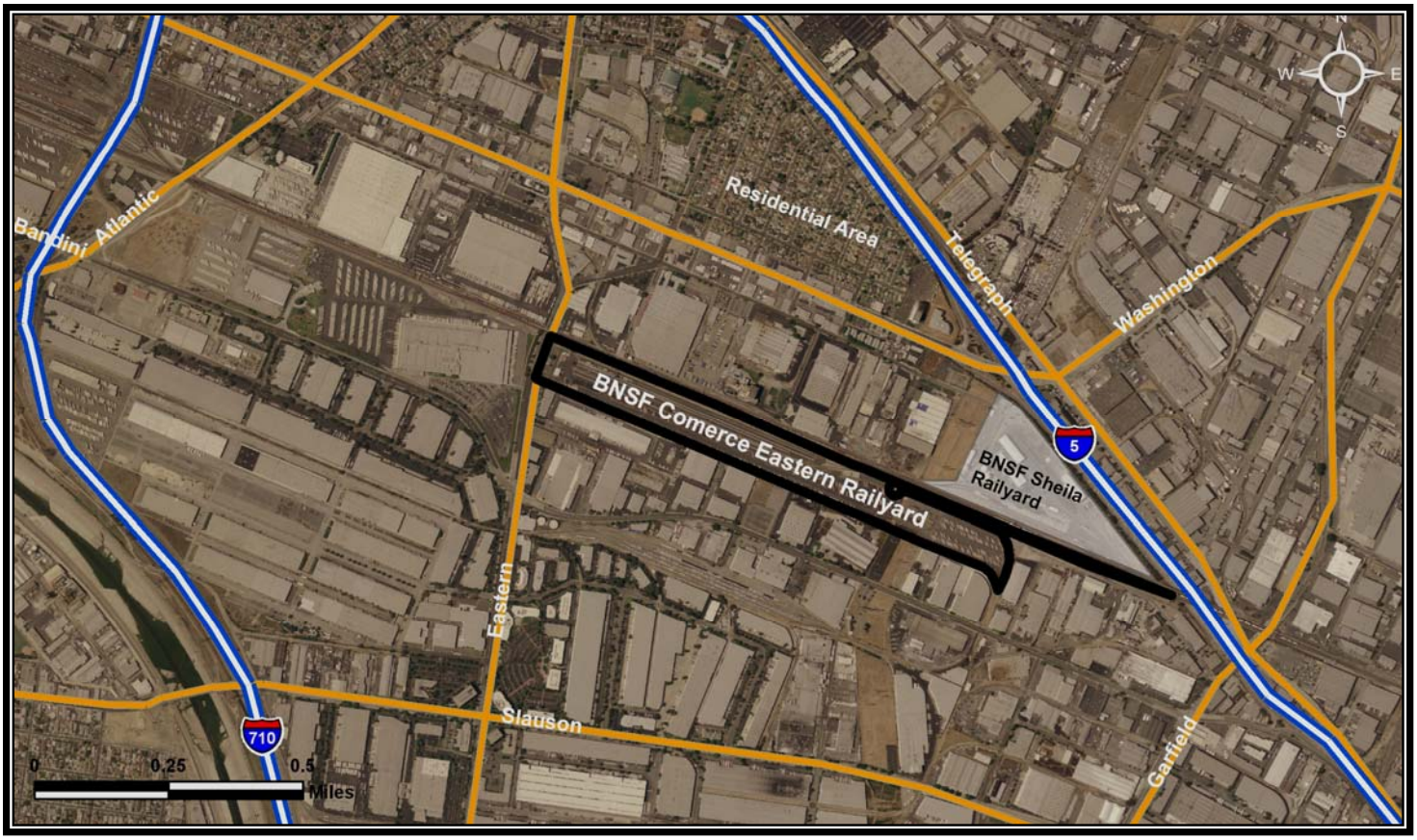
California Environmental Protection Agency

Air Resources Board

"Draft" Health Risk Assessment For the BNSF Railways (BNSF) Commerce Eastern Railyard



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Air Resources Board

Draft Health Risk Assessment For BNSF Railways (BNSF) Commerce Eastern Railyard

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I. INTRODUCTION

The California Air Resources Board (ARB or Board) conducted a health risk assessment study to evaluate the health impacts associated with toxic air contaminants emitted in and around the BNSF Railway's (BNSF) Commerce Eastern Railyard located in the city of Commerce, California. The BNSF Commerce Eastern Railyard is located at 2818 Eastern Avenue in Commerce, California and is approximately six miles southeast of Los Angeles and one mile east of the BNSF Hobart Railyard and nearly adjacent to BNSF Sheila Mechanical Railyard. The study focused on the railyard property emissions from locomotives, on-road trucks, and off-road vehicles and equipment used to move bulk cargo such as forklifts. Also evaluated were mobile and stationary sources with significant emissions within a two mile distance from the railyard. There are four railyards located in the city of Commerce (UP Commerce, BNSF Hobart, BNSF Commerce Eastern, and BNSF Sheila Mechanical). In order to cover the zone of significant health impacts associated with emissions from all of the four railyards in Commerce, ARB staff chose to analyze the significant emission sources within a two-mile distance from the joint boundaries of the four Commerce railyards.

In addition, ARB staff prepared a separate report to provide the cumulative analysis for all of the four Commerce railyards.

A. Why is ARB concerned about diesel PM emissions?

In 1998, 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 research has shown that diesel PM contributes to premature death[1] (ARB, 2002). 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. In addition, the diesel PM particles are very small. Approximately 94 percent of the mass of these particles are less than 2.5 microns in diameter ($PM_{2.5}$). Because of their tiny size, diesel PM is readily respirable and can penetrate deep into the lung and enter the bloodstream, carrying with them an array of toxins. 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, 2006e).

Diesel PM emissions are the dominant toxic air contaminant (TAC) in and around a railyard facility. Diesel PM typically accounts for about 70% of the State's estimated potential ambient air toxic cancer risks. This estimate is based on data from ARB's ambient monitoring network in 2000 (ARB, 2000). These findings are consistent with that of the study conducted by South Coast Air Quality Management District: *Multiple Air*

[1] 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 premature death.

Toxics Exposure Study in the South Coast Air Basin (SCAQMD, 2000*).* Based on these scientific research findings, the health impacts in this study primarily focus on the risks from the diesel PM emissions.

B. Why evaluate diesel PM emissions at the BNSF Commerce Eastern Railyard?

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

The Agreement requires that health risk assessments (HRAs) be prepared for each of the 17 major or designated railyards in the State. The Agreement also requires the railyard HRAs to be prepared based on ARB's experience in preparing the UP Roseville Railyard HRA study in 2004, and the ARB draft Health Risk Assessment Guidelines for Railyard and intermodal Facilities developed by the ARB in 2006 (See http://www.arb.ca.gov/railyard/hra/hra.htm) (ARB, 2006d). The BNSF Commerce Eastern Railyard is one of the designated railyards subject to the Agreement and the HRA requirements.

C. What are Health Risk Assessments (HRAs)?

An HRA uses mathematical models to evaluate the health impacts from exposure to certain chemical or toxic air contaminant released from a facility or found in the air. HRAs provide information to estimate potential long term cancer and non-cancer health risks. HRAs do not gather information or health data on specific individuals, but are estimates for the potential health impacts on a population at large.

An HRA consists of three major components: air pollution emission inventory, air dispersion modeling, and assessment of associated risks. The air pollution emission inventory provides an understanding of how the air toxics are generated and emitted. The air dispersion modeling takes the emission inventory and meteorology data such as temperature and wind speed/direction as its inputs, then uses a computer model to predict the distributions of air toxics in the air. Based on this information, an assessment of the potential health risks of the air toxics to an 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. Children, however, are impacted more during the childhood period. Exposure duration 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)[2] is used to predict if there will be certain identified adverse health effects, 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 number, the reference exposure level is compared to the concentration that a person is exposed to and a "hazard index" (HI) is calculated. Typically, the greater the hazard index is above 1.0, the greater the potential for possible adverse health effects. If the hazard index is less than 1.0, then it is an indicator that adverse effects are less likely to happen.

- For premature deaths linked to diesel PM emissions in the South Coast Air Basin (SCAB), ARB staff estimated about 1,300 premature deaths per year due to diesel exhaust exposure in 2000. The total diesel PM emissions from all sources in the South Coast Air Basin is about 7,750 tons per year in 2005 (ARB, 2006a). Diesel PM in 2005 from the BNSF Commerce Eastern Railyard is estimated at 3 tons per year, which is about 0.04% of total South Coast Air Basin emissions. For comparison with another 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 at about 1,760 tons per year, which resulted in an estimated twenty nine (29) premature deaths per year in the basin (ARB 2006b).

The potential cancer risk from a given carcinogen estimated from the health risk assessment is expressed as the incremental number of potential cancer cases that could be developed per million people, assuming population is exposed to the carcinogen at a constant annual average concentration over a presumed 70-year lifetime. For example, if the cancer risk were estimated to be 100 chances per million, the probability of an individual developing cancer would be expected to not 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 are likely to develop cancer from a lifetime of exposure (i.e., 70 years) due to diesel PM emissions from a facility.

The HRA 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

[2] 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.

process of risk assessment. The uncertainty arises from lack of data in many areas necessitating the use of assumptions. The assumptions used in the assessments are often designed to be conservative on the side of health protection to avoid underestimation of risk to the public. 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. In addition, the HRA results are best used to compare 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 BNSF Commerce Eastern Railyard HRA?

Under the Agreement, ARB worked collaboratively with affected local air quality management districts, communities, cities, counties, and the two railroads to develop two guideline documents for performing the health risk assessments. The two documents, entitled draft *Rail Yard Emissions Inventory Methodology* (ARB, 2006c), and draft *Health Risk Assessment Guidance for Railyard and Intermodal Facilities* (ARB, 2006d), provide guidelines for the identification, modeling, and evaluation of the toxic air contaminants (TACs) from Designated Railyards throughout California.

