling, starts, and off-road equipment outside the rail yards. Individual sources such as local truck distribution centers and warehouses were not evaluated due to insufficient activity data, but their truck traffic related to these facilities is reflected in the roadway link traffic activities. Because the off-site mobile sources have only focused on the on-road diesel emissions, the exclusion of extended idling and off-road equipment may result in an underestimation of off-site mobile sources emissions.

> **Roadway link:** is defined as a discrete section of roadway with unique estimates for the fleet specific population and average speed and is classified as a freeway, ramp, major arterial, minor arterial, collector, or centroid connector.

Figure III-5 presents the one-mile off-site boundary from the UP ICTF and Dolores Railyards, where the off-site diesel PM emissions are evaluated. Within the one-mile boundary, the diesel PM emissions are predominantly generated by mobile sources, about 96% of total off-site diesel PM emissions. The mobile diesel PM emissions are allocated by the roadway links illustrated in Figure III-6. Some low local traffic activities of diesel PM emissions within major local roadways are presented by equivalent aggregated links or merged to near major links.

The off-site diesel PM mobile source emissions were estimated based on the local traffic flow, and calculated by different classifications of truck gross vehicle weights, as shown in Table III-6. For the year 2005, the total diesel PM emissions are estimated at about 48 tons per year from heavy-heavy duty, medium heavy duty, and light duty diesel trucks, accounting for about 48%, 36% and 16%, respectively.

Table III-6 Off-site mobile source diesel PM emissions by vehicle type.

Vehicle type	Gross vehicle weight (Pounds)	Diesel PM emissions	
		Tons per year	Percent of total
Light heavy duty	8,501 – 14,000	7.7	16%
Medium heavy duty	14,001 – 33,000	17.3	36%
Heavy heavy duty	> 33,000	22.9	48%
Total		47.9	100%

A great portion of the off-site diesel PM emissions are estimated from diesel-fueled heavy duty trucks traveling on freeways I-405, I-710, and major local streets. Table III-7 presents the distribution of mobile source emissions from the major freeway traffic flows in the area. Out of about 48 tons per year, the I-405 and I-710 contribute approximately 32 tons per year of diesel PM emissions, which accounts for about 69% of total off-site diesel PM mobile source emissions. The remaining 31% or about 15 tons of mobile diesel PM emissions is contributed from local street traffic flows. The detailed methodology for mobile diesel PM emission estimation is provided in Appendix A.

The PHL also operates switching and pulling of overflow railcars along the San Pedro Branch Line. This branch line is located about 100 yards east of the UP ICTF Railyard. ARB staff estimates that these activities contribute up to about 0.5 tons per year of diesel PM emissions associated with the activities in 2005 based on average fuel consumption. This represents about 1% of the total estimated off-site diesel PM emissions. These diesel PM emissions are not included in the off-site emission inventory for modeling; however, the impact is considered to be relatively low as compared to other nearby mobile sources because of lower emission densities along the track line within the one-mile boundary.

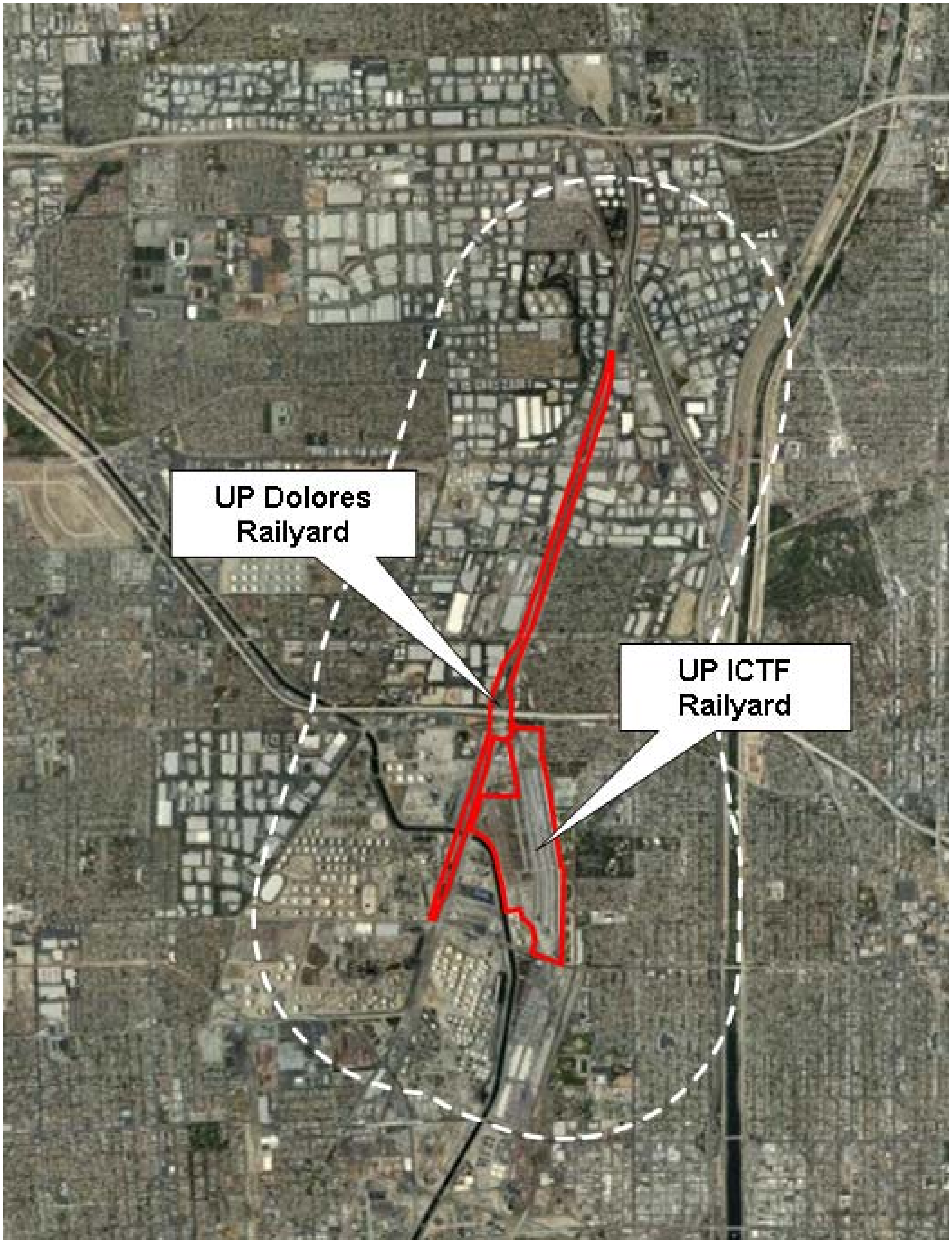


Figure III-5 Off-site one-mile distance boundary (dashed line) from the UP ICTF/Dolores Railyards (encompassed by solid lines).

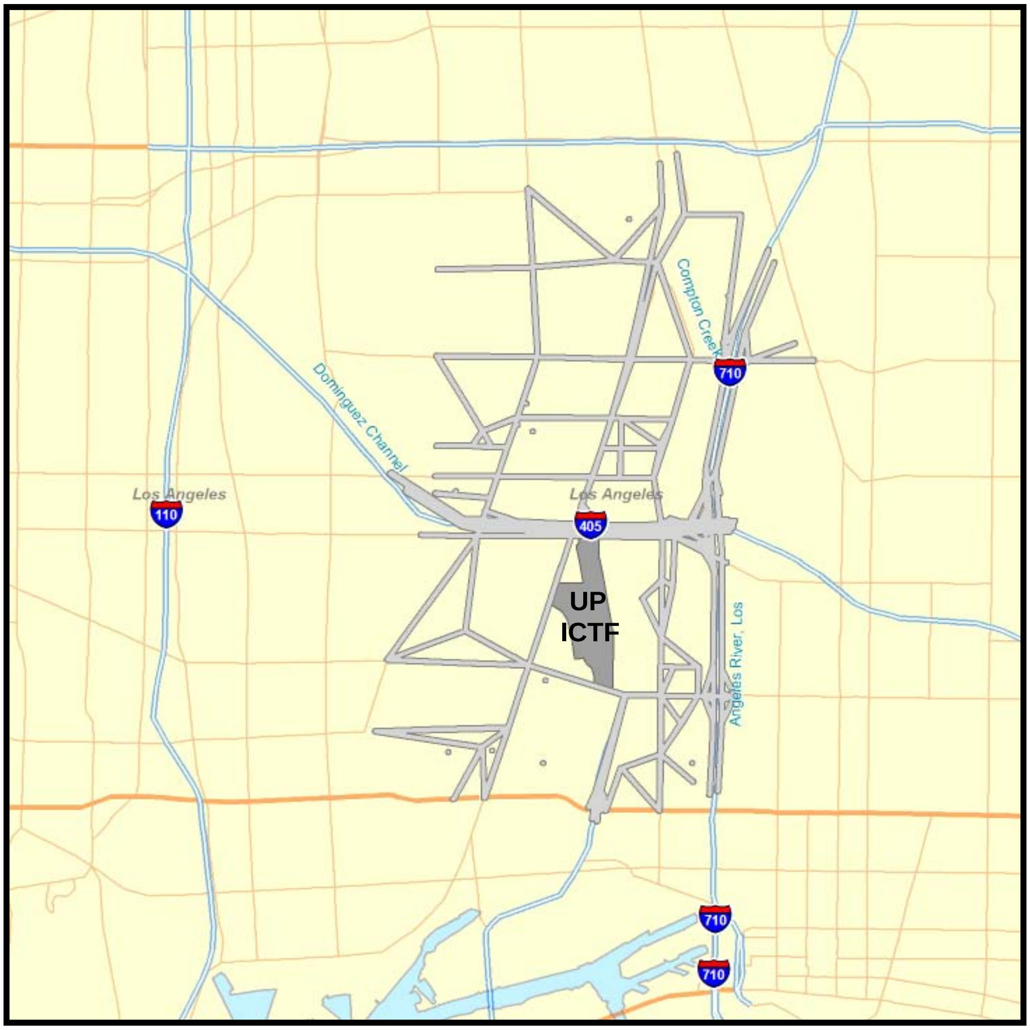


Figure III-6 Allocation of off-site mobile diesel PM emissions by roadway links from the SCAG (Southern California Association of Governments) Heavy Duty Truck Transportation Demand Model.

Table III-7 Off-site mobile source diesel PM emissions by traffic routes.

Traffic routes	Diesel PM emissions	
	Tons per year	Percent of total off-site mobile sources
Interstate-405	8.4	18%
Interstate-710	24.6	51%
Local streets	15.0	31%
Total	48.0	100%

2. Stationary Sources

Emissions from off-site stationary source facilities are identified using the California Emission Inventory Development and Reporting System (CEIDARS) database, which contains information reported by the local air districts for stationary sources within their jurisdiction. The CEIDARS facilities whose locations fell within the one-mile distance from the boundary of the railyards are selected. Diesel PM emissions are estimated from stationary internal combustion (IC) engines burning diesel fuel, operating at stationary sources reported in CEIDARS.

Within the one-mile distance from the boundaries of the UP ICTF and Dolores Railyards, the diesel PM emissions from stationary sources are estimated at about 2.1 tons per year, about than 4% of the total off-site diesel PM emissions. There are some large petroleum product facilities in this area: BP Carson Refinery, Shell Refinery (purchased by Tesoro in 2007), ConocoPhillips Refinery, Chemoil marine fuel station, and Kinder Morgan petroleum terminal. Among these petroleum product facilities, the BP refinery is the largest stationary diesel PM source, estimated at 1.6 tons per year, followed by other petroleum facilities.

ARB staff also evaluated other toxic air contaminants from stationary emissions around the UP ICTF/Dolores Railyards. Not all of these toxic air contaminants are identified as carcinogens. According to ARB's *Risk Reduction Plan to Reduce Particulate Matter Emissions from Diesel-Fueled Engines and Vehicles* (ARB, 2000), diesel PM, 1,3-butadiene, benzene, carbon tetrachloride, and formaldehyde are defined as the top 5 potential cancer risk contributors, based on ambient concentrations. These TACs account for 95% of the State's estimated potential cancer risk levels. This study also concluded that diesel PM contributes over 70% of the state's estimated potential cancer risk levels, which are significantly higher than other TACs (ARB, 2000). Among the toxic air contaminants other than diesel PM from stationary sources, benzene and formaldehyde were identified to be major contributors and estimated at about 7.9 tons per year with other. Benzene and formaldehyde were also identified to be major toxic air contaminants generated from the refineries nearby.

> **Cancer potency factors (CPF)** are expressed as 95% upper confidence limit of excess cancer cases occurring in an exposed population assuming continuous lifetime exposure to a substance at a dose of one milligram per kilogram of body weight, and are expressed in units of $(mg/kg\text{-}day)^{-1}$.

The Office of Environmental Health Hazard Assessment (OEHHA) has estimated an inhalation cancer potency factor (CPF) for individual chemicals and some chemical mixtures such as whole diesel exhaust. Diesel exhaust PM contains many individual cancer causing chemicals. The individual cancer-contributing chemicals from diesel exhaust are not separately evaluated so as to avoid double counting. The compounds listed in Table III-6 from top five TACs in inventory are given a weighting factor by comparing each compound's cancer potency factor to the diesel PM cancer potency factor. This factor is multiplied by the estimated actual emissions for a given compound, which gives the potency weighted toxic emission as shown in the Table. As indicated, the cancer potency weighted toxic air contaminant emissions from stationary sources are estimated at about 0.43 tons per year. Based on the emission inventory, the potential cancer risks from these non-diesel toxic air contaminants are considerably lower than the diesel PM emissions, by about a factor of 115. Because of the dominance of diesel PM emissions, other toxic air contaminants from the stationary sources were not included in the analysis.

Table III-8 Cancer potency weighted toxic air contaminant emissions from significant off-site stationary sources surrounding UP ICTF/Dolores Railyards

Toxic Air Contaminant	Cancer Potency Factor	Weighted Factor	Estimated Emissions (tons/year)	Potency Weighted TAC Emissions (tons/year)
Diesel PM	1.1	1.0	50	**50**
1,3 Butadiene	0.6	0.55	0.05	**0.03**
Carbon Tetrachloride	0.15	0.14	0.001	**< 0.01**
Benzene	0.1	0.09	3.4	**0.31**
Formaldehyde	0.021	0.019	4.5	**0.09**
Non-Diesel PM Toxic Air Contaminants			8.0	**0.43**

E. Current applicable diesel fuel regulations and their benefits to the railyards

1. California Air Resources Board (CARB) diesel fuel specifications

The initial California diesel fuel specifications were approved by the Board in 1988 and limited sulfur and aromatic contents. The requirements for "CARB diesel," which became applicable in October 1993, consisted of two basic elements:

- A limit of 500 parts per million by weight (ppmw) on sulfur content to reduce emissions of both sulfur dioxide and directly emitted PM.
- A limit on aromatic hydrocarbon content of 10 volume percent for large refiners and 20% for small refiners to reduce emissions of both PM and NO_x.

At a July 2003 hearing, the Board approved changes to the California diesel fuel regulations that, among other things, lowered the maximum allowable sulfur levels in

California diesel fuel to 15 ppmw beginning in June 2006. Thus, ARB's specifications for sulfur and aromatic hydrocarbons are shown in Table III-7.

Table III-9 California diesel fuel standards

Implementation Date	Maximum Sulfur Level (ppmw)	Aromatics Level (% by volume)	Cetane Index
1993	500	10	N/A
2006	15	10	N/A

The regulation limiting aromatic hydrocarbons also includes a provision that enables producers and importers to comply with the regulation by qualifying a set of alternative specifications of their own choosing. The alternative formulation must be shown, through emissions testing, to provide emission benefits equivalent to that obtained with a 10 aromatic standard (or in the case of small refiners, the 20 percent standard). Most refiners have taken advantage of the regulation's flexibility to produce alternative diesel formulations that provide the required emission reduction.

2. U.S. EPA on-road diesel fuel specifications

The United States Environmental Protection Agency (U.S. EPA) has also established separate diesel fuel specifications for on-road diesel fuel and off-road (non-road) diesel fuel. The initial U.S. EPA diesel fuel standards were applicable in October 1993. The U.S. EPA regulations prohibited the sale or supply of diesel fuel for use in on-road motor vehicles, unless the diesel fuel had a sulfur content no greater than 500 ppmw. In addition, the regulation required on-road motor-vehicle diesel fuel to have a cetane index of at least 40 or have an aromatic hydrocarbon content of no greater than 35% by volume (vol. %). All on-road motor-vehicle diesel fuel sold or supplied in the United States, except in Alaska, must comply with these requirements. Diesel fuel, not intended for on-road motor-vehicle use, must contain dye solvent red 164.

On January 18, 2001, the U.S. EPA published a final rule which specified that, beginning June 1, 2006, refiners must begin producing highway diesel fuel that meets a maximum sulfur standard of 15 ppmw for all and later model year diesel-fueled on-road vehicles The current U.S. EPA on-road diesel fuel standard is shown in Table III-8.

Table III-10 U.S. EPA diesel fuel standards

Applicability	Implementation Date	Maximum Sulfur Level (ppmw)	Aromatics Maximum (% by volume)	Cetane Index[‡] (Minimum)
On-Road	2006	15	35	40
Non-road *	1993	5,000	35	40
Non-road *	2007	500	35	40
Non-road, *excluding loco/marine **	2010	15	35	40
Non-road, *loco/marine**	2012	15	35	40

* Non-road diesel fuels must comply with ASTM No. 2 diesel fuel specifications for aromatics and cetane index.

‡ A measure of the combustion quality of diesel fuel via the compression ignition process.

3. U.S. EPA non-road diesel fuel specifications

Until recently, fuel supplied to outside of California was allowed a sulfur content of up to 5,000 ppmw (parts per million by weight). However, in 2004, the U.S. EPA published a strengthened rule for the control of emissions from non-road diesel engines and fuel. The U.S. EPA rulemaking requires that sulfur levels for non-road diesel fuel be reduced from current uncontrolled levels of 5,000 ppmw ultimately to 15 ppmw, though an interim cap of 500 ppmw is contained in the rule. Beginning June 1, 2007, refiners are required to produce non-road, locomotive, and marine diesel fuel that meets a maximum sulfur level of 500 ppmw. This does not include diesel fuel for stationary sources. In 2010, non-road diesel fuel will be required to meet the 15 ppmw standard except for locomotives and marine vessels. In 2012, non-road diesel fuel used in locomotives and marine applications must meet the 15 ppmw standard. The non-road diesel fuel standards are shown above in Table III-8.