Using the guidelines BNSF and their designated consultant (i.e., ENVIRON International Corporation) were responsible for the preparation of the emission inventories and performing the air dispersion modeling for operations that occur within the BNSF Commerce Eastern Railyard. The base year of the analysis was 2005.

ARB staff was 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 (HRAs). 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 are 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 BNSF Commerce Eastern Railyard operations, emissions, air dispersion modeling, and health risk assessment results. Following the summary, the third chapter presents the details of the BNSF Commerce Eastern Railyard emission inventories. After that, the fourth chapter explains how the air dispersion modeling was conducted, and the fifth chapter provides the detailed health risk assessment for the BNSF Commerce Eastern Railyard. The appendices present the technical supporting documents for the analyses discussed in the main body of the report.

II. SUMMARY

Below is a summary of the BNSF Commerce Eastern Railyard operations, emissions, air dispersion modeling, and health risk assessment results.

A. General Description of the BNSF Commerce Eastern Railyard

The BNSF Commerce Eastern Railyard is located at 2818 Eastern Avenue Commerce, California (see Figure II-1) and is approximately 6 miles southeast of Los Angeles and is one mile east of BNSF Hobart Railyard, which is the largest intermodal railyard in the United States. The BNSF Commerce Eastern Railyard is adjacent to the BNSF Sheila Mechanical Railyard and located in an industrial and commercial area, with several residential areas located within a two miles. The BNSF Commerce Eastern Railyard is bordered by an adjacent main line to the north and east, Eastern Avenue to the west, and commercial properties to the south. The BNSF Commerce Eastern Railyard is also located within 5 miles of three major highways including I-710 to the west, I-5 to the east, and highway 60 located to the north. The railyard facility encompasses about a 0.1 mile wide by 0.9 mile-long strip of land or about 44 acres.

B. What are the primary operations at the BNSF Commerce Eastern Railyard?

The BNSF Commerce Eastern Railyard is a small intermodal facility with a focus on the distribution of local domestic containers. In comparison, nearby BNSF Hobart Railyard focuses on the distribution of international containers. The BNSF Commerce Eastern facility processed about 130,000 containers in 2004 as compared to BNSF Hobart Railyard which currently processes an estimated 1.2 million containers. Cargo containers and other freight are received, sorted, and distributed within the BNSF Commerce Eastern Railyard 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 railyard. The railyard also includes facilities for crane and yard hostler maintenance.

Activities at the BNSF Commerce Eastern Railyard include receiving inbound trains, switching rail cars, loading and unloading intermodal trains, storage of intermodal containers, and building and departing outbound trains. The BNSF Commerce Eastern Railyard facility can be divided into the following three operational areas: 1-Adjacent Main Line, Classification Yard, and Intermodal Area. The adjacent main line is located just north of the BNSF Commerce Eastern Railyard and activities on it include arriving/departing line haul locomotives, pass through line haul locomotives, pass through passenger locomotives, and track maintenance. The classification yard includes locomotive switching operations (i.e. moving railcars within the railyard), which occur on two tracks just south of the adjacent main line. Intermodal operations occur over the entire facility and operations include use of cargo handling equipment, on-road trucks, on-road fleet vehicles, and container transportation refrigeration units (TRUs).

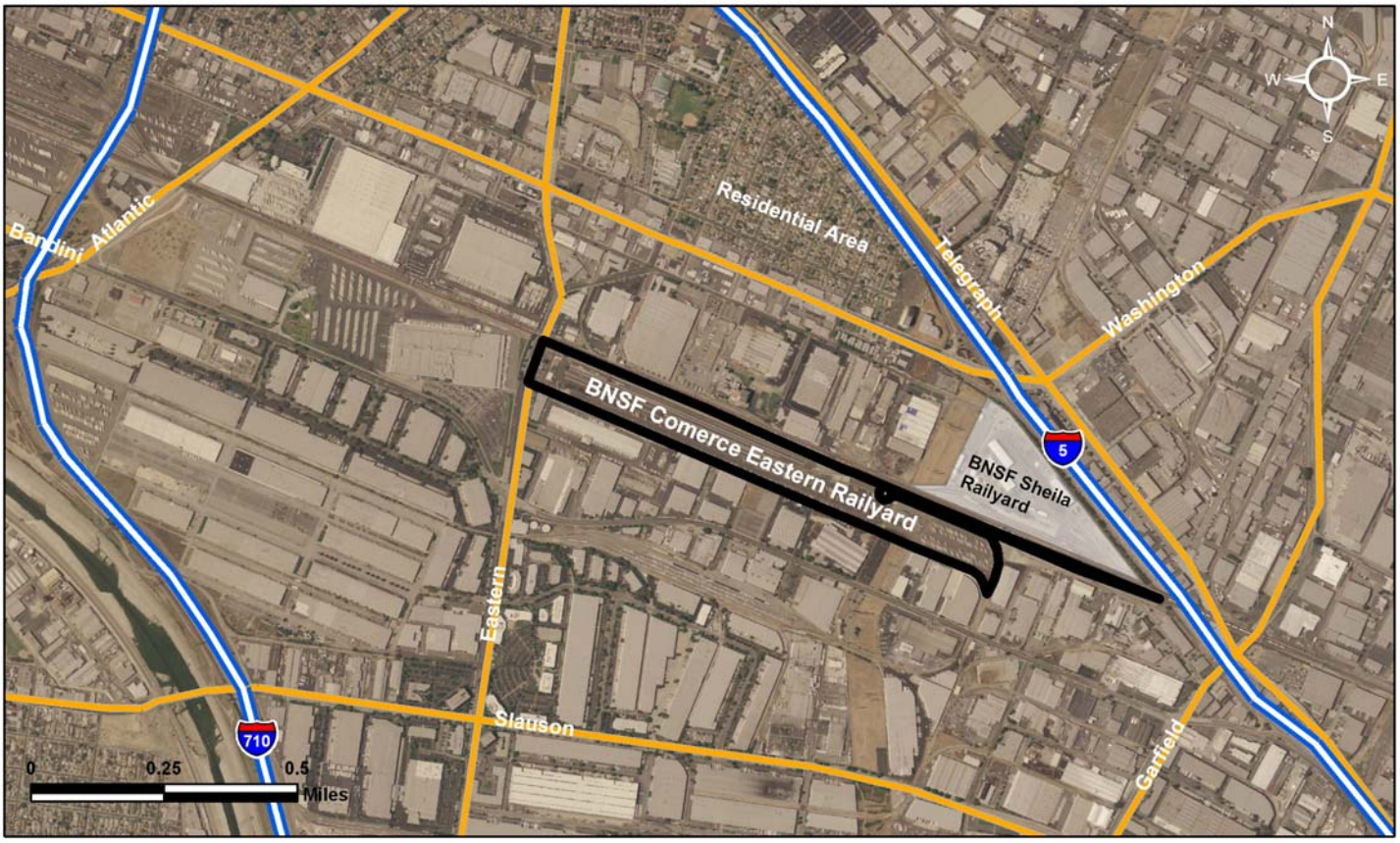


Figure II-1: BNSF Commerce Eastern Railyard and Surrounding Area

C. What are the diesel PM emissions in and around the BNSF Commerce Eastern Railyard?

In 2005, the combined diesel PM emissions from the BNSF Commerce Eastern Railyard and other significant emission sources within a two-mile distance from the joint boundaries of the four Commerce railyards (see Figure II-2) are estimated at about 116 tons per year, excluding emissions occurring at the other three railyards in the Commerce area. Estimated off-site diesel PM emissions from mobile sources (not generally related to activities at the railyard) are about 113 tons per year, or about 97 % of the total combined railyard and off-site diesel PM emissions. Off-site stationary

sources contribute at about 0.20 ton (400 pounds) per year of the total diesel PM emissions. The BNSF Commerce Eastern Railyard diesel PM emissions were estimated at about 3 tons per year, which accounts for less than 3% of the total combined railyard (on-site) and off-site diesel PM emissions.

To provide a perspective on the railyard diesel PM emissions, Table II-1 lists the estimated diesel PM emissions (for the year of 2005) for eleven railyards. The diesel PM emissions from the BNSF Commerce Eastern Railyard ranks ninth among these eleven railyards.

Figure II-2: Two-mile Joint Boundary for the Four Commerce Railyards.