4. What are the current properties of in-use diesel fuel?

Table III-9 shows average in use level of sulfur content and four other properties for motor vehicle diesel fuel sold in California after the California and Federal diesel fuel regulation became effective in 1993. The corresponding national averages are shown for the same properties for on-road diesel fuel only since the U.S. EPA sulfur standard does not apply to off-road or non-vehicular diesel fuel. Non-road diesel fuel sulfur levels have been recorded as about 3,000 ppmw in-use and similar levels as U.S. EPA on-road diesel fuel for aromatics at about 35% by volume in-use.

Table III-11 Average 1999 properties of reformulated diesel fuel.

Property	California	U.S.[1]
Sulfur, ppmw	10[2]	10 [2]
Aromatics, vol.%	19	35
Cetane No.	50	45
PNA[3], wt.%	3	NA
Nitrogen, ppmw	150	110

(1) U.S. EPA, December 2000.
(2) Based on margin to comply with 15 ppmw sulfur standards in June 2006.
(3) Polynuclear aromatics.

5. Diesel fuels used by California-based locomotives

The ARB Board approved a regulation in November 2004 which extended the CARB diesel fuel requirements to intrastate locomotives (those operating 90% or more of the time in California) effective on January 1, 2007. UP and BNSF agreed in the 2005 railroad Agreement to dispense only CARB diesel or U.S. EPA on-road diesel fuels to interstate locomotives that fueled in California beginning on January 1, 2007.

Line haul locomotives have a range of about 800 to 1,200 miles between refueling. BNSF locomotives typically refuel at Belen, New Mexico before traveling to Barstow, California and UP locomotives typically refuel at Salt Lake City, Utah before traveling to Roseville in northern California or Colton in southern California. These major out-of-state railroad facilities have the option to use Federal non-road diesel fuels for the refueling of line haul locomotives. When these out-of-state line haul locomotives arrive in California they typically have about 10% remaining volume of diesel fuel relative to their tank capacity.

UP and BNSF surveyed each of the California refueling centers, and major interstate fueling centers to California, to estimate the average diesel fuel properties for locomotives for the railyard health risk assessments. Diesel fuel sulfur levels were estimated to be an average of 1,100 ppmw based on the mixture of CARB, U.S. EPA on-road, and non-road diesel fuel consumed by locomotives in California in 2005. ARB staff believes this is a conservative estimate for the types of diesel fuels and sulfur levels consumed by locomotives in California.

The U.S. EPA on-road and CARB on-road and off-road diesel ultra low sulfur specifications (15 ppmw) went into effect on June 1, 2006. The CARB diesel fuel requirements for intrastate locomotives went into effect on January 1, 2007. The U.S. EPA non-road diesel fuel sulfur limit will drop from 5,000 ppmw to 500 ppmw on June 1, 2007. In 2012, the non-road diesel limits for fuel used in locomotives and marines will drop from 500 ppmw to 15 ppmw.

The NO_x emission benefits associated with the use of CARB diesel compared to U.S. EPA on-road and non-road diesel fuels are due to the CARB aromatic hydrocarbon limit of 10% by volume or an emission equivalent alternative formulation limit. ARB staff estimates that use of CARB diesel provides a six percent reduction in NO_x and a 14% reduction in particulate emissions compared with the use of U.S. EPA on-road and non-road diesel fuels. In addition, CARB diesel fuel will provide over a 95% reduction in fuel sulfur levels in 2007 compared to U.S. EPA non-road diesel fuel. This reduction in diesel fuel sulfur levels will provide SO_x emission reductions, and additional PM emission reductions by reducing indirect (secondary formation) PM emissions formed from SO_x.

In addition, the ARB, UP and BNSF Railroads entered into an agreement in 2005 which requires that at least 80% of the interstate locomotives must be fueled with either CARB diesel or U.S. EPA on-road ultra low sulfur diesel fuel by January 1, 2007. Both the CARB diesel fuel regulation for intrastate locomotives and the 2005 Railroad Agreement for interstate locomotives require the use of ultra low sulfur diesel fuel in 2007, five years earlier than the U.S. EPA non-road diesel fuel regulations for locomotives in 2012.

6. What are the current properties of in-use diesel fuel?

Both the U.S. EPA and CARB diesel fuels had sulfur levels lowered from 500 ppmw to 15 ppmw on June 1, 2006. Under the prior sulfur specification of 500 ppmw, CARB diesel fuel in-use sulfur levels averaged around 140 ppmw versus U.S. EPA on-road sulfur levels of about 350 ppmw. With the 2006 implementation of the 15 ppmw sulfur levels, in-use levels for both CARB diesel and U.S. EPA on-road now average about 10 ppmw.

Sulfur oxides and particulate sulfate are emitted in direct proportion to the sulfur content of diesel fuel. Reducing the sulfur content of diesel fuel from the California's statewide average of 140 ppmw to less than 10 ppmw would reduce sulfur oxide emissions by about 90% or by about 6.4 tons per day from 2000 levels. Direct diesel particulate matter emissions would be reduced by about four percent, or about 0.6 tons per year in 2010 for engines not equipped with advanced particulate emissions control technologies. U.S. EPA on-road lower sulfur diesel fuel would provide similar levels of sulfur oxide and direct diesel particulate matter emission reductions.

The emissions reductions would be obtained with low sulfur diesel used in mobile on-road and off-road engines, portable engines, and those stationary engines required by district regulations to use CARB diesel. In addition, NO_x emissions would be reduced by seven percent or about 80 tons per year for those engines not currently using CARB diesel, assumed to be about 10% of the stationary engine inventory and including off-road mobile sources such as interstate locomotives.

The lower sulfur diesel makes much more significant emissions reductions possible by enabling the effective use of advanced emission control technologies on new and retrofitted diesel engines. With these new technologies, emissions of diesel particulate matter and NO_x can be reduced by up to 90%. Significant reductions of non-methane hydrocarbons and carbon monoxide can also be achieved with these control devices.

IV. AIR DISPERSION MODELING OF UP ICTF/DOLORES RAILYARDS

Air dispersion modeling is conducted to estimate the downwind dispersion of diesel PM emissions resulting from the on-site and off-site sources at the UP ICTF/Dolores Railyards. A description of the air quality modeling parameters is provided in this chapter, including air dispersion model selection, estimated emissions, meteorological data selection, model receptor network, and building wake effects. .

A. Air dispersion model selection

Air dispersion models or other air quality models are often used to simulate atmospheric processes on different scale applications where the spatial scale ranges from the tens of meters to the tens of kilometers, or to hundreds of kilometers over large scale domains. Selection of air dispersion models usually depends on a number of factors, such as characteristics of emission sources, the type of terrain at the emission source locations, and the scale of source-receptor relationships. For the UP ICTF/Dolores Railyards, the U.S. EPA's AERMOD (**A**merican Meteorological Society/**E**PA **R**egulatory **MOD**el) is used for air dispersion modeling work. The AERMOD is a model preferred by the *US EPA Guideline for Air Quality Methods (*40 CFR Part 51, Appendix W*)* (US EPA , 2005) for micro-scale applications. The AERMOD model was developed as replacement for its predecessor, the U.S. EPA Industrial Sources Complex (ISC) air dispersion model, to improve the accuracy of model estimations. This replacement was made in November 2005, and AERMOD has become a U.S. EPA regulatory dispersion model after a one-year transition period.

The AERMOD model 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. In the stable boundary layer, it assumes the distribution of pollutant concentrations to be normal (or bell-shaped, or Gaussian) in both the vertical and the horizontal directions. In the mixing layer (or the convective boundary layer) near ground surface, the horizontal distribution of a plume mass is also assumed to be normal, but the vertical mass distribution is described with a bi-normal probability density function. In addition, the AERMOD model treats "plume lofting," whereby a portion of plume mass, released from a buoyant source, rises to and remains near the top of the boundary layer before becoming mixed into the mixing layer. For sources in both the convective boundary layer and the stable boundary layer, the AERMOD model treats the enhancement of lateral dispersion resulting from plume meander.

> ***Mixing Layer**: A type of atmospheric boundary layer characterized by vigorous turbulence tending to stir and uniformly mix.*

B. Source characterization and parameters

The emission sources from the locomotives and other diesel PM sources at the UP ICTF/Dolores Railyards are characterized by source types, as required by the ARB Guidelines (ARB, 2006e). Emission sources were treated as either point or volume sources in the dispersion modeling. Point source treatment includes calculated plume rise based on source stack dimensions and exhaust parameters, and hour-by-hour meteorological conditions; volume source treatment includes user-specified release height and initial horizontal and vertical dispersion. Larger stationary emission sources (e.g., idling locomotives and cranes where present) were treated as a series of point sources within their areas of operation. Spacing between sources was selected based on the magnitude of emissions and the proximity to off-site receptors. Smaller and moving sources (e.g., idling and moving trucks, and moving locomotives) were treated as a series of volume sources. Source spacing and initial dispersion coefficients for volume sources were also selected based on the magnitude of the emissions and the proximity to off-site receptors.

The emission rates for individual locomotives are a function of locomotive makes, notch setting, activity time, duration, and operating location. Emission source parameters for locomotive model classifications at the yard include emission source height, diameter, exhaust temperature, and exhaust velocity. While the BNSF assumed more specific temperatures and stack heights from their switchers and line haul locomotives fleets, the UP used data from the *Roseville Railyard Study* (ARB, 2004a) based on the most prevalent locomotive model of switchers and line hauls to parameterize locomotive emission settings. In total, the assumptions on the locomotive emission parameters are slightly different between UP and BNSF; however, both are within reasonable ranges according to their activities, and the slight differences in stack height have an insignificant impact on predicted air concentrations, within two percent, based on a sensitivity analysis conducted by ARB staff.

For the stationary locomotives, the locations of individual locomotive emission sources used for the model inputs were determined based on the detailed locomotive distribution and activity information provided by UP. The emissions from all other stationary sources (storage tanks, sand tower, waste water treatment plant, etc.) and portable sources (welders, steam cleaners, air compressors, etc.) are simulated as a series of point sources.

C. Meteorological data

The AERMOD model requires meteorological parameters to characterize air dispersion dynamics in the atmosphere. Wind speed determines how rapidly the pollutant emissions will be diluted in air. It also influences emission plume rise, thus affecting downwind concentrations of pollutants. Under low wind conditions, the plume's initial buoyancy and inertia will cause the emissions to go higher into the air than during high wind conditions. Wind direction determines where pollutants will be transported.

Atmospheric stability determines the rate of mixing in the atmosphere and is typically characterized by the atmospheric vertical temperature profile. The difference of ambient temperature and the emission source exhaust exit temperature determines the initial buoyancy. In general, the greater the temperature difference, the higher the plume rise. The model also incorporates upper air sounding data, cloud ceiling height, and cloud coverage, which will determine the mixing height in the atmosphere.

The meteorological data used in the model are selected on the basis of representativeness. Representativeness is determined primarily on whether the wind speed/direction distributions and atmospheric stability estimates generated through the use of a particular meteorological station (or set of stations) are expected to mimic those actually occurring at a location where such data are not available. Typically, the key factors for determining representativeness are proximity of the meteorological station and the presence or absence of nearby terrain features that might alter airflow patterns.

> ***AERMET****: A meteorological preprocessing program for AERMOD..*

Surface meteorological data from July 1, 2005 through June 30, 2006, was collected at the Sts. Peter and Paul School meteorological station, about 3.5 miles southwest from the UP ICTF Railyard (see Figure IV-1). Cloud cover data from the Long Beach Daugherty Field (Naval Reserve Air Base) station, and upper air data from Miramar Marine Corps Air Station in San Diego were processed in AERMET (US EPA, 2004) for dispersion model inputs. Surface parameters supplied to the model were specified for the area surrounding the surface meteorological monitoring site as recommended by AERMOD and ARB Guidelines (ARB, 2006b). According to the sensitivity analyses conducted by BNSF, the impacts on the diesel PM air concentration spatial patterns, locations of highest concentrations, and absolute concentrations by using the long-term (i.e., five-year) vs. short-term (i.e., one-year) are found to be insignificant. This is consistent with the findings from a sensitivity analysis from one of UP railyards conducted by ARB staff (see Appendix F). Therefore, whether five-year or one-year meteorological data are used, the modeling results show similar estimated exposures and potential cancer risks surrounding the railyard facility.

Figure IV-1 Location of the meteorological station at Saints Peter and Paul School in Wilmington, CA.

Figure IV-2 and IV-3 illustrate the wind rose and the wind class frequency distributions under the surface meteorological conditions at the UP ICTF/Dolores Railyard facility. Figure IV-2 indicates that the prevailing wind in the region is northwesterly with an average wind speed at 1.95 meters per second.

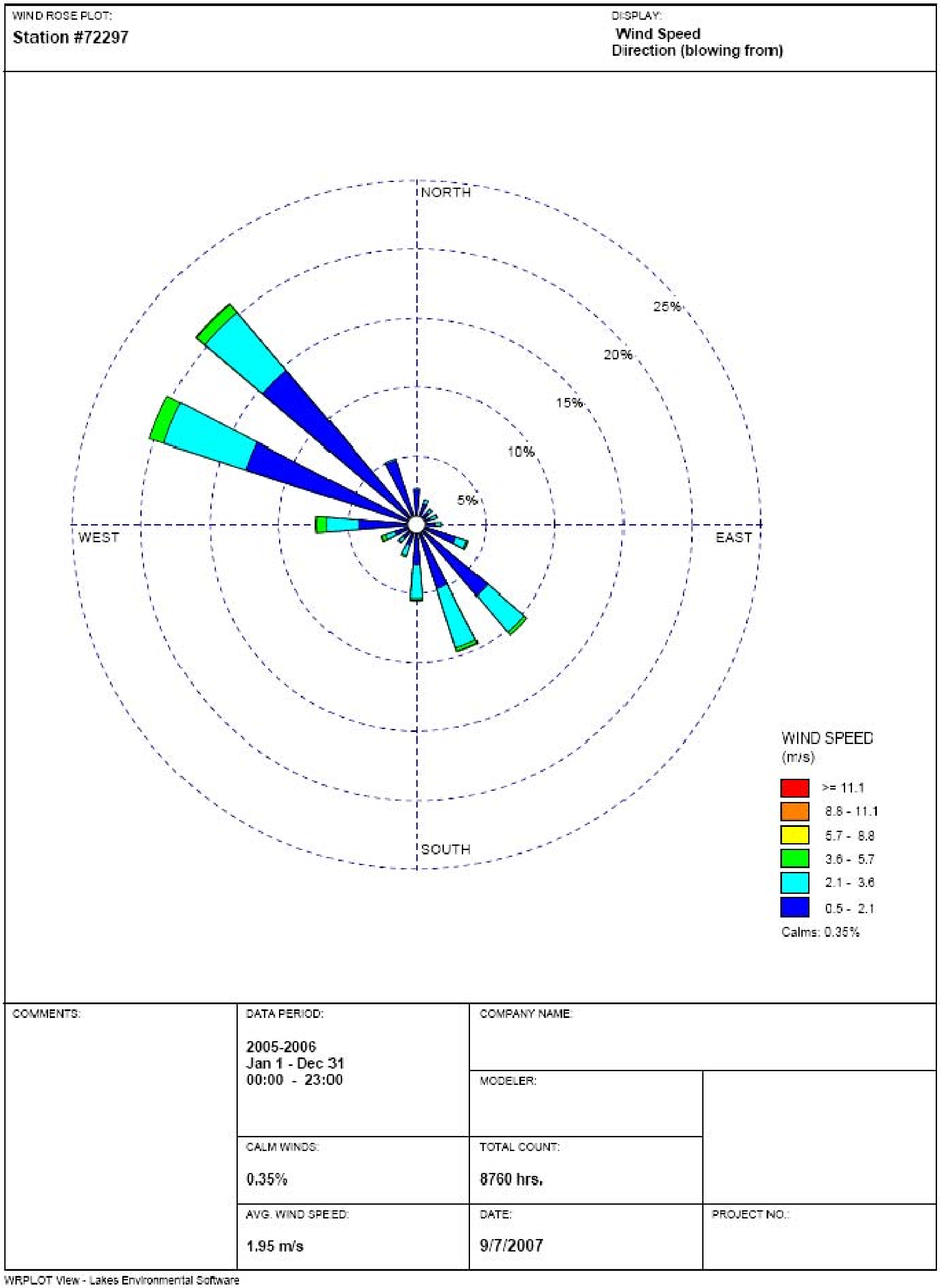


Figure IV-1 Wind rose plot of Saints Peter and Paul School meteorological station in Wilmington for the year 2005-2006.

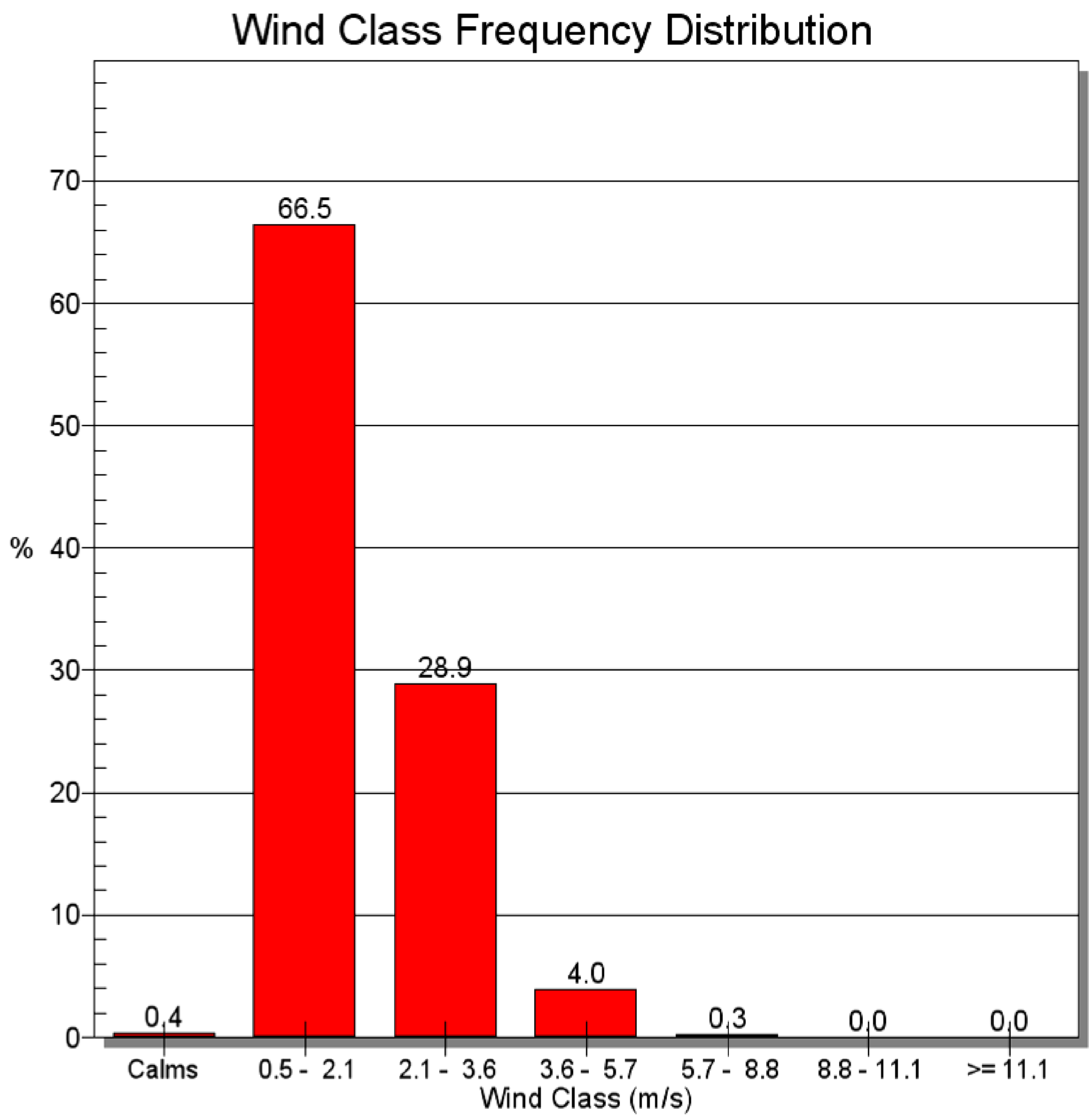


Figure IV-2 Wind class frequency distribution of 2005-2006 meteorological data at Saints. Peter and Paul School in Wilmington.