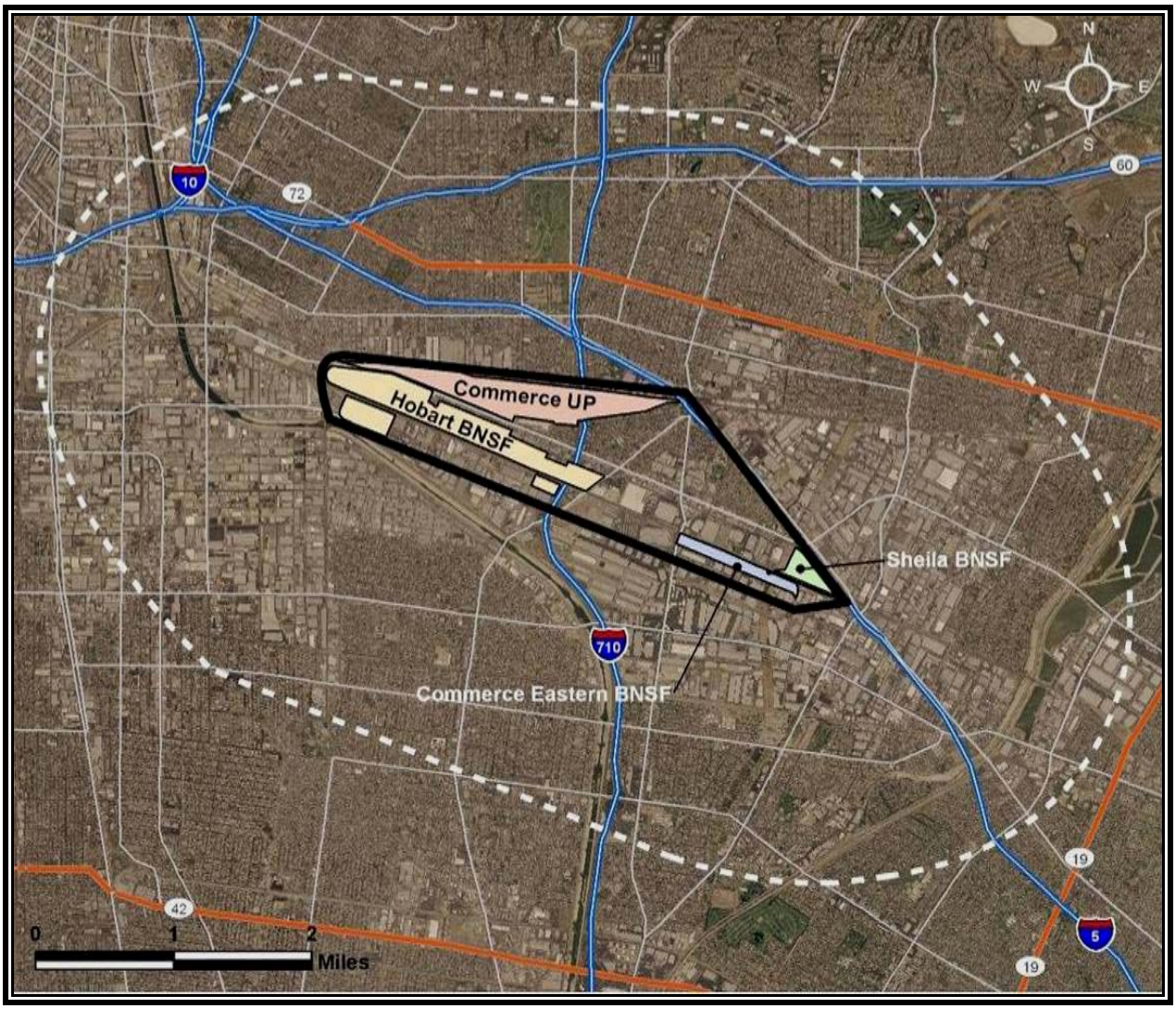


Table II-1: Comparison of Diesel PM Emissions from Eleven Railyards (tons per year)

Railyard	Locomotive	Cargo Handling Equipment	On-Road Trucks	Others (Off-Road Equipment, TRUs, Stationary Sources, etc.)	Total§
UP Roseville*	25.1**	N/A‡	N/A‡	N/A‡	**25.1**
BNSF Hobart	5.9	3.8	10.1	3.7	**23.4**
UP Commerce	4.9	3.9	2.0	0.4	**11.2**
UP LATC	3.2	2.3	1.0	0.5	**6.9**
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	**4.6**
BNSF Stockton	3.6	N/A‡	N/A‡	0.02	**3.6**
BNSF Commerce Eastern	0.6	0.4	1.1	1.0	**3.0**
BNSF Sheila	2.2	N/A‡	N/A‡	0.4	**2.7**
BNSF Watson	1.9	N/A‡	<0.01	0.04	**1.9**

* The UP Roseville Health Risk Assessment (ARB, 2004) 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 tons per year.
‡ Not applicable.
§ Numbers may not add precisely due to rounding.

1. Railyard

The BNSF Commerce Eastern Railyard emission sources include, but are not limited to, locomotives, diesel-fueled trucks, cargo handling equipment and transportation refrigeration units (TRUs). The facility operates 24 hours per day, 365 days per year. The BNSF Commerce Eastern Railyard diesel PM 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 (TAC) emissions is based on ARB draft *Rail Yard Emissions Inventory Methodology* (ARB, 2006c).

As indicated by Table II-2 , within the BNSF Commerce Eastern Railyard on-road container truck operations accounts for an estimated 1.13 tons per year of diesel PM emissions (about 37% of the railyard diesel PM emissions). The second major source for diesel PM emissions was off-road equipment/vehicles, which was estimated at about 0.97 tons per year of diesel PM emissions (about 33% of the total railyard diesel PM emissions).

An estimated 72,064 locomotives passed through the main line at the BNSF Commerce Eastern Railyard between May, 2005 and April 2006. Among these numbers, about 1,415 actually stopped and visited the BNSF Commerce Eastern Railyard. Diesel PM

emissions from locomotive operations were estimated at about 0.55 tons per year or approximately 18% of the railyard diesel PM emissions. Yard operations (primarily switch locomotives moving railcars within the railyard) contribute 0.21 tons per year. Arriving and departing train activities accounts for 0.22 tons per year, and line haul freight movements and commuter rail (AMTRAK and Metrolink) operations on the adjacent main line contributed 0.12 tons per year of the diesel PM emissions.

Diesel PM is not the only toxic air contaminant (TAC) emitted in the BNSF Commerce Eastern Railyard. A relatively small amount of gasoline TACs is also emitted from some of the gasoline fleet vehicles, and two of the track maintenance forklifts, including isopentane, toluene, benzene etc. The detailed emission inventories for these TACs are presented in the Air Dispersion Modeling Assessment of Air Toxic Emissions from BNSF Commerce Eastern Intermodal Railyard and Commerce Eastern Railyard TAC Emission Inventory reports (ENVIRON International Corporation). The total amount of these TACs emissions is about one pound per year, which is insignificant, compared to the diesel PM emissions in the railyard. These TACs have substantially lower levels of potential cancer risks as compared to diesel PM, the predominant emissions at the BNSF Commerce Eastern Railyard. Hence, only diesel PM emissions are discussed in this study.

2. Surrounding Sources

ARB staff also evaluated significant mobile and stationary sources of diesel PM emissions surrounding the BNSF Commerce Eastern Railyard. The health risk assessment study for UP Roseville Railyard (ARB, 2004) indicated that cancer risk associated with on-site diesel PM emissions is substantially reduced beyond a one-mile distance from the railyard. Therefore, in this study, ARB staff usually analyze the significant diesel PM emission sources within one-mile distance from the railyard property boundary, where on-site emissions have significant health impacts. There are four railyards located in city of Commerce (UP Commerce, BNSF Hobart, BNSF Commerce/Eastern, and BNSF Sheila Mechanical railyards). In order to securely cover the zone of significant health impact associated with emissions from all of the four railyards in Commerce, ARB staff chose to analyze the significant emission sources within a two-mile distance from the joint boundaries of the four Commerce railyards, as shown by the dashed outer line in Figure II-2.

ARB staff analyzed the significant off-site emission sources based on two categories: mobile and stationary. For the off-site mobile sources, the analysis focused on heavy duty diesel trucks, as these 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 two-mile distance from the joint boundaries of the four Commerce railyards are included in the analysis. The estimates do not include the diesel PM emissions generated from other modes such as extended idling, starts,

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.

tire and break wear, 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 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.

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 two-mile distance from the joint boundaries of the four Commerce railyards, were selected. Diesel PM emissions are estimated from stationary internal combustion (IC) engines burning diesel fuel, and operating at stationary sources reported in CEIDARS.

Within a two-mile distance from the joint boundaries of the four Commerce railyards, off-site diesel PM emissions are predominantly generated by mobile sources and estimated at about 113 tons per year, as indicated by Table II-2. The majority of the off-site diesel PM emissions are from diesel-fueled heavy duty trucks traveling on I-5, I-710, CA-60, I-10 and major local streets. The diesel PM emissions from off-site stationary sources are estimated at about 0.20 tons per year or 400 pounds. Three major stationary sources, Los Angeles City Department of General Services, City of Vernon Light & Power Department, and Los Angeles County Sheriff's Department contribute at about 0.15 tons per year (300 pounds) of the off-site diesel PM emissions. The off-site diesel PM emissions do not include those from the four railyards located in the city of Commerce.

Diesel PM emissions from on-site sources in the BNSF Commerce Eastern Railyard and the off-site sources within a two-mile distance from the joint boundaries of the four Commerce railyards are summarized in Table II-2.

ARB staff also evaluated other toxic air contaminant (TACs) emissions around the BNSF Commerce Eastern Railyard. There are 2,620 stationary TAC sources identified within the two-mile distance from the joint boundaries of the four Commerce railyards. The total emissions of TACs, other than diesel PM emitted from these stationary sources, were estimated at about 210 tons per year. Over 100 TAC species are identified among these emissions, in which ammonia, toluene and methyl chloroform are three major contributors with emissions estimated at 57, 25, and 24 tons per year, respectively. Not all of these toxic air contaminants are identified as carcinogens. According to ARB' *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% percent of the state's estimated potential cancer risk levels, which are significantly higher than other TACs (ARB, 2000). Among the off-site TACs

emissions, the top five cancer risk contributors (without diesel PM) were estimated at about 1.6 tons per year.