The detailed procedures for meteorological data preparation and the QA/QC are documented in the dispersion modeling report (Sierra Research, 2007)

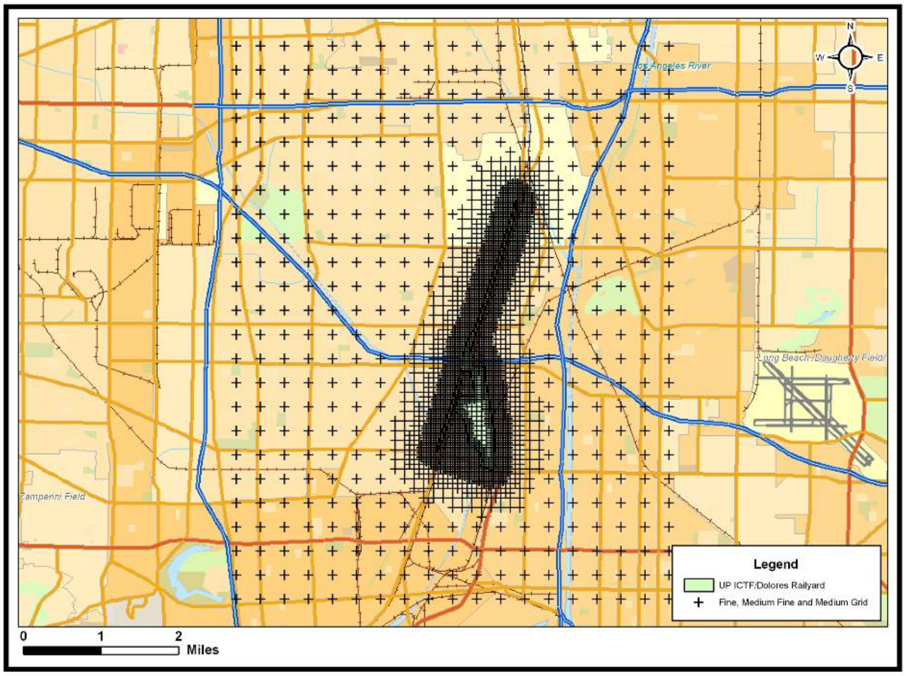
D. Model receptors

Model receptors are the defined discrete locations where concentrations are estimated by the dispersion model. A Universal Transverse Mercator (UTM) coordinate grid receptor network is used in the study where an array of points are identified by their coordinates. This network is capable of identifying the emission sources within the railyard with respect to the receptors in the nearby areas.

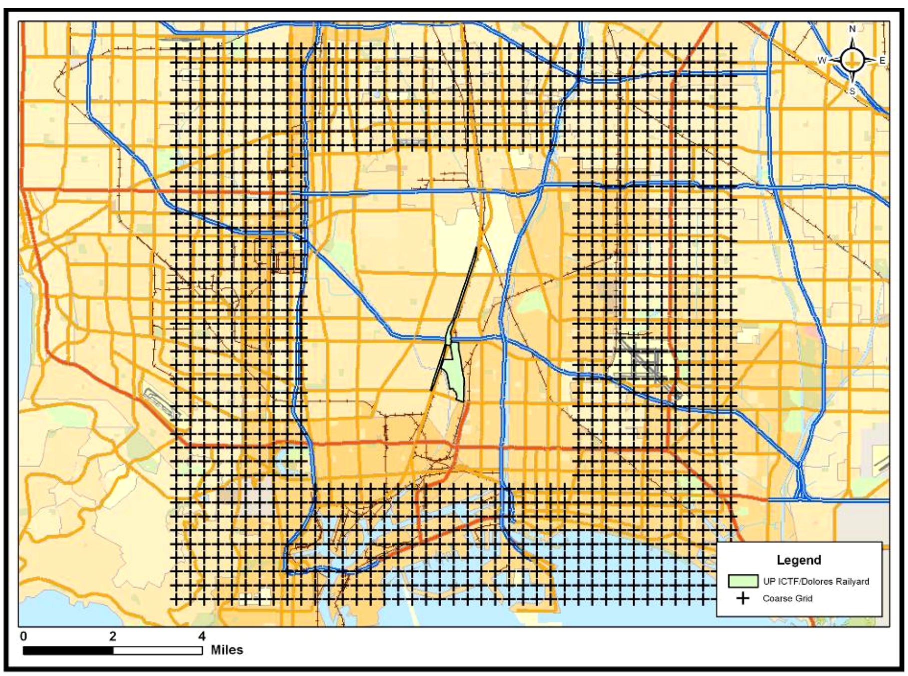
According to the *ARB Railyard Health Risk Assessment Guidance for Railyard and Intermodal Facilities* (ARB, 2006b), the modeling domain is defined as a 20×20 km region, which covers the railyard in the center of domain and extends to the surrounding areas. To better capture the different concentration gradients surrounding the railyard area, three sets of receptor grids were used for the UP ICTF/Dolores Railyards air dispersion modeling assessment. The ARB's Guidance require coarse and fine modeling receptor grids, including a fine receptor grid with spacing of 50 meters, and a coarse receptor grid with spacing of 500 meters. The fine grid of 50m x 50m surrounding the yard facilities was used for modeling within 300 m of the fence line. A medium-fine grid of 100 m x 100 m was used for receptors between 300 and 600 meters of the fence line around the fine grid network, and a medium grid of 200 m x 200 m was used for receptor distances between 600 and 1000 meters, surrounded by coarse grid receptors of 500 m x 500 m. The locations of the fine, medium and coarse receptor grid networks are presented in Figures IV-3a and IV-3b respectively.

E. Building wake effects

One of characterizations in the air dispersion model is mixing process of air pollutants due to the air flow cause by surrounding environment. The spacing and placement of emission sources relative to surrounding building or structures can have such an effect on the pollutant plume in the air. If pollutant emissions are released at or below the Good Engineering Practice (GEP) height as defined by U.S. EPA Guidance (US EPA, 1985), the plume dispersion may be affected by surrounding facility buildings and structures. The aerodynamic wakes and eddies produced by the buildings or structures may cause pollutant emissions to be mixed more rapidly to the ground, causing elevated ground level concentrations. The AERMOD model has the option to simulate the effects of building downwash. To do so, "direction-specific" building dimensions for each emission point need to be input. The direction-specific building dimensions represent the building width perpendicular to the wind direction along with the building height, and are estimated by a model built-in module, the Building Profile Input Program – Plume Rise Model Enhancements, to account for potential building-induced aerodynamic downwash effects.



(a)



(b)

Figure IV-3 The receptor grid networks of AERMOD air dispersion modeling at the UP ICTF/Dolores Railyards facility,(a) fine, medium-fine and medium grids; (b) coarse grids. (Source: *Toxic Air Contaminant Emissions Inventory and Dispersion Modeling Report for the Dolores and ICTF Railyards, Long Beach, California*. (Sierra Research, 2007))

Although UP ICTF/Dolores Railyards included building wake effects in their modeling analyses, BNSF conducted a sensitivity analysis and found that the building wake effect has an insignificant impact on the diesel PM air concentrations of the railyard. This sensitivity analysis also indicated that, at receptor distances close to the sources (i.e., within 100 meters), building downwash may have a large impact on the modeled concentrations. However, at distances further away from the sources (i.e., 400 to 700 meters), receptor concentrations from model predictions with and without building downwash were similar (ENVIRON, 2006).

F. Model implementation inputs

One of the basic inputs to AERMOD is the runstream setup file which contains the selected modeling options, as well as source location and parameter data, receptor locations, meteorological data file specifications, and output options. Another type of basic type of input data needed to run the model is the meteorological data. AERMOD requires two types of meteorological data files. One consists of surface scalar parameters, and the other file consists of vertical profiles of meteorological data. For applications involving elevated terrain effects, the receptor and terrain data will need to be processed by the terrain preprocessing program before input to the AERMOD model.

Source inputs require source identification and source type. Each source type requires specific parameters to define the source. For example, the required details for a point source are emission rate, release height, emission source diameter, exhaust exit temperature, and exhaust exit velocity. The requirements and the format of input files to the AERMOD are documented in the user's guide of AERMOD (US EPA, 2004a).

V. HEALTH RISK ASSESSMENT OF UP ICTF/DOLORES RAILYARDS

This chapter describes the ARB's guidelines on health risk assessment and characterization of potential cancer and non-cancer risks associated with exposure to toxic air contaminants, especially diesel PM emissions from the sources within and surrounding the UP ICTF/Dolores Railyards, followed by a discussion of uncertainties with respect to the components of health risk assessment.

A. ARB railyard health risk assessment guidelines

The railyard HRA follows *The Air Toxics Hot Spots Program Risk Assessment Guidelines* published by OEHHA, and is consistent with the methodologies used for the UP Roseville Railyard Study (ARB, 2004a). The OEHHA Guidelines outline a tiered approach to risk assessment, providing risk assessors with flexibility and allowing for consideration of site-specific differences:

- Tier-1: a standard point-estimate approach that uses a combination of the average and high-end point-estimates.
- Tier-2: utilizes site-specific information for risk assessment when site-specific information is available and is more representative than the Tier 1 point-estimates.
- Tier-3: a stochastic or random approach for exposure assessment when the data distributions are available.
- Tier-4: similar to the Tier 3 approach, but all site-specific data distributions are used.

> ***Percentile**: Any one of the points dividing a distribution of values into parts each of which contain 1/100 of the values. For example, the 65th percentile breathing rate is a value such that the breathing rates from 65 percent of population are less or equal to it.*

The Health Risk Assessment is based on the railyard specific emission inventory and air dispersion modeling predictions. The OEHHA guidelines recommend that all health hazard risk assessments adopt a Tier-1 evaluation for the Hot Spots Program, even if other approaches are also presented. Two point-estimates of breathing rates in Tier-1 methodology are used for this HRA, one representing an average and the other representing a high-end value based on the probability distribution of breathing rate. The average and high-end of point-estimates are defined as 65th percentile and 95th percentile from the distributions identified in the OEHHA guidelines. In 2004, ARB recommended the interim use of the 80th percentile value (the midpoint value of the 65th and 95th percentile breathing rates referred as an estimate of central tendency) as the minimum value for risk management decisions at residential receptors for the breathing intake (ARB, 2004b). The 80th percentile corresponds to a breathing rate of 302 Liters/Kilogram-day (302 L/Kg-day) from the probability distribution function. As indicated by the OEHHA Guidelines, the Tier-1 evaluation is useful in comparing risks among a number of facilities and similar sources.

The ARB has also developed *Health Risk Assessment Guidance for Railyard and Intermodal Facilities* (ARB, 2006b) to help ensure that the air dispersion modeling and HRA performed for each railyard meet the OEHHA guidelines. The risk assessment adopted in this study assumes that the receptors (or an individual) will be exposed to the same toxic levels for 24 hours per day for 70 years. If a receptor is exposed for a shorter period of time to a given ambient concentration of diesel PM, the cancer risk will proportionately become less.

B. Exposure assessment

Exposure assessment is a comprehensive process that integrates and evaluates many variables. Three process components have been identified to have significant influences on the results of a health risk assessment – emissions, meteorological conditions, and exposure duration of nearby residents. The emissions have a linear effect on the risk levels, given meteorological conditions and a defined exposure duration. Meteorological conditions have a critical impact on resultant ambient concentration of a pollutant, with higher concentrations found along the predominant wind direction and under calm wind conditions. An individual's proximity to the emission plume, exposure duration, and the individual's breathing rate also play key roles in determining the potential risk. The longer the exposure time for an individual is, the greater the estimated potential risk for the individual will be. A 24-hour per day, 70-year lifetime exposure, duration has been assumed for the quantification of health risk for residents in this study. In addition, 40- and 9-year exposure assessments were conducted for off-site workers and school-aged children, respectively. Children have a greater risk than adults, i.e., an early life exposure, because they have greater exposure on a per unit body weight basis and also due to other factors.

Diesel PM is not the only TAC emitted from the UP ICTF/Dolores Railyards. A relatively small amount of TACs are also generated at the railyard from gasoline-fueled engines, storage tanks and wastewater treatment plant. The total amount of these toxic air contaminants emissions is estimated at about 1.4 tons per year, as compared to 24 tons per year facility-wide diesel PM emissions in 2005 baseline emission inventory. As described in Chapter III, the cancer potency weighed emissions of these TACs are about a factor 1,200 less than the diesel PM emissions at the railyard. ARB staff also evaluated the health impacts of the diesel PM emissions and other TACs from off-site stationary and mobile sources around the UP ICTF/Dolores Railyards.

The relationship between a given level of exposure to diesel PM and the cancer risk is estimated by using the diesel PM cancer potency factor (CPF). A description of how the diesel cancer potency factor was derived can be found in the document of *Proposed Identification of Diesel Exhaust as a Toxic Air Contaminant* (ARB, 1998) and a shorter description can be found in the Air Toxics Hot Spot Program Risk Assessment Guidelines, Part II, Technical Support Document for Describing Available Cancer Potency Factors (OEHHA, 2002). The use of the diesel unit risk factor for assessing cancer risk is described in the OEHHA guidelines. The potential cancer risk is estimated by multiplying the inhalation dose by the CPF of diesel PM, i.e., 1.1 (mg/kg-day)$^{-1}$.

C. Risk characterization

Risk characterization is defined as the process of obtaining a quantitative estimate of risk. The process integrates the results of air dispersion modeling and relevant toxicity data (e.g., diesel PM CPF) to estimate potential cancer or non-cancer health impacts associated with contaminant exposure.

Exposures to pollutants usually occur through different intake pathways, such as air breathing, dermal contact, ingestion of contaminated produce, and ingestion of fish that have taken up contaminants from water bodies. These exposures can all contribute to an individual's health risk. However, diesel PM risk is evaluated by the inhalation pathway only because the risk contributions by other pathways of exposure are known to be insignificant compared to the inhalation intake and difficult to quantify. It should be noted that the background or ambient diesel PM concentrations are not incorporated into the risk quantification in this study. Additional details on the risk characterization are provided in the Toxic Hot Spot Program Risk Assessment Guidelines (OEHHA, 2000).

To characterize the risk from the diesel PM emissions, three Cartesian receptor networks are used for the coverage of UP ICTF/Dolores Railyards and its surrounding areas, including (1) a fine receptor grid network with spacing of 50 meters out to a distance of approximately 300 meters from the facility boundary, (2) medium-fine receptor grid with spacing of 100 meters and a medium receptor grid with spacing of 200 meters are defined within the area from 300 meters to 1,000 meters from the facility boundary, and (3) a coarse receptor grid with spacing of 500 meters out to ten kilometers from the facility boundary. These receptor grid networks are graphically presented in Figure IV-3a and IV-3b. The risk levels are presented as two-dimensional isopleths (or contours). These isopleths are used to display the risk plume ranges and gradient (or risk changes with distance) in all wind directions.

In the following sections, the cancer risk levels and non-cancer chronic risk levels resulting from on-site and off-site diesel PM emissions will be presented, followed by a discussion of non-cancer acute risk assessment.

D. Risk characterization associated with on-site emissions

1. Cancer risk

Diesel PM emissions at UP ICTF/Dolores Railyards are from several sources, including locomotives, heavy heavy duty and light heavy duty on-road diesel trucks, diesel-powered heavy equipment, IC engine driven equipment, and other stationary sources.

Figure V-1 shows the isopleths of estimated potential cancer risk from on-site railyard diesel PM emissions based on the 80th percentile breathing rate approach and a 70-year exposure duration. The average estimated potential cancer risk is about 700 chances per million around the area near railyard property boundaries, assuming a 70-year exposure duration. The risks decrease rapidly to 100 in a million within a one-mile distance from the railyard then to 25 in a million within another 2 to 4-mile distance. About 5 miles upwind and 8 miles downwind from the railyard boundary, the estimated cancer risks are estimated at about 10 in a million or lower. The population near the railyard facility is located at the east and southeast areas from the UP ICTF Railyard, and generally has higher estimated cancer risks as compared to other residential areas. Table V-1 shows the estimated area coverage and exposed population for different cancer risk ranges estimated from modeling results. The residential areas near the UP ICTF/Dolores Railyards are located east of the railyard. The area with an estimated risk greater than 10 in a million encompasses approximately 54,310 acres outside the railyard facilities where about 597,500 residents live, based on the 2000 U.S. Census Bureau's data. Table V-1 presents the exposed population and area coverage size for various impacted zones of cancer risks.

The OEHHA Guidelines specify that, for health risk assessments, the location of the point of maximum exposure at the point of maximum impact (PMI) be reported. The PMI is defined as a location or the receptor point with the highest cancer risk level outside of the railyard boundary, with or without residential exposure. The PMI is predicted to be located next to the east boundary of ICTF Railyard fence line, based on the highest diesel PM concentrations estimated from the modeling results outside of the facility. The PMI is located downwind from the locomotive, cargo handling, drayage truck activities at the UP ICTF Railyard, which are the dominant sources of diesel PM emissions (see the emission spatial allocation in Appendix E).

The cancer risk at the PMI is estimated at to be about 1,200 chances per million based on a 70-year exposure duration. The land use in the vicinity of the PMI is primarily zoned for industrial use. However, there may be residents living in this zoned area. In the residential zoned area, the potential cancer risk of maximally exposed individual resident (MEIR) or maximum individual cancer risk (MICR) is estimated at about 800 chances in a million, assuming a 70-year lifetime exposure.

As indicated by *Roseville Railyard Study* (ARB, 2004a), the location of the PMI may vary depending upon the settings of the model inputs and parameters, such as meteorological data set or emission allocations in the railyard. Therefore, given the estimated emissions, modeling settings, and the assumptions applied to the risk assessment, there are great uncertainties associated with the estimation of PMI and MICR. These indications should not be interpreted as a literal prediction of disease incidence but more as a tool for comparison. In addition, the estimated point of maximum impact and maximum individual cancer risk may not be replicated by air monitoring.

ARB staff also conducted a comparison of cancer risks estimated at the PMI versus MICR, and the differences of facility-wide diesel PM emissions between the UP and BNSF railyards. The ratios of cancer risks at the PMI or MICR to the diesel PM emissions do not suggest that one railroad's facilities have statistically higher cancer risks than the other railroad's or vice versa. Rather, the differences are primarily due to emission spatial distributions from individual operations among railyards.

Table V-1 Estimated acreage and exposed population of different cancer risk zones associated with on-site railyard diesel PM emissions (based on Tier-1 estimate and 80th percentile breathing rate for 70-year exposure duration).

Estimated Risk (chances per million)	Estimated Impacted Area (acres)	Estimated Exposed Population†
> 500	220	1,200
250 - 500	730	10,100
100 - 250	2,760	20,200
50 - 100	5,100	51,000
25 - 50	11,900	206,000
10 - 25	33,600	309,000
> 10	54,310	597,500

† The population centroid of each census block is used to avoid possible double counting.

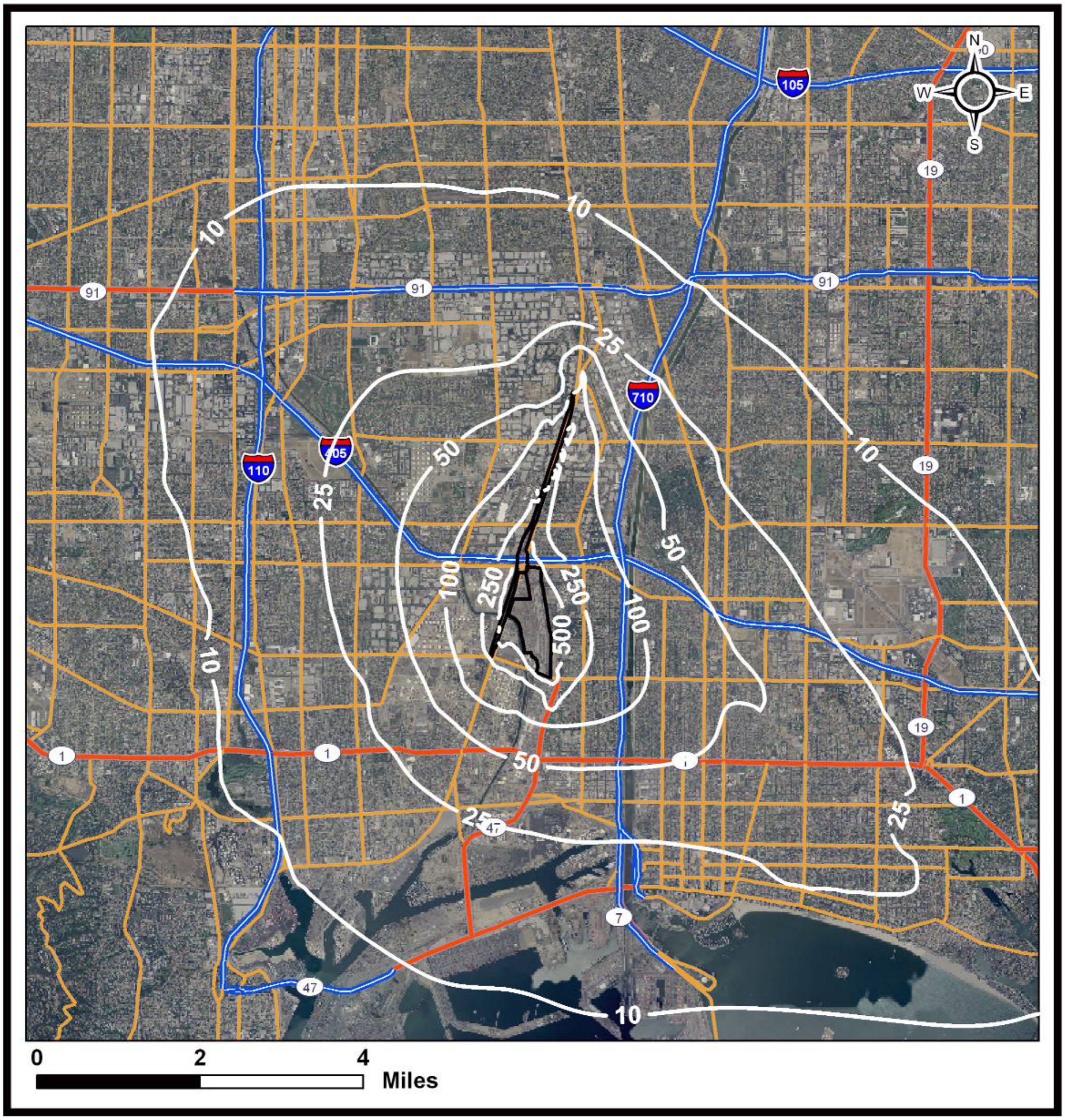


Figure V-1 Estimated potential cancer risk (in a million) associated with on-site diesel PM emissions at the UP ICTF/Dolores Railyards facility (based on Tier-1 estimate and 80th percentile breathing rate for 70-year exposure duration).

The OEHHA Guidelines recommend a 70-year lifetime exposure duration to evaluate the potential cancer risks for residents. Shorter exposure duration of 30 years and 9 years may be also provided for shorter residency and children as supplement information. These exposure durations are all based on the exposures of 24 hours a day, and 7 days a week. It is important to note that children, for physiological as well as behavioral reasons, have higher rates of exposure than adults on a per unit body weight basis. To evaluate the potential cancer risks for off-site workers, the OEHHA Guidelines recommend that a 40-year exposure duration to be used, assuming workers have a different breathing rate of 149 Liters/Kilogram-day for an 8-hour workday, with adjustments of five days a week and 245 days a year. Table V-2 shows the equivalent risk levels of 70-, 30-year exposure durations for exposed residents, and 40-, 9-year exposure durations for workers and school-aged children, respectively. Using Table V-2, the isopleth line with a risk level of 10 in a million in Figures V-1 would become 4 in a million for exposed population with a shorter residency of 30 years, 2.5 in a million for children at the age range of 0-9 (the first 9-year childhood), and 2 in a million for off-site workers.

Table V-2 Equivalent potential cancer risk levels of 70-, 30-, 9-, and 40-year exposure durations associated with on-site railyard diesel PM emissions (based on Tier-1 methodology and 70-year exposure).

Exposure Duration (years)	**Equivalent Estimated Cancer Risk Levels (chances in a million)**			
70	10	25	50	100
30	4	11	21	43
9*	2.5	6.3	12.5	25
40‡	2	5	10	20

* Exposure duration for school-aged children during the first 9-year childhood.
‡ Exposure duration for off-site workers.

ARB staff also estimated other toxic air contaminants generated at the railyard. In the UP ICTF/Dolores Railyards, the total toxic air contaminant emissions other than diesel PM is estimated at about 0.02 tons or 40 pounds per year, including benzene, formaldehyde, 1,3-butadiene and acetaldehyde. Using cancer potency weighted factors adjustment discussed in Chapter II, these non-diesel PM toxic air contaminants have considerably less potential cancer risks, about a factor of 1,200 less, as compared to the diesel PM, a predominant emission at the UP ICTF/Dolores Railyards. Hence, only diesel PM emissions are presented in the on-site emission analysis.

2. Non-cancer chronic risk

The quantitative relationship between the amount of exposure to a substance and the incidence or occurrence of an adverse health impact is referred to a dose-response assessment. According to the OEHHA Guidelines, dose-response information for non-carcinogens is presented in the form of reference exposure levels. OEHHA has developed chronic reference exposure levels for assessing non-cancer health impacts from long-term exposure.

A chronic reference exposure level is a concentration level, expressed in units of micrograms per cubic meter (µg/m^3) for inhalation exposure, at or below which no adverse health effects are anticipated following long-term exposure. Long-term exposure for these purposes has been defined as 12% of a lifetime, or about eight years for humans. The methodology for developing chronic reference exposure levels is fundamentally the same as that used by U.S. EPA in developing the inhalation Reference Concentrations (RfCs) and oral Reference Doses (RfDs). Chronic reference exposure levels are frequently calculated by dividing the no observed adverse effect level (NOAEL) or lowest observed adverse effect levels (LOAEL) in human or animal studies by uncertainty factors. A substantial number of epidemiologic studies have found a strong association between exposure to ambient particulate matter and adverse health effects. For diesel PM, OEHHA has determined a chronic reference exposure level of 5 µg/m^3, with the respiratory system, as a target of the reference exposure level.

It should be emphasized that exceeding the chronic reference exposure level does not necessarily indicate that an adverse health impact will occur. However, levels of exposure above the reference exposure level have an increasing but undefined probability of resulting in an adverse health impact, particularly in sensitive individuals (e.g., depending on the toxicant, the very young, the elderly, pregnant women, and those with acute or chronic illnesses).

The significance of exceeding the reference exposure level is dependent on the seriousness of the health endpoint, the strength and interpretation of the health studies, the magnitude of combined safety factors, and other considerations. In addition, there is a possibility that a reference exposure level may not be protective of certain small, unusually sensitive human subpopulations. Such subpopulations can be difficult to identify because of their small numbers, lack of knowledge about toxic mechanisms, and other factors. It may be useful to consult OEHHA staff when a reference exposure level is exceeded.

As described previously, reference exposure level for diesel PM is essentially the U.S. EPA reference concentration (RfC) first developed in the early 1990s based on histological changes in the lungs of rats. Since the identification of diesel PM as a toxic air contaminant, California has evaluated the latest literature on particulate matter health effects to set the ambient air quality standard. Diesel PM is a component of particulate matter in the air. Health effects from particulate matter in humans include illness and death from cardiovascular and respiratory disease, and exacerbation of asthma and other respiratory illnesses. Additionally, a body of literature has been published, largely after the identification of diesel PM as a toxic air contaminant and adoption of the REL, which shows that diesel PM can enhance allergic responses in humans and animals. Thus, it should be noted that the reference exposure level does not reflect adverse impacts of particulate matter on cardiovascular and respiratory disease and deaths, exacerbation of asthma, and enhancement of allergic response.

The hazard index is then calculated by taking the annual average diesel PM concentration, and dividing by the chronic reference exposure level of 5 $\mu g/m^3$. A hazard index value of 1 or greater indicates an exceedance of the chronic reference exposure level, and some adverse health impacts would be expected.

Hazard Index*: The ratio of the potential exposure to the substance and the level at which no adverse effects are expected*.

As part of this study, ARB staff conducted an analysis of the potential non-cancer health impacts associated with exposures to the model-predicted ambient levels of directly emitted diesel PM from on-site sources within the modeling domain. The hazard index values were calculated, and then plotted as a series of isopleths in Figure V-2. As shown in the figure, the potential non-cancer chronic health risks due to the diesel PM emissions at the UP ICTF/Dolores Railyards range from 0.05, about one to 1.5 miles from the railyards, to 0.5 near the UP ICTF Railyard boundary on the east. The impacted zone with hazard indices greater than 0.05 covers an area of about 4,900 acres.

According to the OEHHA Guidelines (OEHHA, 2003), these levels (less than 1.0) indicate that the potential non-cancer chronic public health risks from diesel PM are less likely to occur. Due to the northwesterly prevailing wind, the coverage extends over populated areas on the west of the railyard, the average chronic risk levels are much lower than 1.0. However, according to the OEHHA Guidelines (OEHHA, 2003), the estimated hazard indices indicate that the potential non-cancer chronic health risks are less likely to occur.

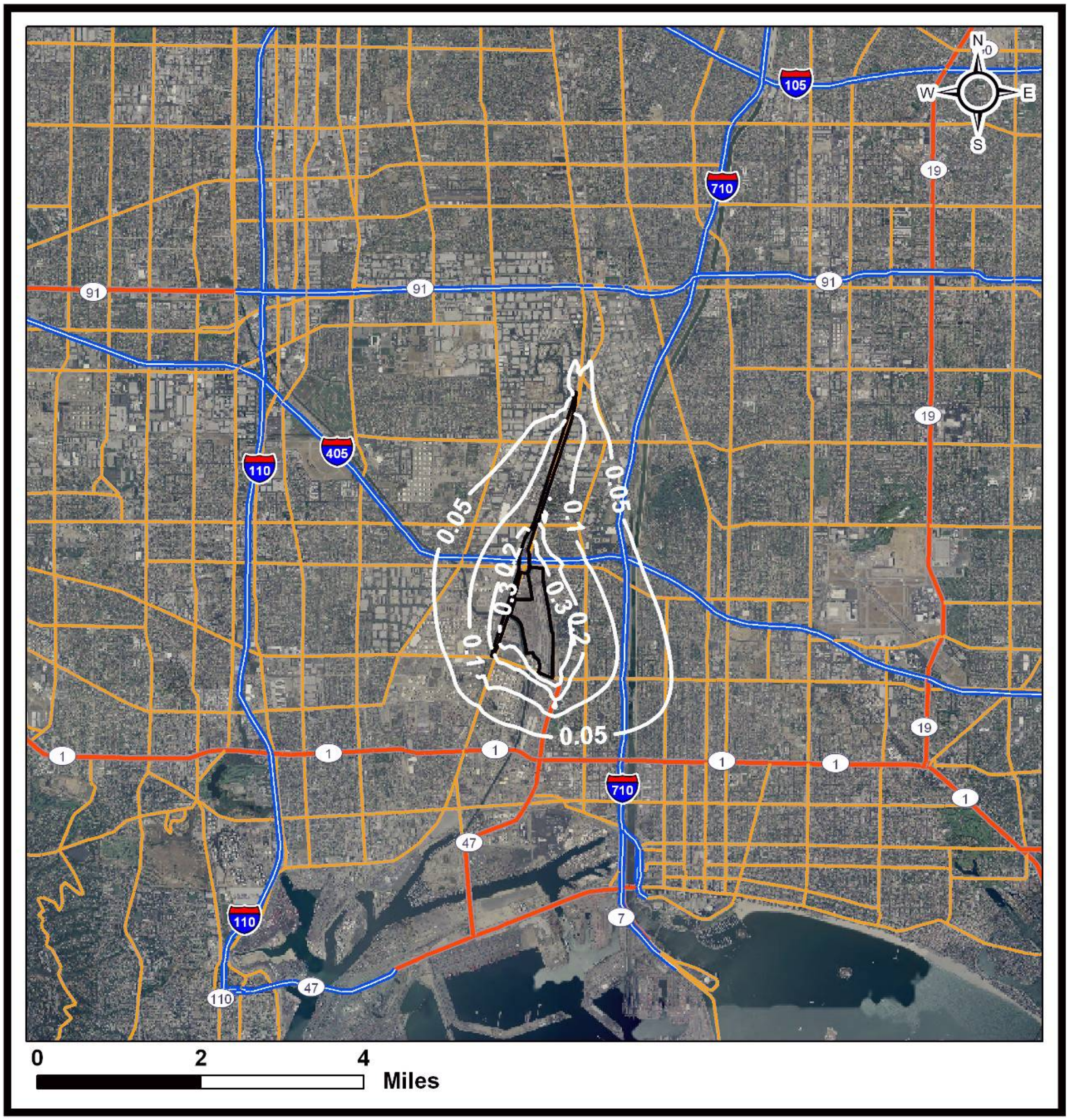


Figure V-2 Estimated non-cancer chronic risks (indicated as a Hazard Index) associated with the on-site diesel PM emissions at UP ICTF/Dolores Railyards.

3. Non-cancer acute risk

According to the OEHHA Guidelines, an acute reference exposure level is an exposure that is not likely to cause adverse health effects in a human population, including sensitive subgroups, exposed to a given concentration for the specified exposure duration (generally one hour) on an intermittent basis. Non-cancer acute risk characterization involves calculating the maximum potential health impacts based on short-term acute exposure and reference exposure levels. Non-cancer acute impacts for the diesel PM are estimated by calculating a hazard index.

Due to the uncertainties in the toxicological and epidemiological studies, diesel PM as a whole was not assigned a short-term acute reference exposure level. It is only specific compounds of diesel exhaust (e.g., acrolein) that independently have potential acute effects (such as irritation of the eyes and respiratory tract), and an assigned acute reference exposure level. Acrolein is a by-product of combustion of fossil fuel. In addition, acrolein has been largely used as a chemical intermediate in the manufacture of adhesives. It also has been found in other different sources, such as fires, water treatment ponds, and tobacco smoke. However, acrolein is a chemically reactive and unstable compound, and easily reacts with a variety of chemical compounds in the atmosphere. Compared to the other chemical compounds in the diesel exhaust, the concentration of acrolein has a much lower chance of reaching a distant off-site receptor. Given the multitude of activities ongoing at facilities as complex as railyards, there is a much higher level of uncertainty associated with hourly-specific emission data and hourly model-estimated peak concentrations for short-term exposure, which are essential to assess the acute risk. Therefore, non-cancer acute risk is not addressed quantitatively in this study. From a risk management perspective, ARB staff believes it is reasonable to focus on diesel PM cancer risk because it is the predominant risk driver and the most effective parameter to evaluate risk reduction actions. Further, actions to reduce diesel PM will also reduce non-cancer risks.