Table II-2: BNSF Commerce Eastern Railyard and Surrounding Area Diesel PM Emissions

DIESEL PM EMISSION SOURCES	BNSF Commerce Eastern Railyard		Off-site Emissions Within 2 Mile Radius	
	Tons per year	Percentage	Tons per year	Percentage
ON-ROAD TRUCKS	**1.1**	**35%**	**-**	**-**
OFF-ROAD EQUIPMENT/VEHICLES	**1.0**	**33%**		**-**
LOCOMOTIVES	**0.6**	**19%**		
Switch Locomotives	**0.21**	**7%**		
Line-Haul Locomotives	**0.34**	**11%**		
`Arriving & Departing Trains	0.22	7%		
Freight movement on mainline	0.10	3%		
Commuter Rail Operations	0.02	<1%		
CARGO HANDLING EQUIPMENT	**0.4**	**13%**		**-**
Service/Shop/Testing	**-**	**-**	**-**	**-**
OTHER (e.g., Waste Water Treatment Plant)	**-**	**-**	**-**	**-**
OFF-SITE MOBILE SOURCES (e.g., freeways, trucks, cars, etc.)	**-**	**-**	**113.2**	**100%**
OFF SITE STATIONARY SOURCES (e.g., public facilities, public utilities etc.)	**-**	**-**	**0.2**	**<0.1%**
TOTAL	**3.1***	**100%**	**113.4****	**100%**

***Numbers may not add up precisely due to rounding off.
****Excluding emissions occurring at the other three railyards in the Commerce area.

The Office of Environmental Health Hazard Assessment (OEHHA) has calculated an inhalation cancer potency factor (CPF) for each hazardous compound. The four compounds listed here are given

Cancer potency factors (CPF) are expressed as the upper bound probability of developing cancer assuming continuous lifetime exposure to a substance at a dose of one milligram per kilogram of body weight, and are expressed in units of $(mg/kg\text{-}day)^{-1}$.

a weighing factor by comparing each compound's CPF to the diesel PM CPF. This factor is multiplied by the estimated actual emissions for that compound, which gives the potency weighted toxic emission as shown in Table II-3. As can be seen in Table II-3, the potency weighted toxic emissions for these TACs are about 0.07 tons per year, which is substantially less than the diesel PM emissions.

Table II-3: Potency Weighted Toxic Emissions from Significant Off-Site Stationary Sources Surrounding BNSF Commerce Eastern Railyard.

Compound	Cancer Potency Factor	Weighting Factor	Estimated Emission (tons/year)	Potency Weighted Toxic Emission (tons/year)
Diesel PM	1.1	1	113.2	**113.2**
1,3-Butadiene	0.6	0.55	0.007	**0.0037**
Benzene	0.1	0.09	0.435	**0.0392**
Carbon Tetrachloride[3]	0.15	0.14	0.001	**0.0001**
Formaldehyde	0.021	0.02	1.159	**0.0220**
Total (non-diesel PM)	**-**	**-**	**1.60***	**0.065***

*Numbers may not add up precisely due to rounding-off.

In addition, ARB staff evaluated the potential cancer risk levels contributed by gasoline exhausts in the South Coast Air Basin. Table II-4 shows the emissions of four major carcinogen compounds of gasoline exhausts in South Coast Air Basin in the year of 2005 (ARB, 2006a). As indicated in Table II-4, the potency weighted emissions of these four toxic air contaminants from all types of gasoline sources are estimated at about 815 tons per year, or about 11% of diesel PM emissions in South Coast Air Basin. If only gasoline-powered vehicles are considered, the potency weighted emissions of these four TACs are estimated at about 438 tons per year, or about 6% of diesel PM emissions in the Basin. Therefore, the potential cancer risk levels caused by non-diesel PM TACs emitted from off-site gasoline-powered vehicular sources are substantially less than the potential cancer risk levels associated with diesel PM, and are not included in the analysis.

[3].Very small amount of carbon tetrachloride are emitted today. Ambient concentrations are highly influenced by past emissions due to long atmospheric life time of this compound.

Table II-4: Emissions of Major Toxic Air Contaminants from Gasoline Exhausts in South Coast Air Basin

Compound	TACs Emissions (tons/year)			
	From All Sources	Potency Weighted**	From Gasoline Vehicles	Potency Weighted**
Diesel PM	*7,446*	***7,446***	-	-
1,3-Butadiene	695	**382**	420	**231**
Benzene	3,606	**325**	2,026	**182**
Formaldehyde	4,623	**92**	1,069	**21**
Acetaldehyde	1,743	**16**	314	**3**
Total (non-diesel PM)	10,668	**815**	3,829	**437**

**Based on cancer potency weighting factors.

D. What are the potential cancer risks from the BNSF Commerce Eastern Railyard?

As discussed previously, the ARB developed draft Health Risk Assessment Guidance for Railyard and Intermodal Facilities (ARB, 2006d) to help ensure that the methodologies used in each railyard HRA meet the requirements in the ARB Railroad Statewide Agreement. The railyard HRA follows The Air Toxics Hot Spots Program Risk Assessment Guidelines (OEHHA, 2003) published by the Office of Environmental Health Hazard Assessment (OEHHA), and is consistent with the. methodologies used for the UP Roseville Railyard Study (ARB, 2004a).

The United States Environmental Protection Agency (U.S. EPA) recently approved state-of-science air dispersion model AERMOD (**A**merican Meteorological Society/**E**PA **R**egulatory Model Improvement Committee **MOD**EL) is used in the ARB railyard health risk assessments. One of the critical inputs required for the air dispersion modeling is the meteorology, such as wind direction and wind speed. These parameters determine where and how the pollutants will be transported. Based on the U.S. EPA AERMOD meteorological data selection criteria, four meteorological stations around the BNSF Commerce Eastern Railyard were evaluated and the data from the most representative meteorology station, Lynwood station operated by South Coast Air Quality Management District, was selected for the modeling.

> 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 potential cancer risk levels associated with the estimated diesel PM emissions at the BNSF Commerce Eastern Railyard are displayed by **isopleths**. In this study, ARB staff elected to present the cancer risk isopleths focusing on risk levels of 10, 25, 50, 100, 250, and 500 in a million, presented in Figure II-3 and Figure II-4. Figure II-3 shows the risk levels at areas near railyard and Figure II-4 focuses on the more regional impacts. In each figure, the risk isopleths are

overlaid onto a satellite image of the Commerce area surrounding the BNSF Commerce Eastern Railyard, to illustrate the land use (residential, commercial, industrial, or mixed use) within the impacted areas.

The OEHHA Guidelines specify that, for health risk assessments, the cancer risk for the maximum exposed individual at the point of maximum impact be reported. The point of maximum impact, which is defined as the receptor point with the highest cancer risk level outside of the facility boundary, is predicted to be located right next to the yard fence line on the north side of the railyard facility. The maximum individual cancer risk (MICR) is estimated to be 700 chances in a million at this point. The land use in the vicinity of the point of maximum impact is an open land or for industrial use. In the residential area, the highest potential cancer risk is estimated at about over 100 chances in a million. As indicated by Roseville Railyard Study (ARB, 2004a), the location of the point of maximum impact 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, the point of maximum impact location and maximum individual cancer risk is uncertain and should not be interpreted as a literal prediction disease incidence but more as a tool for comparison. The estimated point of maximum impact location and maximum individual cancer risk value may not be replicated by air monitoring.

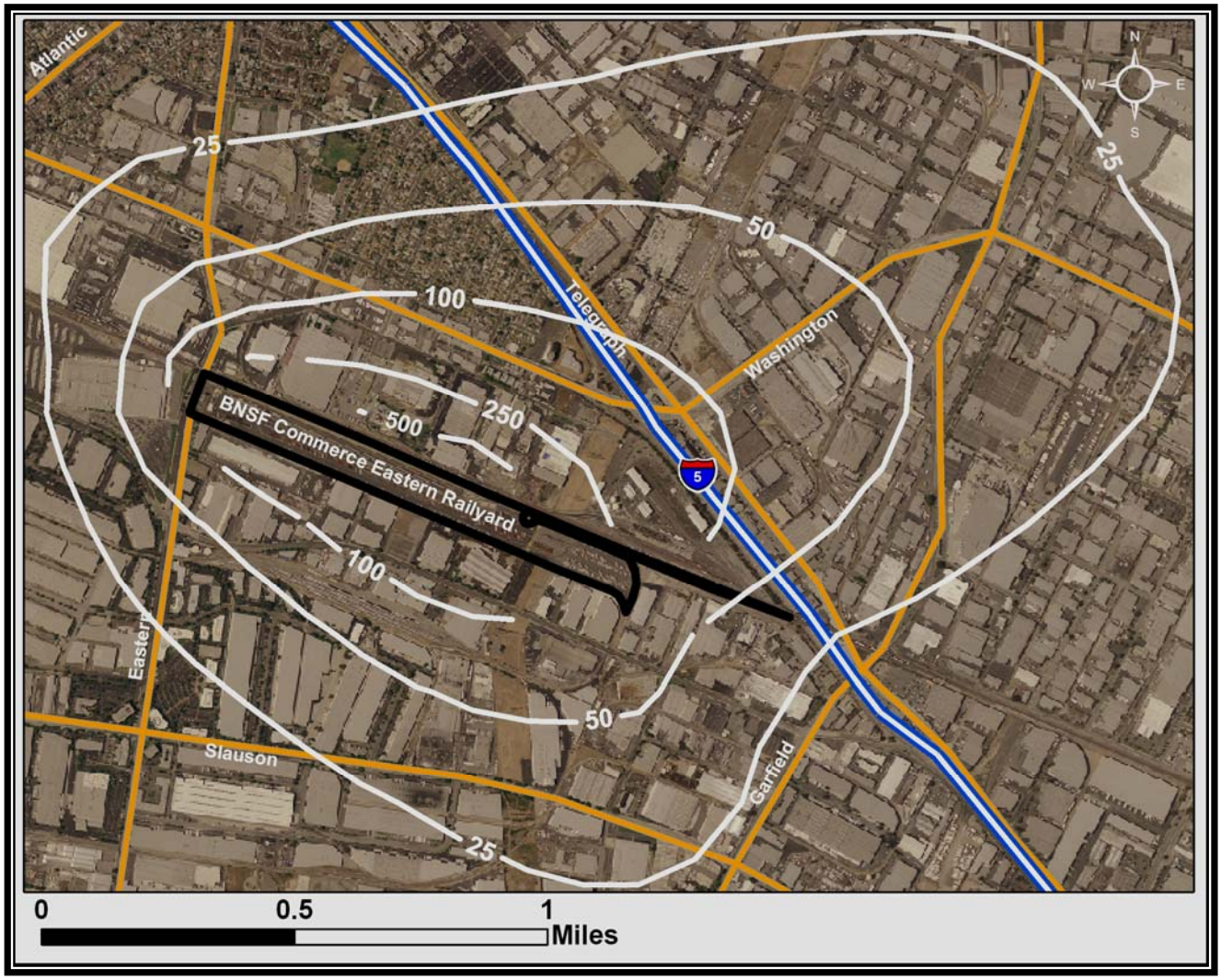
As shown in Figure II-3 at the BNSF Commerce Eastern Railyard, the area with the greatest impact have an estimated potential cancer risk over 500 in a million, occurring at a very small area right next to the north side of the railyard fence line. Majority of the BNSF activities take place in this area, and emissions allocations is presented in Appendix F. At locations 400 yards outside of the BNSF Commerce Eastern Railyard boundary, the estimated cancer risks are lowered to about 250 cases in a million. At about a half mile from the BNSF Commerce Eastern Railyard boundaries, the estimated cancer risk is 100 in a million, and within a mile of the railyard boundary the estimated cancer risks are further lowered to about 50 in a million. At about two miles from the BNSF Commerce Eastern Railyard, the estimated cancer risks are lowered to about 10 in a million. Within three miles of the railyard boundaries the estimated cancer risks are 5 in a million or lower.