E. Risk characterization associated with off-site (non-railyard) emissions

1. Cancer risk

The diesel PM emissions from mobile sources were mostly generated from the traffic along the I-405 and I-710, due to the high density of heavy heavy duty truck activities. As shown in Figure V-3, the areas near both freeways have relatively higher cancer risk compared to other areas, estimated from about 400 to 700 in a million cancer risk level. As indicated in Figure V-3, the zone of impacts of estimated cancer risks associated with off-site diesel PM emissions is larger than that of the UP ICTF/Dolores Railyard facility-wide emissions. The impacted zone for cancer risk levels greater than 10 chances per million was estimated at about 65,000 inland acres where a residential population of about 740,000 was reported according to the 2000 Census data. The impacted zones and exposed population are summarized in Table V-4. In comparison, the impacted inland area with cancer risk above 10 in a million is larger than the impacted area with the same risk level from the facility-wide railyard diesel PM emissions

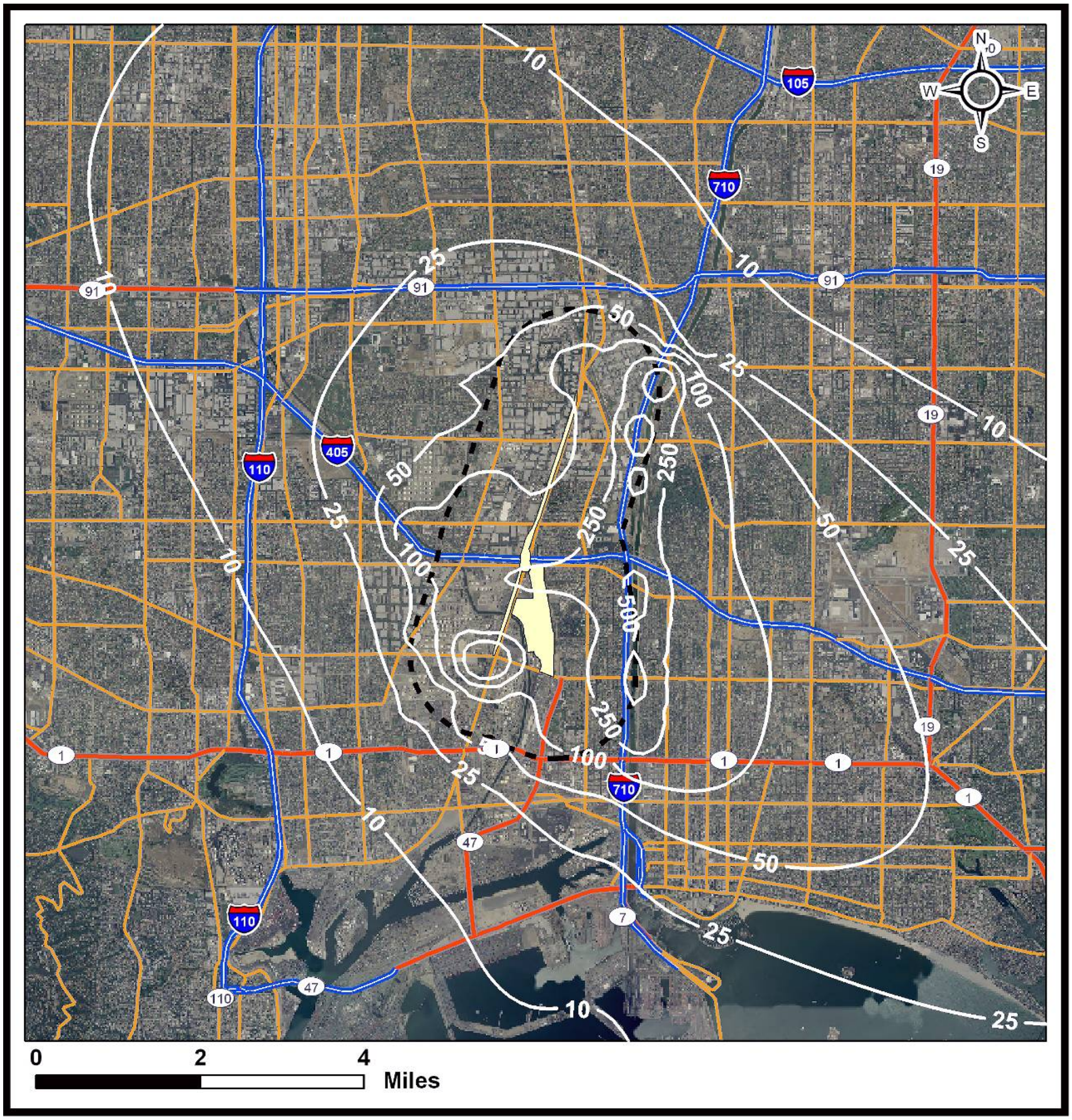


Figure V-3 Estimated potential cancer risks (as chances per million) from off-site stationary and mobile diesel PM emissions within the one-mile boundary (dashed line) around the UP ICTF/Dolores Railyards (based on Tier-1 estimate and 80th percentile breathing rate for a 70-year exposure duration).

Table V-3 The estimated acreages of impacted areas and the associated exposed population from off-site diesel PM emissions (based on Tier-1 estimate and 80th percentile breathing rate for 70-year exposure duration).

Estimated Risk (in a million)	Impacted Area* (Acres)	Exposed Population†
> 500	500	1,300
250 - 500	2,500	25,100
100 - 250	7,000	94,400
50 - 100	9,200	145,000
25 - 50	15,600	142,000
10 - 25	30,000	331,200
> 10	64,800	739,000

* Inland only.
† The population centroid of each census block is used to avoid possible double counting.

ARB staff evaluated other toxic air contaminants emissions around the UP ICTF/Dolores Railyards. Among the toxic air contaminants other than diesel PM from stationary sources, benzene and formaldehyde were identified to be dominant cancer risk contributors and estimated at about 11 tons per year. Based on California Emission Inventory Development and Reporting System (CEIDAS) database, benzene and formaldehyde were reported from the estimated emissions associated with petroleum production facilities nearby. According to the cancer potency factors estimated by the OEHHA Guidelines, 1,3-butadiene, carbon tetrachloride, benzene, and formaldehyde, are given a weighting factor by comparing each compound's cancer potency factor to the diesel PM cancer potency factor. This factor is multiplied by the estimated actual emissions for that compound, which gives the cancer potency weighted toxic emission as presented in Table V-5. As shown in the Table, the potency weighted toxic air contaminant emissions from stationary sources are estimated at about 0.43 tons per year. Based on the estimated emissions, the potential cancer risks from these non-diesel toxic air contaminants are considerably lower, about a factor of 115 less compared to the diesel PM emissions.

Table V-4 Cancer potency weighted toxic air contaminant emissions from significant off-site non-railyard stationary sources surrounding UP ICTF/Dolores Railyards.

Toxic Air Contaminant	Cancer Potency Factor	Weighted Factor	Estimated Emissions (tons/year)	Potency Weighted Toxic Emissions (tons/year)
Diesel PM	1.1	1.0	50	**50**
1,3 Butadiene	0.6	0.55	0.05	**0.03**
Carbon Tetrachloride	0.15	0.14	0.001	**< 0.01**
Benzene	0.1	0.09	3.4	**0.31**
Formaldehyde	0.021	0.019	4.5	**0.09**
Non-Diesel PM Toxic Air Contaminants			8.0	**0.43**

ARB staff also estimated the potential cancer risk levels contributed by the use of gasoline in the South Coast Air Basin based on 2005 emission inventory. Table V-6 presents the emissions of major toxic air contaminants weighted by individual cancer potency factor. The cancer potency weighted emissions of these carcinogens from all gasoline related sources in the Air Basin are estimated at about 481 tons per year for the major risk contributors, 1,3-butadiene, benzene, formaldehyde and acetaldehyde. For gasoline-fueled vehicles only, the cancer potency weighted emissions are estimated at about 253 tons per year, or about 6% of diesel PM emissions basinwide. The potential cancer risks associated with non-diesel PM toxic air contaminants emitted from off-site gasoline vehicular sources are substantially less than the potential cancer risks associated with diesel PM emissions. Because of the risk dominance from diesel PM emissions, these air toxic contaminants are not included in the analysis of this study.

Table V-5 Major toxic air contaminants from gasoline-related sources in South Coast Air Basin, based on 2005 emission inventory.

Toxic Air Contaminant	Emissions (tons per year)			
	All Sources	Potency Weighted†	Gasoline Vehicular Sources	Potency Weighted†
Diesel PM	7,746	**7,746**	—	—
1,3-Butadiene	695	**382**	420	**231**
Benzene	3,606	**325**	2,026	**182**
Formaldehyde	4,623	**92**	1,069	**21**
Acetaldehyde	1,743	**17**	314	**3**
Total (other than diesel PM)	10,668	**817**	3,829	**438**

†: Emissions weighted by cancer potency factors.

2. Non-cancer chronic risk

The estimated non-cancer chronic risks (indicated as hazard indices) from the off-site diesel PM emissions range from about 0.01 to 0.5. The level of 0.1 to 0.5 are located generally near the major off-site diesel PM emission sources, such as I-405, I-710, and petroleum production facilities nearby, presented in Figure II-6. At neighboring residential areas between the Dolores Railyard and I-710, the non-cancer chronic risk levels range from 0.1 to 0.3. The residents living close to the freeways, i.e., I-405 and I-710, have non-cancer chronic risk ranging from about 0.3 to 0.5. All estimated hazard indices in the modeling domain area are less than 1.0; therefore, the results may suggest that the potential non-cancer chronic health risks be less likely to occur according to the OEHHA Guidelines (OEHHA, 2003).

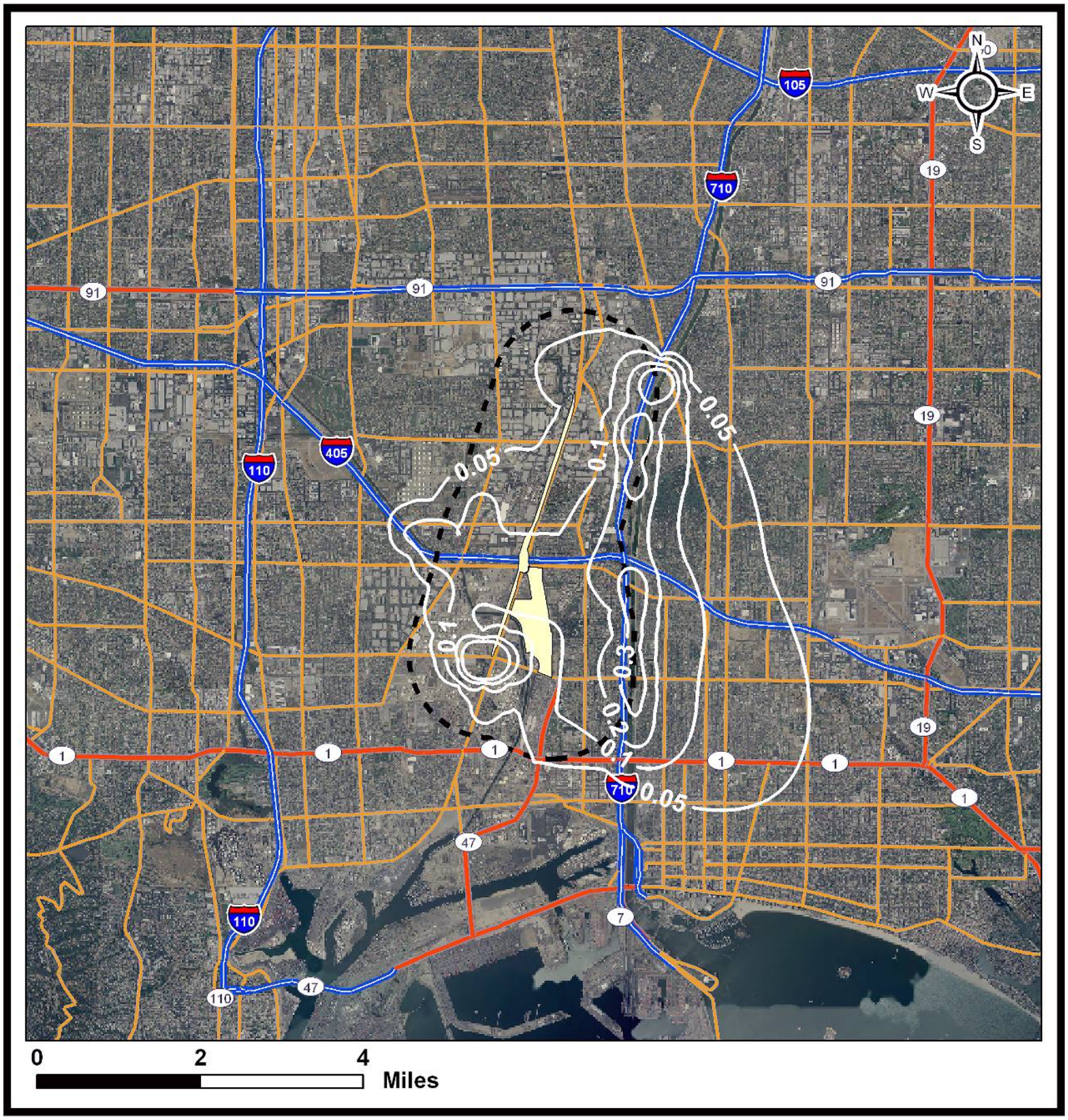


Figure V-4 Estimated non-cancer risks (indicated as hazard indices) associated with the off-site non-railyard diesel PM emissions within a one-mile boundary around the UP ICTF/Dolores Railyards (dashed line).

F. Risks to sensitive receptors surrounding the UP ICTF/Dolores Railyards

Individuals may be more sensitive to toxic exposures than the general population. These sensitive subpopulations include school-aged children, elderly, and patients in hospitals. There are twenty sensitive receptors identified in a one-mile boundary area around the UP ICTF/Dolores Railyards. These receptors include schools, preschools, child care centers, hospitals, and health facilities. Table V-7 summarizes the numbers of sensitive receptors identified in different levels of estimated cancer risks based on 70-year exposure duration. The potential non-cancer chronic health risks at these sensitive receptors are found to be less than the hazard index of 1.0, and are less likely to occur.

Table V-6 Numbers of sensitive receptors within one-mile radius identified in different levels of estimated cancer risks (based on a 70-year exposure duration) associated with on-site railyard diesel PM emissions.

Estimated Cancer Risk (chances in a million)	Number of Sensitive Receptors
> 500	1
250 - 500	2
100 - 250	4
50 - 100	8
25 - 50	4
10 - 25	1
> 10	20

G. Uncertainty and limitations

Risk assessment is a complex procedure which requires the integration of many variables and assumptions. The estimated diesel PM concentrations and risk levels produced by a risk assessment are based on several assumptions, many of which are designed to be health protective so that potential risks to individual are not underestimated.

As described previously, the health risk assessment consists of three components: (1) emission inventory, (2) air dispersion modeling, and (3) risk assessment. Each component has a certain degree of uncertainty associated with its estimation and prediction due to the assumptions made. Therefore, there are uncertainties and limitations with the results.

The following subsections describe the specific sources of uncertainties in each component. In combination, these various factors may result in potential uncertainties in the location and magnitude of predicted concentrations, as well as the potential health effects actually associated with a particular level of exposure.

1. Emission inventory

The emission rate often is considered to be proportional to the type and magnitude of the activity at a source, e.g., the operation. Ideally, emissions from a source can be calculated on the basis of measured concentrations of the pollutant in the sources and emission strengths, e.g., a continuous emission monitor. This approach can be very costly and time consuming and is not often used for the emission estimation. Instead, emissions are usually estimated by the operation activities or fuel consumption and associated emission factors based on source tests.

The uncertainties of emission estimates may be attributed to many factors such as a lack of information for variability of locomotive engine type, throttle setting, level of maintenance, operation time, and emission factor estimates. Quantifying individual uncertainties is a complex process and may in itself introduce unpredictable uncertainties[6].

For locomotive sources at the UP ICTF/Dolores Railyards, the activity rates include primarily the number of engines in operation and the time spent in different power

[6] The railyard HRAs have been performed using a methodology according to the ARB's and OEHHA Guidelines, and consistent with previous health risk analyses conducted by ARB. Similar to any model with estimations, the primary barriers of an HRA to determine objective probabilities are lack of adequate scientific understanding and more precise levels of data. Subjective probabilities are also not always available.

Tier-1 methodology is a conservative point approach but suitable for the current HRA's scope, given the condition and lack of probability data. Tier-1 approach used in the HRAs is consistent with previous health risk analyses performed by ARB, "The Roseville Railyard Study (ARB, 2004)" and "Diesel PM Exposure Assessment Study for the Ports of Los Angeles and Long Beach (ARB, 2006b)". By recognizing associated uncertainties or variability, the HRAs have qualitatively discussed the limitation and caveats of possible underestimation and overestimation in emission inventory and modeling predictions because of assumptions and simplifications. The discussion provides an additional reference for HRA results even though quantitative uncertainty bounds are unavailable. Most importantly, it is not practical to characterize and quantify the uncertainty of estimated health risks without the support of robust scientific data and actual probability distribution functions of model variables. An attempt to incorporate subjective judgments on uncertainty analyses can lead to misinterpretation of HRA findings.

settings. The methodology used for the locomotive emissions is based on these facility-specific activity data. The number of engines operating in the facility is generally well-tallied by UP's electronic monitoring of locomotives entering and leaving the railyard. However, the monitoring under certain circumstances may produce duplicate readings that can result in overestimates of locomotive activity. In addition to recorded activity data, surveys and communications with facility personnel, and correlations from other existing data, (e.g., from the *Roseville Railyard Study* (ARB, 2004a)), all were used to verify the emission estimations in the emission inventory.

Uncertainties also exist in estimates of the engine time in mode. Idling is typically the most significant operational mode, but locomotive event recorder data could not distinguish when an engine is on or off during periods when the locomotive is in the idle notch. As a result, a professional judgment is applied to distinguish between these two modes. While the current operations may not be precisely known, control measures already being implemented are expected to result in reduced activity levels and lower emissions than are estimated here for future years.

As discussed previously, emission factors are often used for emission estimates according to different operating cycles. The *Roseville Railyard Study* (ARB, 2004a) developed representative diesel PM emission factors for locomotives in different duty cycles. To reduce the possible variability of locomotive population and the uncertainty from assumptions, the emission factors were updated in the study to cover a wide range of locomotive fleet in the State (see Appendix D). The fuel usage in the locomotives in 2005 was calculated from the UP's annual fuel consumption database. These critical updates for locomotive emission inventory have established the most representative locomotive emission factors for the study.

For non-locomotive emissions, uncertainty associated with vehicles and equipment at the railyard facility also exists because the duty cycles (i.e., engine load demanded) are less well characterized. Default estimates of the duty cycle parameters may not accurately reflect the typical duty demanded from these vehicles and equipment at any particular site. In addition, national and state regulations have targeted these sources for emission reductions. Implementation of these rules and fleet turnover to newer engines meeting more strict standards should significantly reduce emissions at these rail sites in future years. However, the effects of these regulations have not been incorporated in the emission estimates, so estimated emissions are greater than those expected for future years at the same activity level.

2. Air dispersion modeling

An air dispersion model is derived from atmospheric diffusion theory with assumptions or, alternatively, by solution of the atmospheric-diffusion equation assuming simplified forms of effective diffusivity. Within the limits of the simplifications involved in its derivation, the model-associated uncertainties are vulnerably propagated into its downstream applications.

Model uncertainty may stem from data gaps that are filled by the use of assumptions. Uncertainty is often considered as a measure of the incompleteness of one's knowledge or information about a variate whose true value could be established if a perfect measurement is available. The structure of mathematical models employed to represent scenarios and phenomena of interest is often a key source of model uncertainty, due to the fact that models are often only a simplified representation of a real-world system, such as the limitation of model formulation, the parameterization of complex processes, and the approximation of numerical calculations. These uncertainties are inherent and exclusively caused by the model's inability to represent a complex aerodynamic process.

An air dispersion model usually uses simplified atmospheric conditions to simulate pollutant transport in the air, and these conditions become inputs to the models (e.g., the use of non site-specific meteorological data, uniform wind speed over the simulating domain, use of surface parameters for the meteorological station as opposed to the railyard, substitution of missing meteorological data, and simplified emission source representation). There are also other physical dynamics in the transport process, such as the small-scale turbulent flow in the air, which are not characterized by the air dispersion models. As a result of the simplified representation of real-world physics, deviations in pollutant concentrations predicted by the models may occur due to the introduced uncertainty sources.

The other type of uncertainty is referred as reducible uncertainty, a result of uncertainties associated with input parameters of the known conditions, which include source characteristics and meteorological inputs. However, the uncertainties in air dispersion models have been improved over the years because of better representations in the model structure. In 2006, the U.S. EPA modeling guidance was updated to replace the Industrial Source Complex model with AERMOD as a recommended regulatory air dispersion model for determining single source and source complex. Many updated formulations have been incorporated into the model structure from its predecessor, ISCST3, for better predictions from the air dispersion process. Nevertheless, quantifying overall uncertainty of model predictions is infeasible due to the associated uncertainties described above, and is beyond the scope of this study.

3. Risk assessment

The toxicity of toxic air contaminants is often established by available epidemiological studies, or use of data from animal studies where data from humans are not available. The diesel PM cancer potency factor is based on long term studies of railyard workers exposed to diesel exhaust in concentrations approximately ten times greater than typical ambient exposures. The differences within human populations usually cannot be easily quantified and incorporated into risk assessments. Factors including metabolism, target site sensitivity, diet, immunological responses, and genetics may influence the response to toxicants. In addition, the human population is much more diverse both genetically and culturally (e.g., lifestyle, diet) than inbred experimental animals. The variability among humans is expected to be much greater than in laboratory animals. Adjustment for tumors at multiple sites induced by some carcinogens could result in a higher potency. Other uncertainties arise (1) in the assumptions underlying the dose-response model used, and (2) in extrapolating from large experimental doses, where, for example, other toxic effects may compromise the assessment of carcinogenic potential due to much smaller environmental doses. Also, only single tumor sites induced by a substance are usually considered. When epidemiological data are used to generate a carcinogenic potency, less uncertainty is involved in the extrapolation from workplace exposures to environmental exposures. However, children, a subpopulation whose hematological, nervous, endocrine, and immune systems are still developing and who may be more sensitive to the effects of carcinogens on their developing systems, are not included in the worker population and risk estimates based on occupational epidemiological data are more uncertain for children than adults.

Human exposures to diesel PM are often based on limited availability of data and are mostly derived based on estimates of emissions and duration of exposure. Different epidemiological studies also suggest somewhat different levels of risk. When the Scientific Review Panel (SRP) identified diesel PM as a toxic air contaminant (ARB, 1998), the panel members endorsed a range of inhalation cancer potency factors (1.3 x 10^{-4} to 2.4 x 10^{-3} $(\mu g/m^3)^{-1}$) and a risk factor of $3x10^{-4}$ $(\mu g/m^3)^{-1}$, as a reasonable estimate of the unit risk. From the unit risk factor an inhalation cancer potency factor of 1.1 $(mg/kg\text{-}day)^{-1}$ can be calculated, which is used in the study. There are many epidemiological studies that support the finding that diesel exhaust exposure elevates relative risk for lung cancer. However, the quantification of each uncertainty applied in the estimate of cancer potency is very difficult and can be itself uncertain.

This study adopts the standard Tier 1 approach recommended by the OEHHA for exposure and risk assessment. A Tier 1 approach is an end-point estimate methodology without the consideration of site-specific data distributions. It also assumes that an individual is exposed to an annual average concentration of a pollutant continuously for individual is exposed to a specific time period. The OEHHA recommends the lifetime 70-year exposure duration with a 24-hour per day exposure be used for determining residential cancer risks. This will ensure a person residing in the vicinity of a facility for a lifetime will be included in the evaluation of risk posed by the facility. Lifetime 70-year exposure is a conservative estimate, but it is a historical benchmark for comparing facility impacts on receptors and for evaluating the effectiveness of air pollution control measures.

Although it is not likely that most people will reside at a single residence for 70 years, it is common that people will spend their entire lives in a major urban area. While residing in urban areas, it is very possible to be exposed to the emissions of another facility at the next residence. In order to help ensure that people do not accumulate an excess unacceptable cancer risk from cumulative exposure to stationary facilities at multiple residences, the 70-year exposure duration is used for risk management decisions. However, if a facility is notifying the public regarding health risk, it is a useful indication for a person who has resided in his or her current residence less than 70 years to know that the calculated estimate of his or her cancer risk is less than that calculated for a 70-year risk (OEHHA, 2003). Risk assessment is best viewed as a comparative tool rather than a literal prediction of diesel incidence in a community.

Since the Tier-1 methodology is used in the study for the health risk assessment, the results have been limited to deterministic estimates based on conservative inputs. For example, an 80 percentile breathing rate approach is used to represent a 70-year lifetime inhalation that tends toward the high end for the general population. Moreover, the results based on the Tier-1 estimates do not provide an indication of the magnitude of uncertainty surrounding the quantities estimated, nor an insight into the key sources of underlying uncertainty.

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APPENDIX A

METHODOLOGY OF OFF-SITE MOBILE SOURCE EMISSIONS

INTRODUCTION

This assessment includes on-road mobile emissions from all heavy duty diesel truck running exhaust as it is the primary source of diesel particulate emissions within the on-road vehicle fleet. Traditionally, on-road mobile emission inventories are generated at the county scale using California's emission factor model EMFAC and then allocated to large grid cells using the Direct Travel Impact Model (DTIM). To enhance the spatial resolution we have estimated emissions based on roadway specific vehicle activity data and allocated them to individual roadway links. All roadway links within a 1-mile buffer of UP ICTF/Dolores Railyards were included in this assessment.

As more and more work has been done to understand transportation modeling and forecasting, access to local scale vehicle activity data has increased. For example, the various Metropolitan Planning Organizations (MPOs) are mandated by the Federal government to maintain a regional transportation plan and regional transportation improvement plan. These reports assess the impact the travel growth and assess various transportation improvement plans. Planning is based on travel activity results from Transportation Demand Models (TDMs) that forecast traffic volumes and other characteristics of the transportation system. Currently, more than a dozen MPOs as well as the California Department of Transportation (Caltrans) maintain transportation demand models.

Through a system of mathematical equations, TDMs estimate vehicle population and activity estimates such as speed and vehicle miles traveled (VMT) based on data about population, employment, surveys, income, roadway and transit networks and transportation costs. The activity is then assigned a spatial and temporal distribution by allocating them to roadway links and time periods. A roadway link is defined as a discrete section of roadway with unique estimates for the fleet specific population and average speed and is classified as a freeway, ramp, major arterial, minor arterial, collector, or centroid connector. Link based emission inventory development utilizes these enhanced spatial data and fleet and pollutant specific emission factors to estimate emissions at the neighborhood scale.

METHODOLOGY

The methodology for estimating emissions from on-road mobile sources outside the rail yards was broken into four main processes and described below. The first step involves gathering vehicle activity data specific to each link on the roadway network. Each link contains 24 hours worth of activity data including vehicle miles traveled, vehicle type, and speed. The activity is then apportioned to the various heavy duty diesel truck types (Table A-1) where speed-specific VMT is then matched to an emission factor from EMFAC-2007 (v2.3) to estimate total emissions from each vehicle type for each hour of the day.

Table A-1: Heavy duty truck categories

Class	Description	Weight (GVW)	Abbreviation	Technology Group
T4	Light-Heavy Duty Diesel Trucks	8,501-10,000	LHDDT1	DIESEL
T5	Light-Heavy Duty Diesel Trucks	10,001-14,000	LHDDT2	DIESEL
T6	Medium-Heavy Duty Diesel Trucks	14,001-33,000	MHDDT	DIESEL
T7	Heavy-Heavy Duty Diesel Trucks	33,001+	HHDDT	DIESEL

Step 1: Obtain Link-Specific Activity Data

The link specific activity data for heavy duty trucks necessary to estimate emissions are speed and vehicle miles traveled (VMT), where VMT is a product of vehicle volume (population) and link length. Link activity for Ventura, Los Angeles, Orange, and more than 90% of Riverside and San Bernardino counties are provided by the Southern California Association of Governments (SCAG)[i] Heavy Duty Truck Transportation Demand Model. Heavy duty truck activity is modeled using truck specific data, commodity flows and goods movement data. SCAG, however, is the only MPO with a heavy duty truck model. The remaining counties under the rail yard study are covered by the Integrated Transportation Network (ITN) developed by Alpine Geophysics[ii]. The Integrated Transportation Network was developed by stitching together MPO transportation networks and the Caltrans statewide transportation network. Link specific truck activity from the ITN is estimated as a fraction of the total traffic on the links and is based on the fraction of trucks within each county as it is estimated in EMFAC.

The product of truck volume and link length is referred to as vehicle miles traveled (VMT) and has units of miles. Transportation demand models provide total VMT for each link without further classification into the various heavy duty truck weight and fuel type classifications. Therefore, in order to assess the emissions only from heavy duty diesel trucks the total heavy duty truck VMT is multiplied by the fraction of trucks that are diesel. Once the total diesel VMT is calculated the heavy duty truck diesel VMT is multiplied by the fraction of trucks that make up the four weight classifications. The fuel and weight fractions are specific to each county and are derived from total VMT for each weight and fuel class in EMFAC for each county. The data is then compiled into an activity matrix (Table A-2) composed of a link identification code, hour of the day,

[i] SCAG Transportation Modeling, http://www.scag.ca.gov/modeling/ [accessed January 2007].
[ii] Wilkinson, James (Alpine Geophysics); et al. “Development of the California Integrated Transportation Network (ITN),” Alpine Geophysics – Atmospheric and Hydrologic Sciences, La Honda, CA (2004). http://www.arb.ca.gov/airways/CCOS/docs/III3_0402_Jun06_fr.pdf

speed, light heavy duty diesel 1 truck (LHDDT1) VMT, light heavy duty diesel 2 truck (LHDDT2) VMT, medium heavy duty diesel truck (MHDDT) VMT, and heavy heavy duty diesel truck (HHDDT) VMT. Due to difficulty in determining weight fractions on all roadways, the county average was used. However, because railyards are commonly located in industrial areas one would expect higher diesel truck fractions near the railyards. Thus, the diesel PM emissions near the railyards are also expected to be relatively higher than other areas.

Table A-2 Activity matrix example

LINK I. D.	Hour	Speed (mph)	LHDDT1 VMT (miles)	LHDDT2 VMT (miles)	MHDDT VMT (miles)	HHDDT VMT (miles)
49761	12	45	0.37	0.48	3.17	5.51
49761	3	45	0.14	0.18	1.16	2.00
49761	3	35	0.16	0.21	1.37	2.38
50234	4	55	0.19	0.26	1.68	2.92

Step 2: Derive Gram per Mile Emission Factors

The second step of the emission inventory process involves developing emission factors for all source categories for a specified time period, emission type, and pollutant. Running exhaust emission factors based on vehicle type, fuel type and speed were developed from the Emfac mode of EMFAC. These are composite emission factors based on the model year distribution for each county and provided in units of grams of emissions per mile traveled. Emission factors are based on test cycles that reflect typical driving patterns, and non-extended idling is included.

Finally, a matrix of emission factors by speed and vehicle type was assembled for each county for light heavy-duty diesel trucks 1 and 2 (LHDDT1 and LHDDT2), medium heavy-duty diesel trucks (MHDDT) and heavy heavy-duty diesel trucks (HHDDT). The following is an example of such a matrix (Table A-3):

Table A-3 Emission factor matrix example.

	Diesel PM Emission Factors (g/mile)			
Speed (mph)	**LHD1 DSL**	**LHD2 DSL**	**MHD DSL**	**HHD DSL**
12	0.101	0.145	0.631	2.371
20	0.072	0.105	0.455	1.277
45	0.037	0.054	0.235	0.728
60	0.033	0.047	0.206	1.095

Step 3: Calculate Emissions

Diesel PM emission factors are provided as grams per mile specific to each speed and heavy duty truck type (see table above). To estimate emissions the activity for each diesel heavy duty truck type was matched to the corresponding emission factor (EF). For example, a 0.25 mile long link at 3 am in the morning has 8 heavy heavy-duty diesel trucks (HHDDTs) traveling at 45 miles per hour. This equates to a VMT of 2.00 miles (8 trucks*0.25 miles). EMFAC has provided a gram per mile emission factor for HHDDT traveling at 45 mph in Los Angeles County as 0.728 grams DPM/mile. In order to estimate total emissions from HHDDTs on that link during that hour of the day the following calculation is made:

$$TotalEmissions(\,grams\,) = EF \cdot (Volume \cdot LinkLength\,) = EF \cdot VMT$$

$$TotalEmissions(\,grams\,) = EF \cdot VMT = 0.728\frac{grams}{mile} \cdot 2.00 miles = 1.45 grams$$

The steps outlined above and in Steps 1 and 2 can be represented with this single equation that provides an emissions total for each link for each hour of the day.

$$Emissions = VMT_{link} \cdot \sum_{i,j} Fraction_{i,j} \cdot EF_{i,j}$$

where

- Emissions – the total emissions in grams for each link
- i = represents the individual diesel heavy duty truck types (LHDDT1, LHDDT2 – light heavy duty diesel trucks 1 and 2; MHDDT – medium heavy duty diesel truck; and HHDDT – heavy heavy duty diesel truck)
- j – represent the hours of the day (hours 1-24)
- VMT_{Link} - total VMT for that link for all heavy duty trucks (gasoline and diesel)

- Fraction = the fraction of the VMT that is attributable to each diesel heavy duty truck type The fraction is estimated based on VMT estimates in EMFAC: Example: $VMT_{MHDDT}/VMT_{\text{all heavy duty trucks (gasoline \& diesel)}}$
- EF = the heavy duty diesel truck emission factors. The emission factor is vehicle type and speed specific and is thus matched according to the link specific activity parameters.

From this expression diesel particulate matter emissions are provided for each link and for each hour of the day. Finally, emissions are summed for all links for all hours of the day to provide a total daily emission inventory.

Step 4: QA/QC – Quality Assurance/Quality Control

To assure that the total emissions were calculated correctly the total emissions (grams) were divided by the total diesel VMT to estimate a composite diesel gram per mile emission factor. This back-calculated emission factor was checked against emission factors in EMFAC. In addition, where possible, heavy duty truck gate counts provided for the rail yards were checked against traffic volumes on the links residing by the gates.

LIMITATIONS AND CAVEATS

We have made several important assumptions in developing this inventory. While these assumptions are appropriate at the county level they may be less appropriate for the particular areas modeled in this assessment. For example, the county specific default model year distribution within EMFAC and vehicle type VMT fractions were assumed to be applicable for all links within the domain modeled. In the vicinity of significant heavy heavy-duty truck trip generators, it is reasonable to expect that surrounding links will also have higher heavy heavy-duty truck fractions. In these cases, using EMFAC county vehicle mix fractions may underestimate the total diesel particulate emissions from on-road heavy duty trucks. In this inventory, EMFAC county defaults were employed as there is insufficient data available to assess the vehicle mix fractions surrounding the railyards.

Travel demand model results are checked by comparing actual traffic counts on links where the majority of vehicle travel takes place. Therefore, there will be greater uncertainty associated with activity from minor arterials, collectors, and centroid connectors than from higher volume freeways. Data based strictly on actual traffic counts for each street would provide better activity estimates, but unfortunately very little data is available for such an analysis. While links representing freeways are accurately allocated spatially, the allocation of neighborhood streets and other minor roads are not as well represented.

The emissions inventory developed for this study only included diesel particulate matter emissions from running exhaust as it is the primary diesel source from on-road mobile sources. Emissions from other modes such as off-road equipment, extended idling, starts, and off-road equipment outside the rail yards were excluded. Vehicle activity from distribution centers, rail yards and ports, however, are included as they are captured on the roadway network by the travel demand models.

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APPENDIX B

METHODOLOGY OF OFF-SITE STATIONARY SOURCE EMISSIONS

Emissions from off-site stationary source facilities were identified using the California Emission Inventory Development and Reporting System (CEIDARS) database, which contains information reported by the local air districts for stationary sources within their jurisdiction.

Geographic information system (GIS) mapping tools were used to create a one-mile buffer zone outside the property boundary footprint reported for each railyard. The CEIDARS facilities whose latitude/longitude coordinates fell within the one-mile buffer zone were selected.

The reported criteria pollutants in CEIDARS include carbon monoxide, nitrogen oxides, sulfur oxides, total organic gases, and particulate matter (PM). The reported toxic pollutants include the substances and facilities covered by the Air Toxics "Hot Spots" (AB 2588) program. Diesel exhaust particulate matter (diesel PM) was estimated from stationary internal combustion (IC) engines burning diesel fuel, operating at stationary sources reported in CEIDARS. Diesel PM emissions were derived from the reported criteria pollutant PM that is ten microns or less in diameter (criteria pollutant PM10) emitted from these engines. In a few cases, diesel exhaust PM was reported explicitly under the "Hot Spots" reporting provisions as a toxic pollutant, but generally the criteria pollutant PM10 reported at diesel IC engines was more comprehensive than the toxics inventory, and was therefore the primary source of data regarding diesel PM emissions.

The CEIDARS emissions represent annual average emission totals from routine operations at stationary sources. For the current analysis, the annual emissions were converted to grams per second, as required for modeling inputs for cancer and chronic non-cancer risk evaluation, by assuming uniform temporal operation during the year. (The available, reported emission data for acute, maximum hourly operations were insufficient to support estimation of acute, maximum hour exposures).