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 also be evaluated for residents and school-aged children, as a supplement. 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 (OEHHA, 2003).

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 different rates of exposure for an 8-hour workday, with adjustments of five days a week and 245 days a year.

Table II-5 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 II-5, the 10 in a million isopleth line in Figures II-4

Figure II-3: Estimated Near-Source Cancer Risks (cases per million people from the BNSF Commerce Eastern Railyard



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, and 2 in a million for off-site workers

To conservatively communicate the risks, ARB staff presents the estimated potential cancer risk isopleths all based on 70 year resident exposure duration, even for those impacted industrial areas where no resident lives.

Table II-5: Equivalent Potential Cancer Risk Levels for 70-, 40-, 30- and 9-Year Exposure Durations

Exposure Duration (years)	Equivalent Risk Level (Chance in a million)					
70	10	25	50	100	250	500
30	4	11	21	43	107	214
9*	2.5	6.3	12.5	25	63	125
40‡	2	5	10	20	50	100

* Exposure duration for school-aged children.
‡ Exposure duration for off-site workers.

The residential areas near the BNSF Commerce Eastern Railyard are located north of the railyard. Areas located east, south and west are predominately industrial areas. Based on the 2000 U. S. Census Bureau's data the zone of impact with the estimated cancer risk over 10 chances in a million encompasses approximately 4,820 acres with 35,000 residents in this area. Table II-6 presents the exposed population and area coverage for various impacted zones of cancer risks. The prevailing wind patterns around the BNSF Commerce Eastern Railyard move from southwest to northeast directions where much of the downwind areas are industrial lands. However, there is a small residential area located directly (about ¼ mile) northeast of the railyard, east of City hall, north of Washington Blvd, and west of I-5. Prevailing wind patterns significantly reduce the potential cancer risks associated with the BNSF Commerce Eastern Railyard diesel PM emissions by significantly reducing population exposure to those emissions.

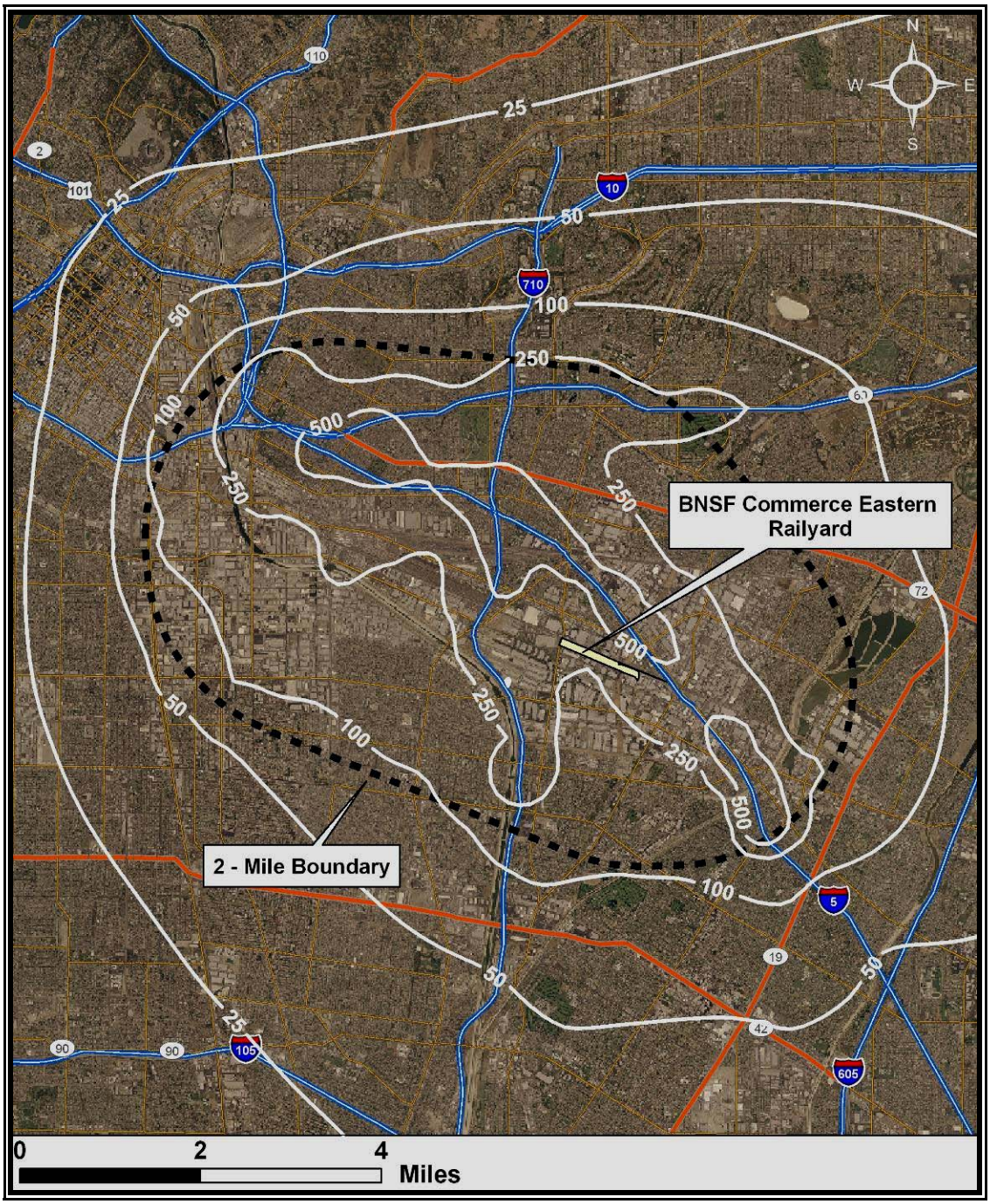
Table II-6: Estimated Impacted Areas and Exposed Population associated with Different Cancer Risk Levels. By Railyard Diesel PM Emissions

Estimated Risk (cases per million)	Impacted Area (Acres)	Estimated Population Exposed*
10 - 25	**3,300**	**32,100**
26 - 50	**900**	**1,360**
51 - 100	**350**	**670**
100 - 250	**270**	**950**

*Based on 2000 Census Data

Figure II-4: Estimated Regional Cancer Risks (cases per million people) from the BNSF Commerce Eastern Railyard.

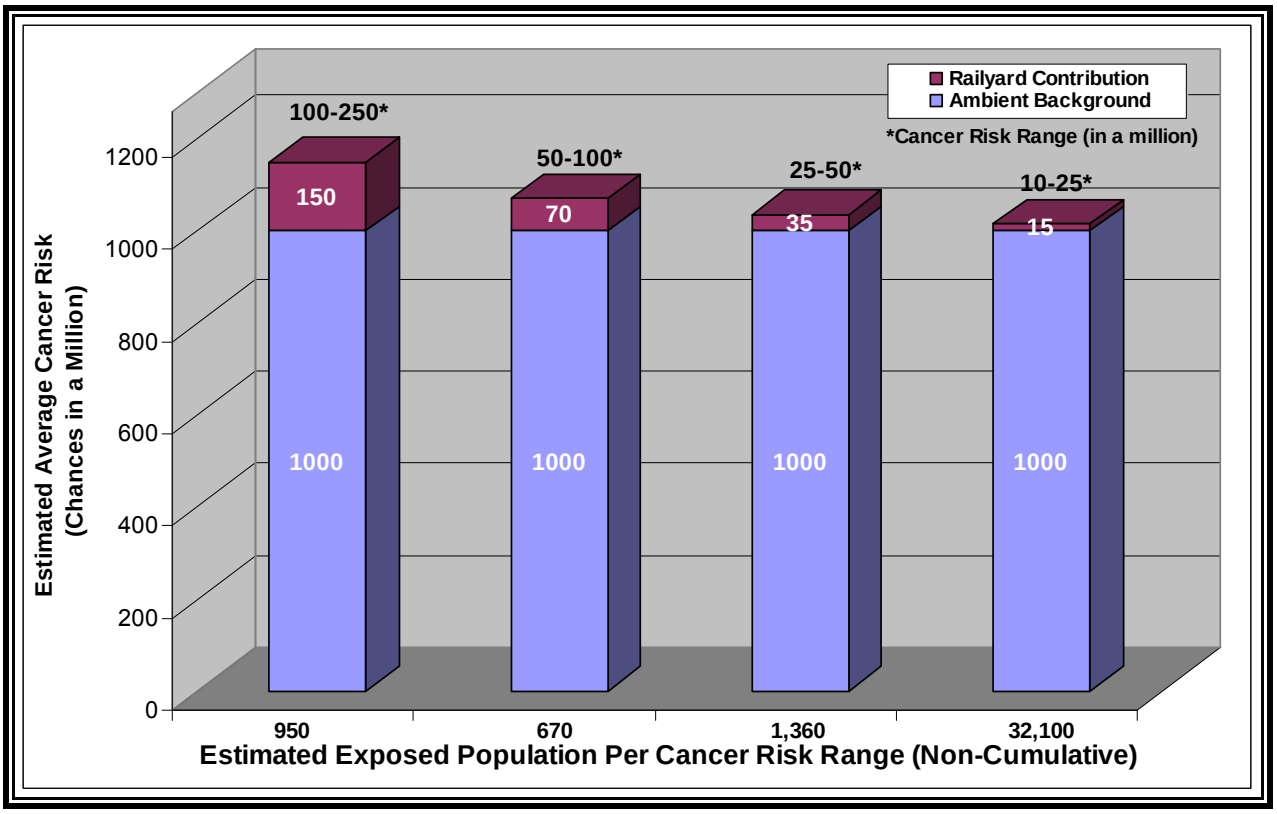
Figure II-5 Estimated Cancer Risk from the Off-site Diesel PM Emissions.