The CEIDARS 2004 database year was used to provide the most recent data available for stationary sources. Data for emissions, location coordinates, and stack/release characteristics were taken from data reported by the local air districts in the 2004 CEIDARS database wherever available. However, because microscale modeling requires extensive information at the detailed device and stack level that has not been routinely reported, historically, by many air districts, much of the stack/release information is not in CEIDARS. Gaps in the reported data were addressed in the following ways. Where latitude/longitude coordinates were not reported for the stack/release locations, prior year databases were first searched for valid coordinates, which provided some additional data. If no other data were available, then the coordinates reported for the overall facility were applied to the stack locations. Where parameters were not complete for the stack/release characteristics (i.e., height, diameter, gas temperature and velocity), prior year databases were first searched for valid data. If no reported parameters were available, then U.S. EPA stack defaults from the Emissions Modeling System for Hazardous Air Pollutants (EMS-HAP) program were assigned. The U.S. EPA stack defaults are assigned based on the Source Classification Code (SCC) or Standard Industrial Classification (SIC) code of the operation. If an applicable U.S. EPA default was not available, then a final generic default was applied. To ensure that the microscale modeling results would be health-protective, the generic release parameters assumed relatively low height and buoyancy. Two generic defaults were used. First, if the emitting process was identifiable as a vent or other fugitive-type release, the default parameters assigned were a height of five feet, diameter of two feet, temperature of 100 degrees Fahrenheit, and velocity of 25 feet per second. For all remaining unspecified and unassigned releases, the final generic default parameters assigned were a height of twenty feet, diameter of two feet, temperature of 100 degrees Fahrenheit, and velocity of 25 feet per second. All English units used in the CEIDARS database were converted to metric units for use in the microscale modeling input files.

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APPENDIX C

SUMMARY OF AIR DISPERSION MODELING RESULTS FROM OFF-SITE DIESEL PM EMISSIONS

Impacts from off-site pollution sources near the UP ICTF/Dolores rail yard facility were modeled using the USEPA-approved AERMOD dispersion model version 04300. Specifically, off-site mobile and stationary diesel PM (DPM) emission sources located out to a distance of one-mile from the perimeter of the UP ICTF/Dolores Railyards were included.

To facilitate modeling of these off-site emission sources, the information summarized in Table C-1 was provided by external sources.

TableC-1. Data Provided by Others for Off-Site Emission Source Modeling.

Type of Data	**Description**	**Data Source**
Emission Estimates	Off-site DPM emissions for 2005 Mobile Sources: 47.9 TPY DPM Stationary Sources: 2.1 TPY DPM	PTSD/MSAB
Receptor Grid	41x41 Cartesian grid covering 400 km^2 with uniform spacing of 500 meters. Grid origin: (376500, 3734000) in UTM Zone 11.	Sierra Research
Meteorological Data	AERMET-Processed data for 2005-2006 Surface: St. Peter and Paul School and Long Beach Daugherty Field Upper Air: San Diego Miramar	ENVIRON
Surface Data	Albedo: 0.15 to 0.20 Bowen Ratio: 0.84 to 2.56 Surface Roughness: 0.71 to 0.94	ENVIRON

The spatial and temporal emissions provided for these sources were converted into the appropriate AERMOD ready files. The off-site emissions were modeled using the same coarse receptor grid and meteorological data used by the consultants for their rail yard model runs, as indicated in the table above.

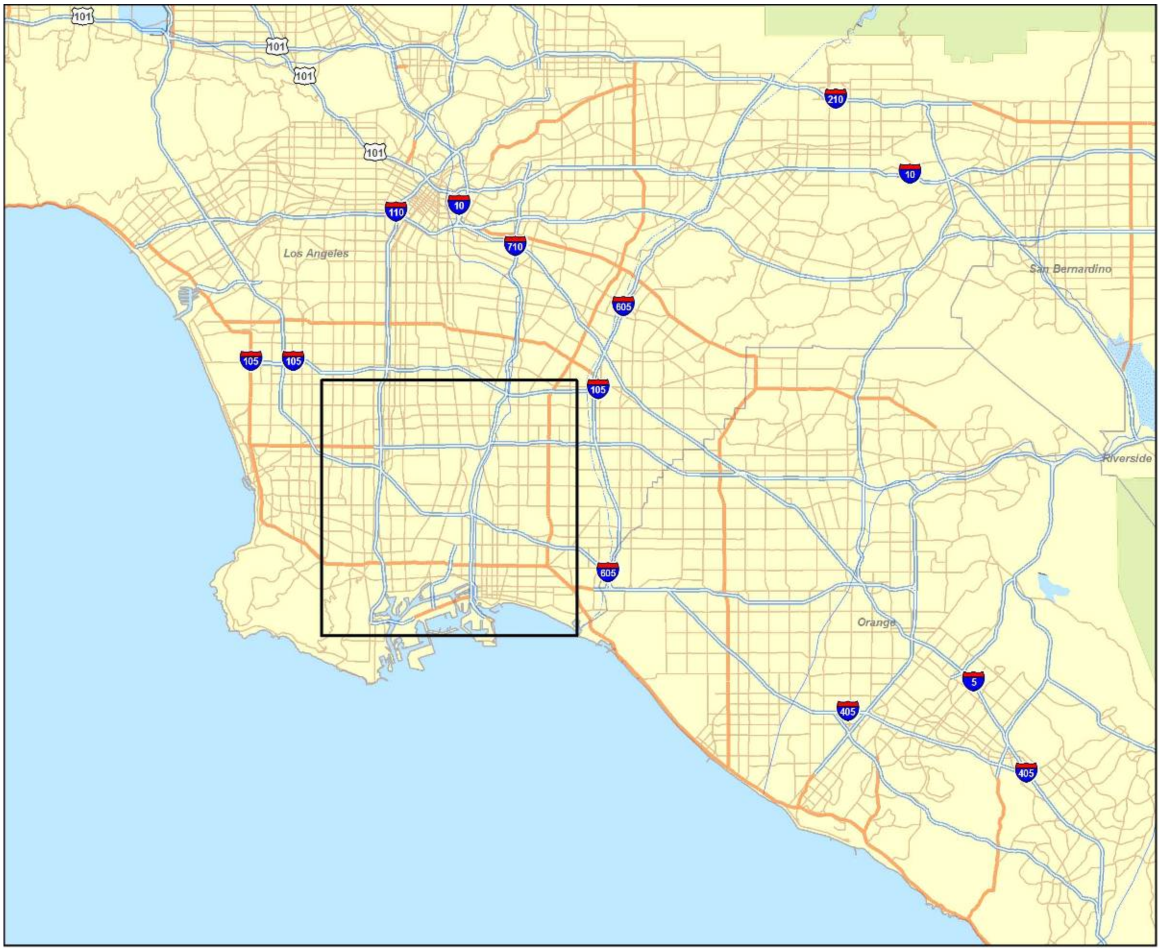

Figure C-1 Region surrounding the UP ICTF/Dolores rail facility with the modeling domain indicated by the black outline.

Figure C-1 illustrates the region surrounding the UP ICTF/Dolores modeling domain. The domain has dimensions 20 km x 20 km and contains a grid of 1681 receptors with a 500 meter uniform grid spacing.

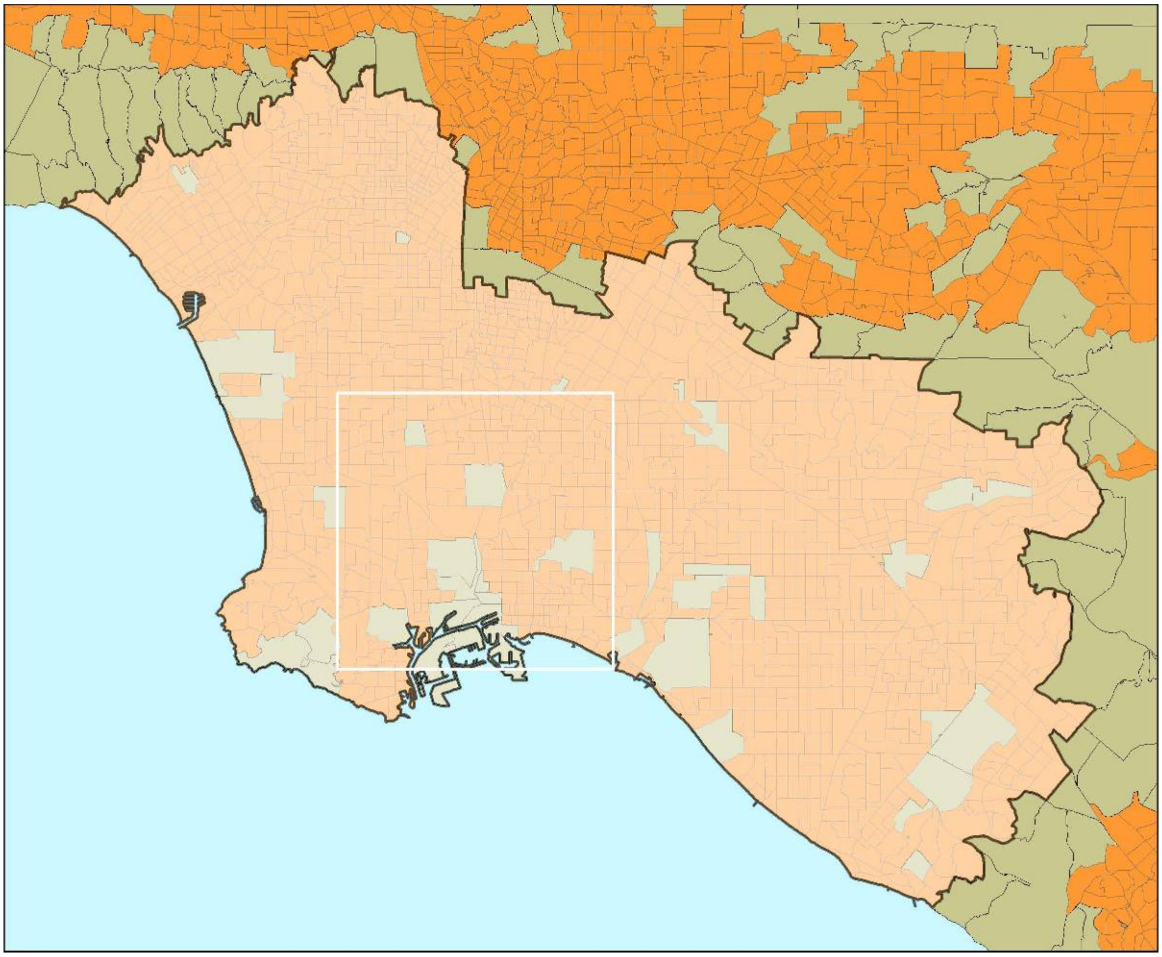

Figure C-2 UP ICTF/Dolores Urban Population: Orange (dark) denotes areas with at least 750 people/km^2. The highlighted region is the contiguous urban area used for modeling purposes.

AERMOD requires an estimate of the urban population for urban source modeling. The urban population parameter was determined by estimating the area of continuous urban features as defined by the model guidelines (AERMOD Implementation Guide September 27, 2005). According to the guidelines, areas with a population of at least 750 people per square kilometer are considered urban. The UP ICTF/Dolores model domain is in a region with considerable urbanization. The continuous urban area selected can be seen in Figure C-2. The population in this selected area is 7,229,086.

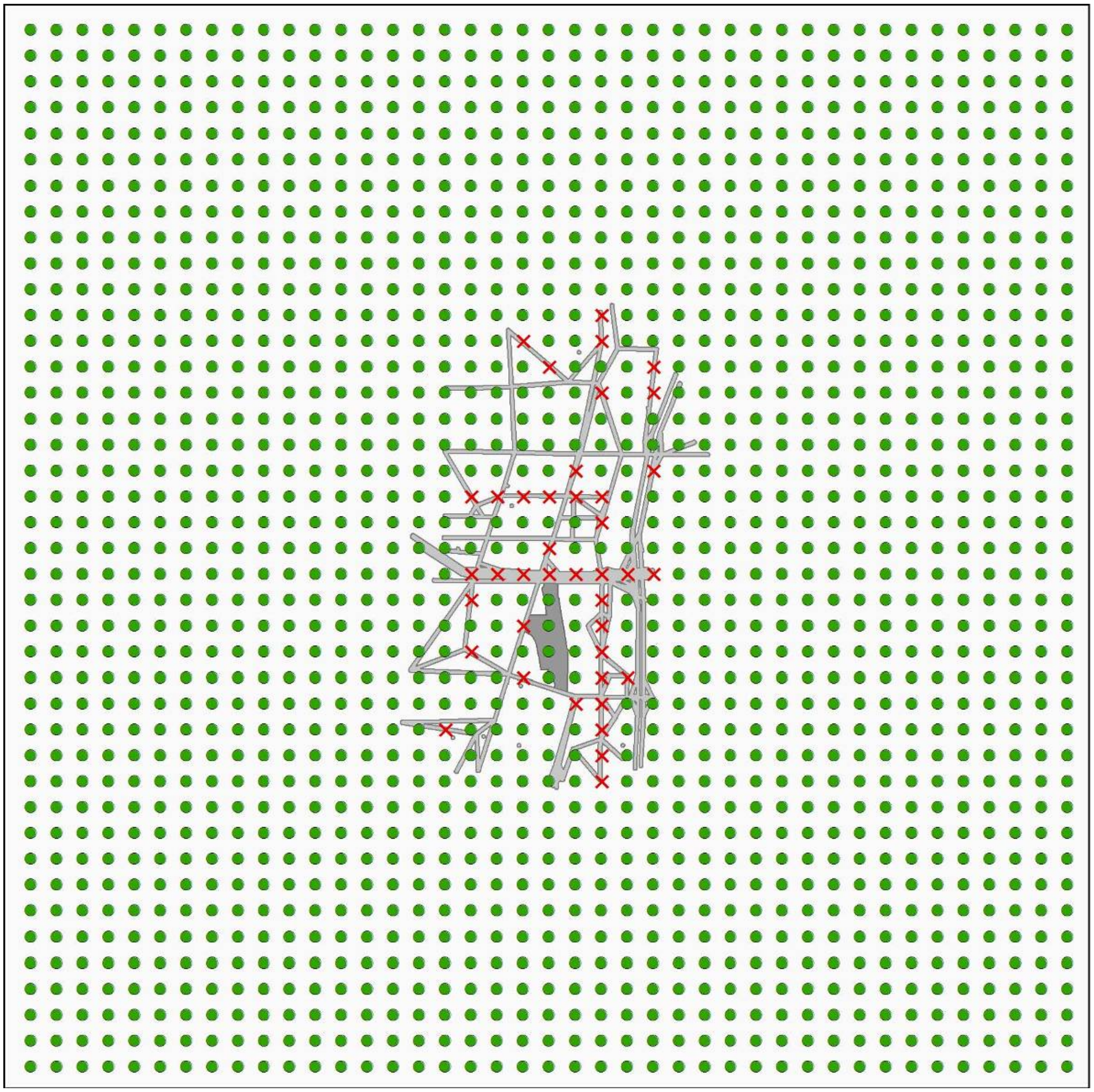

Figure C-3 UP ICTF/Dolores receptor network including off-site sources and rail facility

The off-site stationary and on-road emission sources used in the UP ICTF/Dolores model runs are plotted along with the receptor network in Figure C-3. These sources do not represent all stationary and roadway sources within the domain, but rather a subset made up of those roadways and facilities within one mile of the perimeter of the rail yard facility. Diesel PM off-site emissions used in the off-site modeling runs consisted of 47.9 tons per year from roadways and 2.1 tons per year from stationary facilities, representing emissions for 2005. Roadway emissions were simulated as AERMOD area sources with an aspect ratio of no greater than 100 to 1, with a width of 7.3 meters and a release height of 4.15 meters.

As indicated above, Figure C-3 illustrates a 20 km x 20 km gridded receptor field with uniform 500 meter spacing of receptors that are plotted as "●". Because a uniform grid sometimes places receptors on a roadway, those within 35 meters of a roadway were omitted. The basis for this is that these receptors are likely to fall on the roadway surface, versus a dwelling or workplace, and have high model-estimated concentrations, which could skew average concentration isopleths. Locations where receptors were removed are displayed as an "**x**" in Figure C-3. After removal, 1641 of the original 1681 receptors remained.

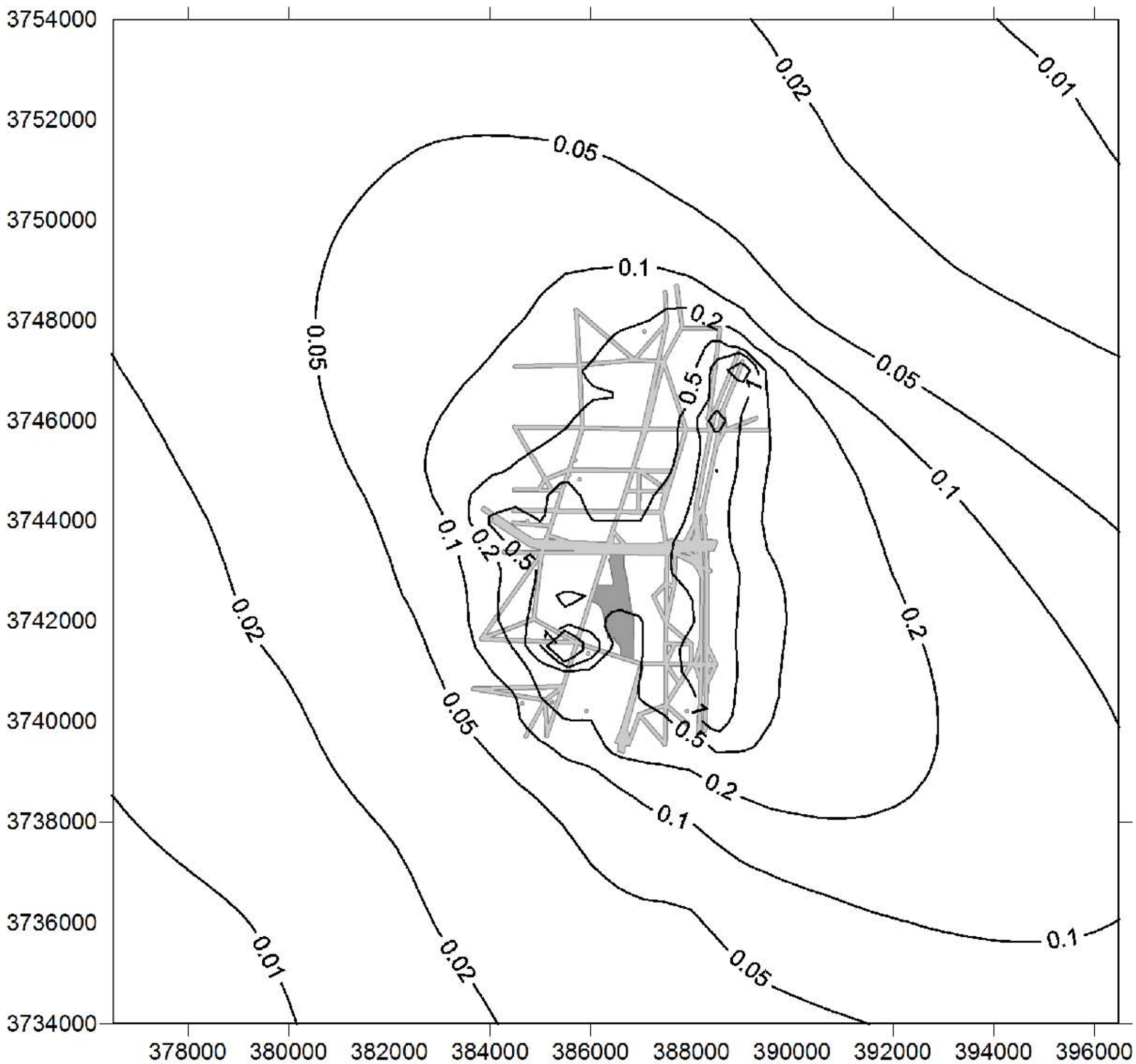

Figure C-4 UP ICTF/Dolores off-site sources and rail yard with modeled annual average concentrations from off-site sources in ug/m^3

Figure C-4 shows annual average diesel PM concentrations from the off-site emissions. Highest values occur near major freeways, with the maximum near a major stationary point source at 385458.88m, 3741583.23m. The five highest concentrations at a receptor and their locations are provided in Table C-2.