It is important to understand that these risk levels represent the predicted risks (due to the BNSF Commerce Eastern Railyard diesel PM emissions) above the existing background risk levels. For the broader South Coast Air Basin, the estimated regional background risk level is estimated to be 1,000 in a million caused by all toxic air pollutants in 2000 (ARB, 2006a). Figure II-6 provides a comparison of the predicted average potential cancer risks in various isopleths to the regional background risk level and estimated exposed population. For example, in the risk range greater than 100, the

average potential cancer risk above the regional background is 150 chances per million. Therefore, residents living in that area would have a potential cancer risk at about 1150 cases in a million.

Figure II-6: Comparison of Estimated Potential Cancer Risks from the BNSF Commerce Eastern Railyard to the Regional Background Risk Levels.



E. What are the estimated non-cancer risks from the BNSF Commerce Eastern Railyard?

The potential non-cancer chronic health hazard index from the estimated diesel PM emissions at the BNSF Commerce Eastern Railyard are estimated to be less than 0.1. According to Office of Environmental Health Hazard Assessment (OEHHA) Guidelines (OEHHA, 2003) these levels indicate that the potential non-cancer chronic public health risks are less likely to happen. When all of the four Commerce Railyards studies are completed, the downwind diesel PM emissions from the other Commerce Railyards may affect and overlap certain areas near the BNSF Commerce Railyard, and possibly increase the levels of non-cancer risk.

Due to the uncertainties in the toxicological and epidemiological studies, diesel PM as a whole was not assigned a short-term acute REL. It is only the 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 REL. 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 compounds in 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 maximum hourly-specific emission data, which is essential to assess 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.

The cumulative impacts (cancer and non-cancer risks) from all of the four Commerce railyards are presented in a separate report.

F. What are the estimated health risks from off-site emissions?

ARB staff evaluated the health impacts from off-site pollution sources near the BNSF Commerce Eastern Railyard facility using the U.S. EPA-approved AERMOD dispersion model. Specifically, off-site mobile and stationary diesel PM emission sources located within a two-mile distance from the joint boundaries of the four Commerce railyards were included. Diesel PM off-site emissions used in the off-site modeling runs consisted of about 113.2 tons per year from roadways and 0.2 tons per year from stationary facilities, in 2005. The diesel PM emissions from the BNSF Commerce Eastern Railyard and the other three railyards nearby are not analyzed in the off-site air dispersion modeling. The estimated potential cancer risks associated with off-site diesel PM emissions are illustrated in Figure II-5. As indicated in Figure II-5, the zone of impacts of estimated cancer risks associated with off-site diesel PM emissions is significantly larger than that of the BNSF Commerce Eastern Railyard diesel PM emissions. Because the diesel PM emissions from the significant off-site sources are 35 times greater than the BNSF Commerce Eastern Railyard diesel PM emissions.

Based on the 2000 U.S. Census Bureau's data, the zone of impact of the estimated potential cancer risks above 100 chances in a million associated with off-site diesel PM emissions encompass approximately 28,300 acres where about 430,700 residents live. For comparison with the BNSF Commerce Eastern Railyard health risks, the same level of potential cancer risks (100 chances in a million) associated with railyard diesel PM emissions covers about 270 acres where approximately 950 residents live.

Table II-7 presents the exposed population and area coverage size for various impacted zones of cancer risks associated with off-site diesel PM emissions.

Table II-7: Estimated Impacted Areas and Exposed Population associated with Different Cancer Risk Levels Associated with Off-Site Diesel PM Emissions

Estimated Cancer Risk (cases per million)	Estimated Impacted Area (Acres)	Estimated Population Exposed
10 - 25	126,000*	650,000*
26 - 50	25,500*	529,000*
51 - 100	18,000*	303,000*
101 - 250	17,500	285,000
251 - 500	8,610	100,000
>500	2,330	45,000

*Approximate estimates because partially these isopleths exceed the air dispersion model domain.

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 a year of monitoring data would generally be needed.

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

The ARB has developed an integrated approach to reduce statewide locomotive and railyard 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. California's key locomotive and railyard air pollution control measures and strategies are summarized below:

South Coast Locomotive NOx 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. This measure will provide an estimated 65% reduction in oxides of nitrogen (NOx) and 50% reduction in locomotive particulate matter emissions in the South Coast Air Basin (SCAB) by 2010.

Statewide Railroad Agreement (2005): ARB and both UP and BNSF signed a voluntary statewide agreement in 2005. When fully implemented, the Agreement is expected to achieve a 20 percent reduction in locomotive diesel PM emissions in and around railyards through a required number of short-term and long-term measures. As of January 1, 2007, ARB staff estimated that the Agreement has reduced diesel PM emissions by 15% in and around the railyard.

ARB Diesel Fuel Regulations Extended to Intrastate Locomotives (2007): This regulation, approved in 2004, requires intrastate locomotives to use only California ultra low sulfur (15 parts per million) and aromatics diesel fuel. CARB diesel fuel can reduce intrastate locomotive diesel PM and NOx emissions by 14% and 6%, on average, respectively. ARB staff estimates there are over 250 intrastate locomotives currently operating in South Coast Air Basin, and CARB diesel 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 statewide for intrastate locomotives 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 statewide. Implementation of this regulation will reduce diesel PM emissions by approximately 40% in 2010 and 65% in 2015, and NO_x emissions by approximately 25% in 2010 and 50% in 2015. The regulation, when fully implemented, is expected to cumulatively reduce diesel PM and NO_x emissions from all cargo handling equipment in the State by up to 80 percent by 2020. At a railyard like BNSF Commerce Eastern, this regulation could reduce up to 0.3 tons per year of diesel PM emissions. The regulation took effect January 1, 2007.

On-Road Heavy Duty Diesel Trucks Regulations: In January of 2001, the U.S. EPA promulgated a Final Rule to reduce 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 NO_x emissions, 72% reduction of non-methane hydrocarbon emissions, and 90 percent 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. This 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.

Transport Refrigeration Unit (TRU) Air Toxics Control Measure (ATCM): This air 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 emission factors for transport refrigeration units and transport refrigeration unit Gen-set engines will be reduced by approximately 65 percent in 2010 and 92 percent in 2020. California's air quality will also experience benefits from reduced NOx emissions and reduced HC emissions. The transport refrigeration unit air toxics control measure is designed to use a phased approach over about 15 years to reduce the PM emissions from in-use transport refrigeration unit and transport refrigeration unit generator set engines that operate in California. The new rule became effective on December 10, 2004.

Proposed On-Road In-Use Truck Regulations: The ARB is developing a control measure to reduce diesel PM and oxides of nitrogen (NO_x) emissions from private fleets of on-road heavy-duty diesel-fueled vehicles. This measure includes, but is not limited to, long and short haul truck-tractors, construction related trucks, port hauling trucks, wholesale and retail goods transport trucks, tanker trucks, package and household goods transport trucks, and any other diesel-powered trucks with a gross vehicle weight rating of 14,000 pounds or greater. The proposed goals of the regulations are: (a) by 2014, emissions are to be no higher than a 2004 model year engine with a diesel particulate filter, and (b) by 2020, emissions are to be no higher than a 2007 model year engine.

Proposed In-Use Port and Railyard Truck Mitigation Strategies: The ARB is evaluating a port truck fleet modernization program that will substantially reduce diesel PM and NOx emissions by 2010, with additional reductions by 2020. There are an estimated 12,000 port trucks operating at the 3 major California ports which are a significant source of air pollution, about 7,075 tons per year of NOx and 564 tons per day of diesel PM in 2005, and operate in close proximity to communities. Strategies will include the retrofit or replacement of older trucks with the use of diesel particulate filters and a NOx reduction catalyst system. ARB staff will propose regulatory strategies for ARB Board consideration by the end of 2007 or early 2008.

ARB Tier 4 Off-Road Diesel-Fueled Emission Standards: On December 9, 2004, the Board adopted a fourth phase of emission standards (Tier 4) that are nearly identical to those finalized by the U.S. EPA on May 11, 2004, in its Clean Air Nonroad Diesel Rule. As such, engine manufacturers are now required to meet aftertreatment-based exhaust standards for particulate matter (PM) and NOx starting in 2011 that are over 90 percent lower than current levels, putting off-road engines on a virtual emissions par with on-road heavy-duty diesel engines.

U.S. EPA Locomotive Emission Standards: Under the Federal 1990 Clean Air Act, U.S. EPA has sole authority to adopt and enforce locomotive emission standards. This federal preemption also extends to the remanufacturing of existing locomotives. The ARB has been encouraging the U.S. EPA to expeditiously require the introduction of Tier 4 locomotives built with diesel particulate filters and selective catalytic reduction. U.S. EPA released the notice of proposed regulation rulemaking (NPRM) for locomotives and marine vessels in the Federal Register on April 3, 2007. The NPRM proposed interim reduction in diesel PM emissions for locomotives from 2010-2013, but the final proposed standards would not be applicable to new locomotives until 2017. The final regulations are expected to be approved by early 2008.

ARB Goods Movement Emission Reduction Plan (GMERP): Approved in 2006, the GMERP provides goods movement emissions growth estimates and proposed strategies to reduce emissions from ships, trains, and trucks and to maintain and improve upon air quality. Based largely on the strategies discussed, one of the goals of the GMERP is to reduce locomotive NO_x and diesel PM emissions by up to 50 percent by 2015, and by up to 90 percent by 2020.

California Yard Locomotive Replacement Program: One locomotive strategy identified in the GMERP is to replace California's older switcher yard locomotives (currently about 800) that operate in and around railyards statewide. There are government incentive programs that may be able to assist in funding the replacement of some intrastate locomotives by 2010.

III. BNSF COMMERCE EASTERN RAILYARD DIESEL PM EMISSIONS

This chapter provides a summary of the diesel PM emissions in and around the BNSF Commerce Eastern Railyard.

From May 2005 to April 2006, the combined diesel PM emissions from the BNSF Commerce Eastern Railyard and significant non railyard emission sources within a two-mile distance from the joint boundaries of the four Commerce railyards (off-site emissions) are estimated at about 116 tons per year excluding emissions occurring at the other three railyards in the Commerce area. Estimated off-site diesel PM emissions from mobile sources (not generally related to activities at the railyard) are about 113 tons per year, or about 97% of the total combined railyard and off-site diesel PM emissions. Off-site stationary sources contribute at about 0.20 ton per year of the diesel PM emissions. The BNSF Commerce Eastern Rrailyard diesel PM emissions are estimated at about 3 tons per year, which accounts for about 3% of the total combined on-site and off-site diesel PM emissions.

A. BNSF Commerce Eastern Railyard Diesel PM Emissions Summary

The BNSF Commerce Eastern Railyard activity data and emission inventories were provided by the BNSF Railways and its consultant ENVIRON International Corporation. The methodology used to calculate the diesel PM and other toxic air contaminant (TAC) emissions is based on ARB draft guidelines for railyard emission inventory (ARB, 2006c). Detailed calculation methodologies and resulting emission factors are included in the *Toxic Air Contaminant Emissions Inventory and Dispersion Modeling Report for the BNSF Commerce Eastern Railyard, Los Angeles, California* (ENVIRON International Corporation, 2006) submitted by ENVIRON International Corporation (hereafter ENVIRON Report).

The BNSF Commerce Eastern Railyard is a small intermodal facility with a primary focus on local domestic containers. Intermodal containers may arrive at the facility by truck and be loaded onto trains for transport to distant destinations, or arrive by train and unloaded onto chassis for transport by truck to local destinations. The activity areas of BNSF Commerce Eastern Railyard consist of a locomotive classification yard, adjacent main line, intermodal area, and administration and equipment maintenance building.

Activities at the BNSF Commerce Eastern Railyard includes: receiving inbound trains, switching rail cars, loading and unloading intermodal trains, building and departing outbound trains, storage of intermodal containers and trucks. To characterize diesel PM emissions from railyard sources, they were allocated into three areas based on specific activities taking place in these areas. The on-site areas are summarized in Table III-1 and shown in Figure III-1. A detailed schematic and description of the area or activity represented by each on-site area is also included in report by ENVIRON International Corporation.

Table III-1: BNSF Commerce Eastern Railyard Activities

Area	Description
Adjacent Mainline	Most activities occurring here include Arriving/Departing line haul locomotives, pass through line haul locomotives, pass through passenger locomotives, and track maintenance.
Classification Yard	Area for Locomotive switching operations (Moving Group of railcars with in the Railyard)
Intermodal Area	Operational area for cargo handling equipment, on-road fleet vehicles, and container transportation refrigeration units (TRUs)

Using the data provided by BNSF and the methodology described in the emission inventory report by ENVIRON International Corporation, the diesel PM emissions calculated for railyard sources are estimated to be approximately 3 tons per year. The diesel PM emissions from each on-site activity are provided in Table III-2.

Table III-2: Summary of the Diesel PM Emissions from the BNSF Commerce Eastern Railyard

Source Types	Diesel PM Emissions	
	Tons per year	Percentage of Total
On-Road Truck and Vehicles	1.1	35%
Off-Road Equipment	1.0	33%
Locomotive	0.6	19%
Cargo Handling Equipment	0.4	13%
Other and Stationary Sources	-	-
Total	**3.1**	**100%**

The difference in total is due to rounding off.

Diesel PM is not the only toxic air contaminant (TAC) emitted at the BNSF Commerce Eastern Railyard. A relatively small amount of gasoline TACs are also emitted as a result of activities at the railyard such as gasoline-powered vehicles and engines, including benzene, isopentane, toluene etc. The detailed emission inventories for these TACs are presented in the Commerce Eastern Railyard TACs Emission Inventory

Report and Air Dispersion Modeling Assessment of Air Toxic Emissions from BNSF Commerce Eastern Intermodal Railyard report by ENVIRON International Corporation (ENVIRON 2006). The total amount of these toxic air contaminant emissions is about one pound per year, which are significantly less than the diesel PM emissions in the railyard (3 tons per year). Based on the potency weighted toxic emission estimates (see a similar analysis for off-site air toxic contaminants in Table II-3) these TACs have substantially lower levels of potential cancer risks as compared to diesel PM, the predominant emissions at the BNSF Commerce Eastern Railyard. Hence, only diesel PM emissions are presented in the on-site emission analysis.

1. On-Road Truck and Vehicles

As shown in Table III-3, on-road container trucks are the largest diesel PM emission sources at the BNSF Commerce Eastern Railyard. The BNSF Commerce Eastern Railyard primary operations are cargo container services. Tractor-trailers trucks receive or deliver containers to the container yard (i.e., the intermodal area at the BNSF Commerce Eastern Railyard). Diesel PM emissions due to on-road container truck travel at the BNSF Commerce Eastern Railyard were estimated using emission factors from the draft EMFAC2005 model provided by ARB (2006c) and is based on average railyard travel distance.

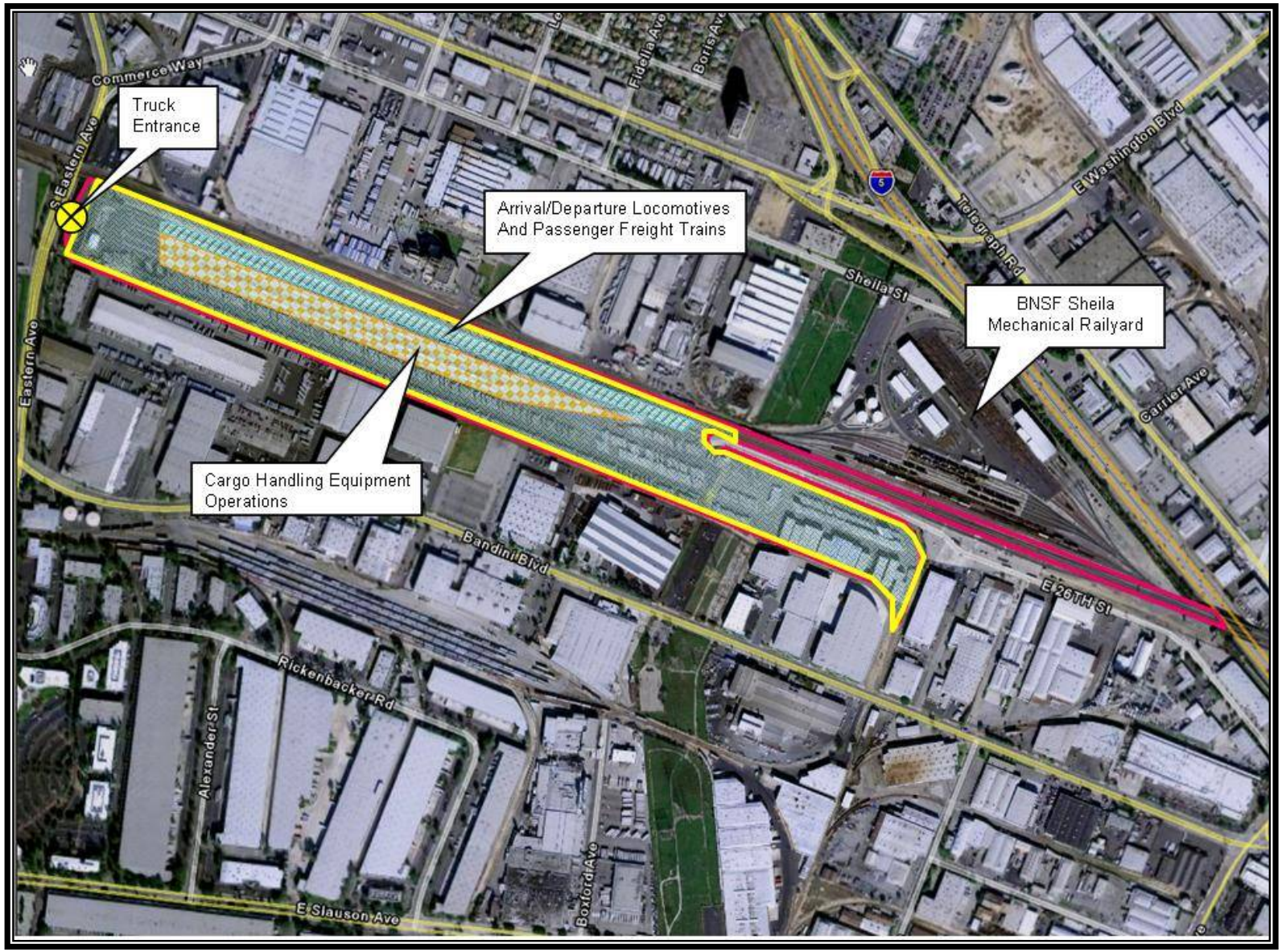
Diesel PM emissions from the on-road trucks operating within the railyard are shown in Table III-3. Heavy Heavy Duty (HHD) diesel fueled trucks were the only source for these emissions. Estimated diesel PM emissions from on-road container trucks are 1.14 tons per year. Two-thirds of the HHD truck diesel PM emissions were emitted while they are traveling in the railyard and the rest of the emissions, are about 0.39 tons per year, while they were idling. On-road fleet vehicles included employee vehicles owned by BNSF and road-legal vehicles owned by BNSF (i.e., passenger vehicles and small trucks) used for both on-site and off-site travel.