The same meteorological data used by Sierra Research were used for the off-site modeling runs. The data were compiled by Environ from the nearby St. Peter and Paul School (33.78°N, 118.27°W) and Long Beach Daugherty Field (33.828°N, 118.163°W) stations. Upper air data for the same time period were obtained from the San Diego Miramar upper air station (32.833°N, 117.117°W). The model runs used one year of meteorological data from July 2005 through June 2006.

Table C-2 The locations of estimated maximum annual diesel PM concentrations ($\mu g/m^3$) from off-site mobile and stationary source emissions

UTM-x (meters)	UTM-y (meters)	Mobile	Stationary	Total (Off-site)
385500	3741500	0.250	4.554	4.804
389000	3747000	2.859	0.006	2.865
388500	3746000	2.505	0.074	2.578
388500	3745000	2.015	0.009	2.024
388500	3743000	1.922	0.011	1.933

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APPENDIX D

LOCOMOTIVE DIESEL PM EMISSION FACTORS

Locomotive Diesel PM Emission Factors (g/hr)												
Model Group	Tier	Throttle Setting										Source[1]
		Idle	DB	N1	N2	N3	N4	N5	N6	N7	N8	
Switcher	N	31.0	56.0	23.0	76.0	131.8	146.1	181.5	283.2	324.4	420.7	ARB and ENVIRON
GP-3x	N	38.0	72.0	31.0	110.0	177.7	194.8	241.2	383.4	435.3	570.9	ARB and ENVIRON
GP-4x	N	47.9	80.0	35.7	134.3	216.2	237.5	303.5	507.4	600.4	771.2	ARB and ENVIRON
GP-50	N	26.0	64.1	51.3	142.5	288.0	285.9	355.8	610.4	681.9	871.2	ARB and ENVIRON
GP-60	N	48.6	98.5	48.7	131.7	271.7	275.1	338.9	593.7	699.1	884.2	ARB and ENVIRON
GP-60	0	21.1	25.4	37.6	75.5	228.7	323.6	467.7	666.4	1058.5	1239.3	KCS7332
SD-7x	N	24.0	4.8	41.0	65.7	149.8	223.4	290.0	344.6	446.8	553.3	ARB and ENVIRON
SD-7x	0	14.8	15.1	36.8	61.1	220.1	349.0	407.1	796.5	958.1	1038.3	ARB and ENVIRON
SD-7x	1	29.2	31.8	37.1	66.2	219.3	295.9	436.7	713.2	783.2	847.7	NS2630[3]
SD-7x	2	55.4	59.5	38.3	134.2	271.7	300.4	335.2	551.5	672.0	704.2	UP8353[3]
SD-90	0	61.1	108.5	50.1	99.1	255.9	423.7	561.6	329.3	258.2	933.6	EMD 16V265H
Dash 7	N	65.0	180.5	108.2	121.2	322.6	302.9	307.7	268.4	275.2	341.2	ARB and ENVIRON
Dash 8	0	37.0	147.5	86.0	133.1	261.5	271.0	304.1	334.9	383.6	499.7	ARB and ENVIRON
Dash 9	N	32.1	53.9	54.2	108.1	197.3	267.3	343.9	392.4	397.3	573.3	SWRI 2000
Dash 9	0	33.8	50.7	56.1	117.4	205.7	243.9	571.5	514.6	496.9	460.3	average of ARB & CN2508[1]
Dash 9	1	16.9	88.4	62.1	140.2	272.8	354.5	393.4	466.4	445.1	632.1	CSXT595[2]
Dash 9	2	7.7	42.0	69.3	145.8	273.0	337.4	376.0	375.1	419.6	493.5	BNSF 7736[2]
C60-A	0	71.0	83.9	68.6	78.6	277.9	234.1	276.0	311.4	228.0	362.7	ARB and ENVIRON

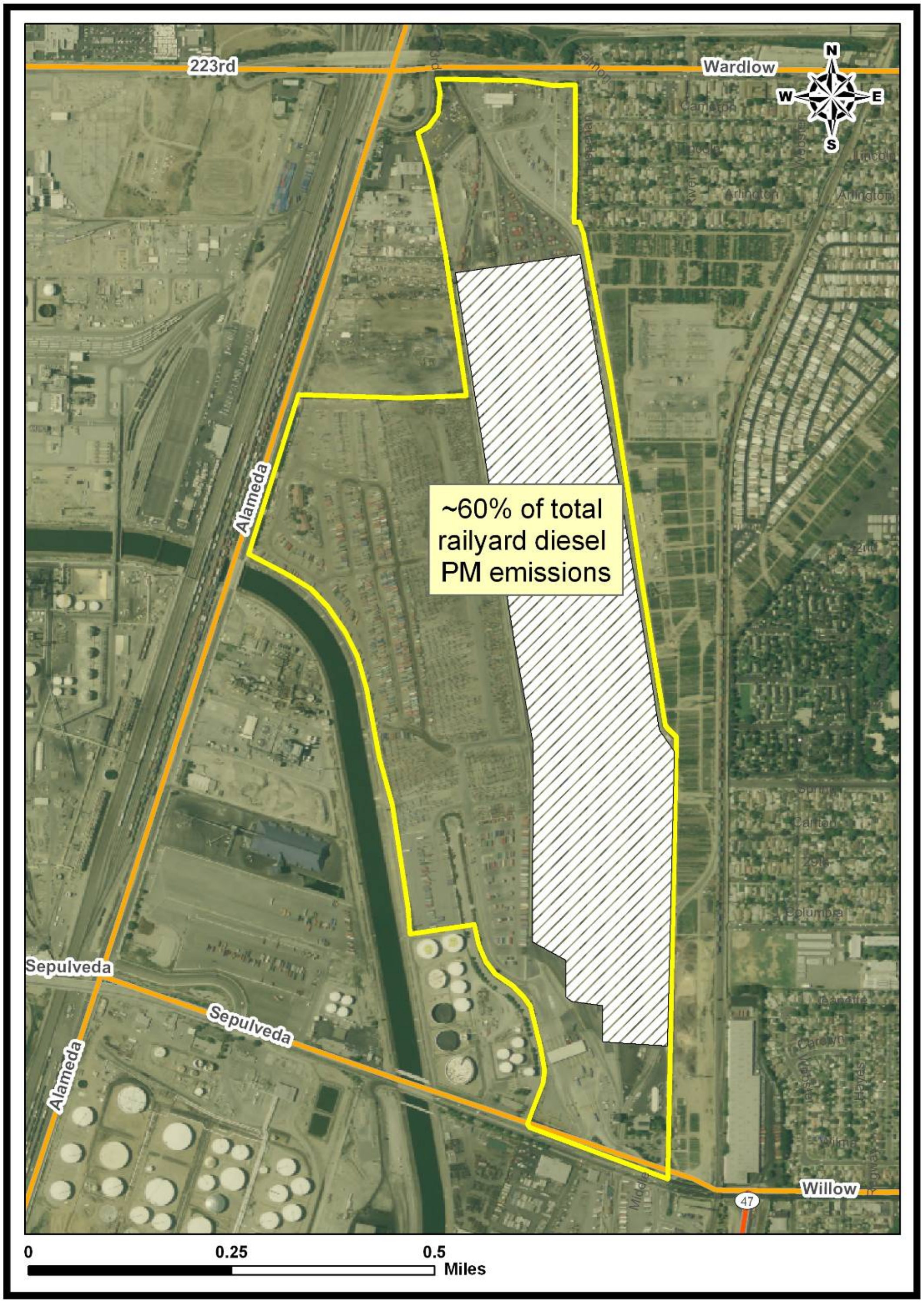
Notes:

1. Except as noted below, these emission rates were originally developed for the ARB *Roseville Rail Yard Study* (October, 2004a), and were subsequently adjusted based on an average fuel sulfur content of 0.11% by ENVIRON as part of the BNSF efforts for their analyses for the Railyard MOU (Personal communication from Chris Lindhjem to R. Ireson, 2006).
2. Emission rates added by ENVIRON based on data produced in the AAR/SwRI Exhaust Plume Study (Personal communication from Steve Fritz to C. Lindhjem, 2006)
3. SD-70 emission rates taken from data produced in the AAR/SwRI Exhaust Plume Study (Personal communication from Steve Fritz to R. Ireson, 2006)

APPENDIX E

SPATIAL ALLOCATIONS OF MAJOR RAILYARD DIESEL PM EMISSION SOURCES

This Appendix is provided as a visual aid to understand where significant sources of diesel PM are generated within the UP ICTF and Dolores Railyards. This visual layout indicates that nearly two-thirds (about 60%) occurs nearly over the full length of UP ICTF Railyard. Other diesel PM emissions are generated at UP Dolores Railyard and within a half-mile of the railyards from some off-site operation-related locomotives and trucks.



Note: According to the UP ICTF/Dolores Railyards' activities, the shaded area accounts for about 14% of the emissions are generated by locomotive switching, about 7% by line haul locomotives, about 20% by drayage trucks, and about 18% by cargo handling equipment, or approximately 60% of the total railyard diesel PM emissions.

APPENDIX F

AERMOD MODEL SENSITIVITY ANALYSIS OF METEOROLOGICAL DATA (ONE- VS. FIVE-YEAR DATA)

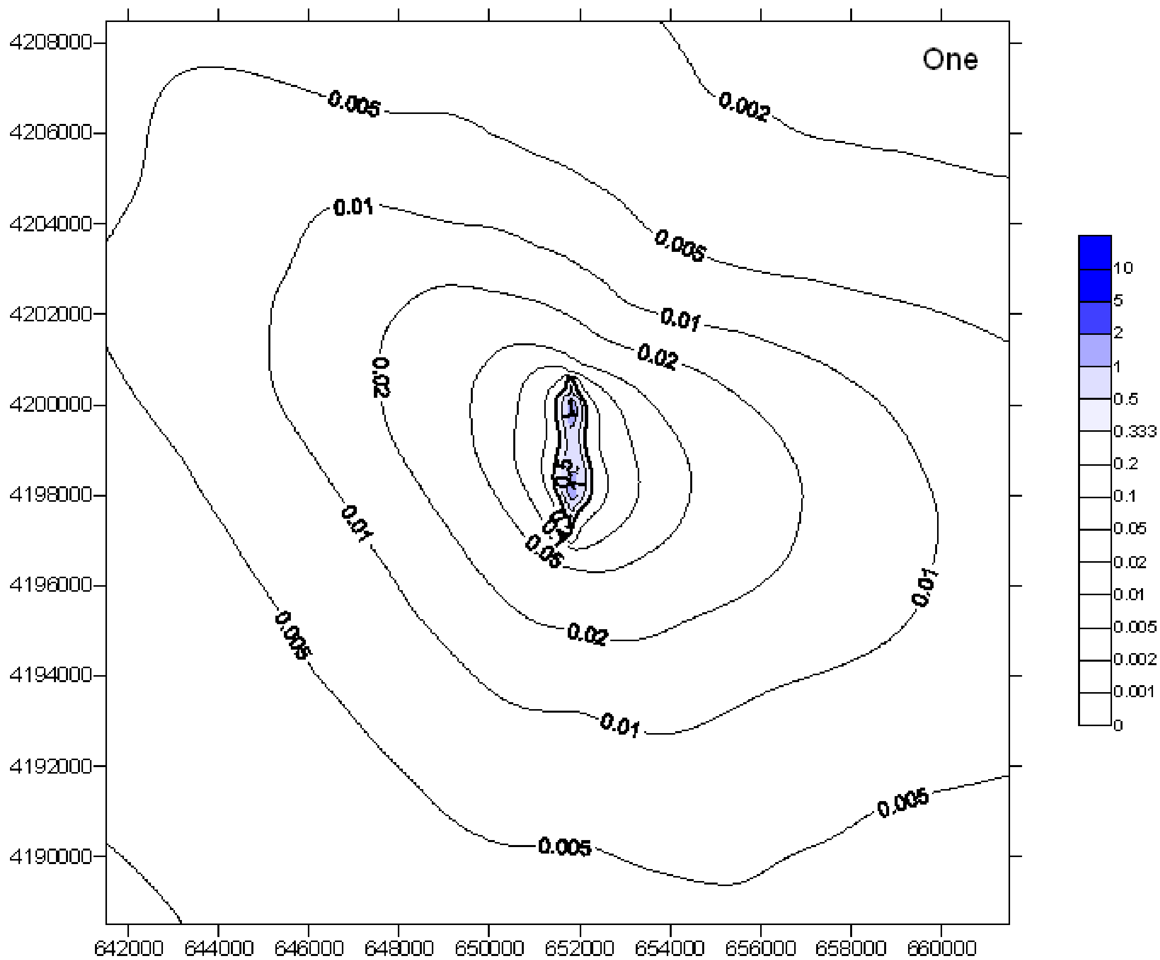


Figure G-1 AERMOD's Simulated Diesel PM Concentrations (due to On-site and Off-site Diesel PM Emissions) around UP Stockton Railyard Using One-year Meteorological Data..

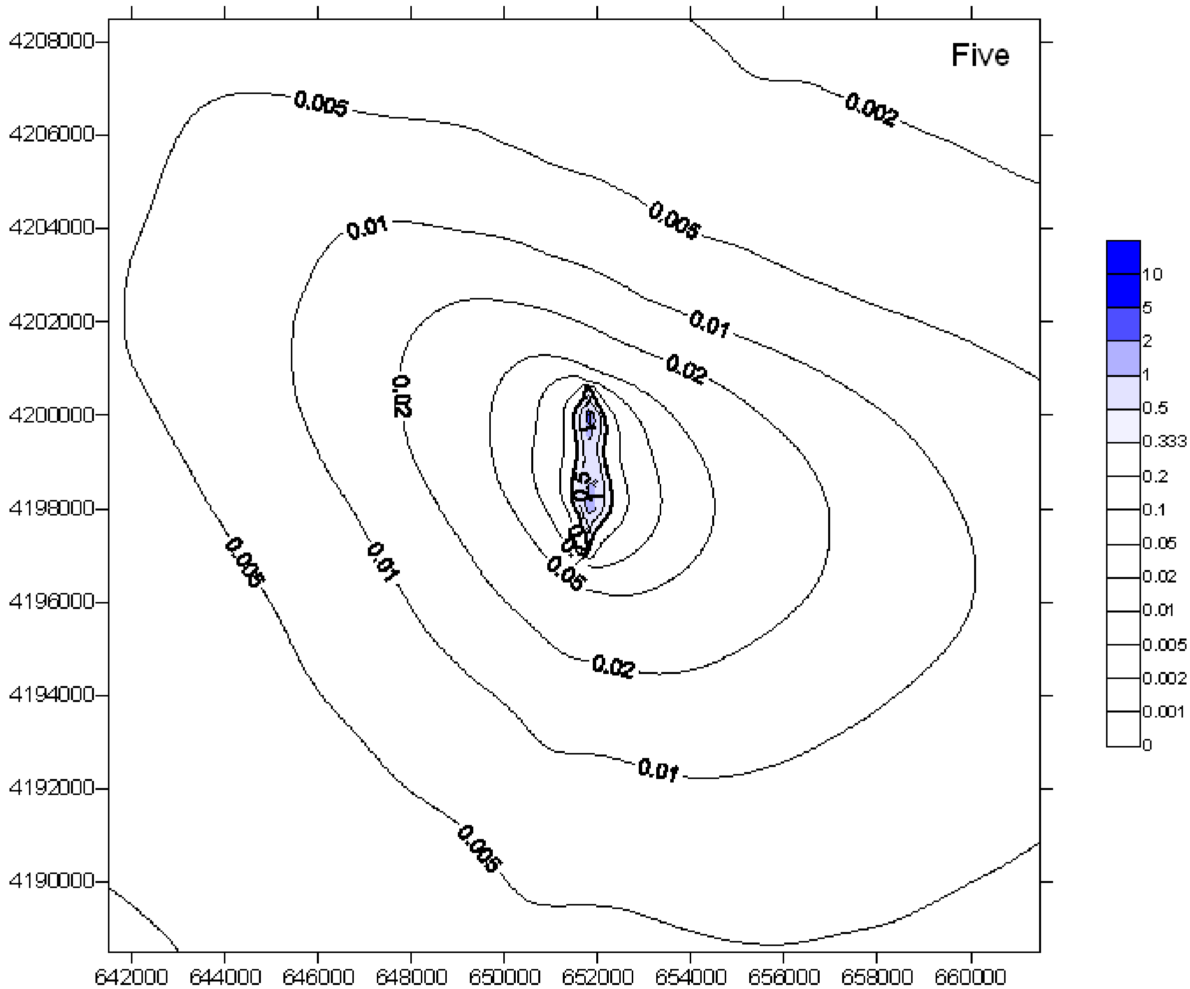


Figure G-2 AERMOD's Simulated Diesel PM Concentrations (due to On-site and Off-site Diesel PM Emissions) around UP Stockton Railyard Using Five-year Meteorological Data.