Table III-3: On-Road Container Trucks Diesel PM Emissions

On-Road Trucks and Vehicles	Source	Diesel PM Emissions (Tons Per Year)		
		Traveling	Idling	Total
On-Road Container Trucks	HHD Diesel-Fueled Trucks**	0.75	0.39	1.14
On-Road Fleet Vehicles	LDT+LHDT	0.0	0.0	0.00
	Total	0.75	0.39	1.14
Percent of Total On-Road Truck Emissions		**66%**	**34%**	**100%**

**HHD: Gross Vehicle Weight Rating: 33,001 lbs or more.

Figure: III-1: Emission Source Locations at BNSF Commerce Eastern Railyard.



In January of 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 percent reduction of oxides of nitrogen emissions, 72 percent reduction of non-methane hydrocarbon emissions, and 90 percent reduction of particulate matter emissions compared to the 2004 model year emission standards. Therefore starting from 2007, the BNSF Commerce Eastern Railyard will benefit from these measures as diesel PM emissions from heavy-duty diesel fueled trucks are gradually reduced as truck fleets turnover.

2. Off-Road Equipment/Vehicles

Diesel PM emissions from off-road equipment are shown in Table III.4. Off-road equipment at the BNSF Commerce Eastern Railyard was categorized into two main types of equipment: Transportation Refrigeration Units (TRUs) and track maintenance equipment. TRUs are used to regulate temperatures during the transport of products with temperature requirements. Container TRUs are responsible for almost 99% of total off-road diesel PM emissions, at 0.96 tons per year. Track maintenance equipment includes equipment used to service tracks anywhere in California, though it may be housed at any given facility. This equipment category includes large and small engines and they contribute about 1% of diesel PM emissions from off-road equipment.

Table III-4: Diesel PM Emissions from Off-Road Equipment

Equipment Type	Diesel PM Emissions (tons per year)	Percent of Total Emissions
Container TRUs	0.96	99%
Off-Road Track Maintenance	0.01	1%
TOTAL	**1.00***	**100%**

*Numbers may not add precisely due to rounding-off**.**

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. Therefore starting in 2009, the BNSF Commerce Eastern Railyard will benefit from these mitigation measures as diesel PM emissions from TRUs are gradually reduced as their fleets turnover.

3. Locomotives

BNSF Commerce Eastern Railyard locomotive emissions are divided into four categories:

1) Freight Trains arriving and departing from the railyard
2) Switch locomotives moving railcars within the railyard
3) Freight trains passing through the railyard on the adjacent main line
4) Passenger trains (i.e., AMTRAK and Metrolink) passing through the railyard on the adjacent mainline.

Freight trains, carrying cargo containers, that arrive and depart from the railyard and switch locomotives that move railcars within the railyard combined accounted for about 78% of the locomotive diesel PM emissions. Freight and passenger trains that pass through the railyard on the adjacent mainline accounted for the other 22% of the locomotive diesel PM emissions as shown in Table III-5.

Table III-5: Diesel PM Emissions by Locomotive Activity

Operation Activity	Diesel PM Emissions	
	Tons per year	Percentage of Total
Arriving and Departing Trains	0.22	40%
Yard Operations (Switching)	0.21	38%
Adjacent freight Movement	0.10	18%
Adjacent Commuter Rail Operations	0.02	4%
Service/Maintenance	N/A**	N/A**
Total	**0.6***	**100%**

*Numbers may not add precisely due to rounding-off.
**Not applicable.

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 has been discussed in Chapter 2. Therefore in the future, the BNSF Commerce Eastern Railyard will benefit from these mitigation measures as diesel PM emissions from locomotives are gradually reduced as the locomotive fleet turnovers.

4. Cargo Handling Equipment

Cargo handling equipment (CHE) is used to move intermodal freight and containers at the BNSF Commerce Eastern Railyard. Three types of equipment were included in cargo handling equipment: yard hostlers, cranes, and container handling equipment.

- Yard hostler is also known as a yard truck. It is the most common type of cargo handling equipment. Yard hostler is very similar to an on-road truck tractor but is designed to move cargo containers within the yard.
- Cranes are used to lift containers.
- Container handling equipment is used to handle containers.

The diesel PM emissions due to cargo handling equipment activities at the BNSF Commerce Eastern Railyard were estimated using the latest version of ARB cargo handling equipment model (ARB, 2006d). The total diesel PM emissions from cargo handling equipment was estimated at about 0.37 tons per year. As indicated in Table III-6, about 51% of cargo handling equipment diesel PM emissions were due to the yard hostlers, at about 0.19 tons per year. The cranes emit about 43% of the total cargo handling equipment diesel PM emission (0.16 tons per year). The remaining 6% of cargo handling equipment diesel PM emissions were emitted by container handling equipment. Additional details of calculations or estimations are presented in ENVIRON International Corporation report.

Table III-6: Diesel PM Emissions by Cargo Handling Equipment

Cargo Handling Equipment	Diesel PM Emissions	
	Tons Per Year	Percent of Total
Yard Trucks	0.19	51%
Cranes	0.16	43%
Container Handling Equipment	0.02	6%
Total	**0.4***	**100%**

*Numbers may not add precisely due to rounding-off.

In December 2005, ARB adopted a new regulation for cargo handling equipment to reduce diesel PM and NOx emissions beginning in 2007. Implementation of this regulation will reduce diesel PM emissions by approximately 40% in 2010 and 65% in 2015, and NO_x emissions by approximately 25% in 2010 and 50% in 2015. The regulation, when fully implemented, is expected to cumulatively reduce diesel PM and NO_x emissions from all cargo handling equipment in the State by up to 80 percent by

2020. Therefore, starting in 2007, the BNSF Commerce Eastern Railyard will benefit from these mitigation measures.

B. Current Available Diesel Fuel Regulations and Their Benefits to the Railyards

1. California Air Resources Board (CARB) Diesel Fuel Specifications

The original 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 percent for small refiners to reduce emissions of both PM and NOx.

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 ppm/w beginning in June 2006. Thus, ARB's specifications for sulfur and aromatic hydrocarbons are shown in Table III-7.

Table III-7: California Diesel Fuel Standards

Implementation Date	Maximum Sulfur Level (ppm/w)	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 percent 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 benefits at a lower cost.

2. U.S. EPA On-Road Diesel Fuel Specifications

The United States Environmental Protection Agency (U.S. EPA) established separate diesel fuel specifications for on-road diesel fuel and off-road (non-road) diesel fuel. The former 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 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 percent 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 diesel fueled vehicles. The current U.S. EPA on-road diesel fuel standard is shown in Table III-8.

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.

Table III-8: 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.

4. What are the Current Properties of In-Use Diesel Fuel?

Table III-9 shows average values for sulfur and four other properties for motor vehicle diesel fuel sold in California after the California and Federal diesel fuel regulations 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 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 percent by volume in-use.

Table III-9: 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, 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.

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 percent 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 onroad diesel fuels to interstate locomotives that fuel in California beginning on January 1, 2007.

Line haul locomotives have a range of about 800 to 1,200 miles between fuelings. 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 percent remaining volume of diesel fuel relative to their tank capacity.

UP and BNSF surveyed each of the California fueling 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 onroad, and nonroad 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 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 fuel limits for used in locomotives and marines will drop from 500 ppmw to 15 ppmw.

The NOx 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 percent by volume or an emission equivalent alternative formulation limit. ARB staff estimates that use of CARB diesel provides a 6 percent reduction in NOx and a 14 percent 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 percent 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 SOx emission reductions, and additional PM emission reductions by reducing indirect (secondary formation) PM emissions formed from SOx.

In addition, the ARB, UP and BNSF Railroads entered into an agreement in 2005 which requires at least 80 percent 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 Potential Overall Benefits from the Use of Lower Sulfur Diesel Fuels?

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 onroad 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 percent or by about 6.4 tons per day from 2000 levels. Direct diesel particulate matter emissions would be reduced by about 4 percent, or about 0.6 tons per year in 2010 for engines not equipped with advanced particulate emissions control technologies. U.S. EPA onroad 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, NOx emissions would be reduced by 7 percent or about 80 tons per year for those engines not currently using CARB diesel, assumed to be about 10 percent 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 NOx can be reduced by up to 90 percent. Significant reductions of non-methane hydrocarbons and carbon monoxide can also be achieved with these control devices.

C. Off-Site Diesel PM Emissions Summary

ARB staff analyzes the significant off-site emission sources based on two categories: mobile and stationary. The off-site emissions were estimated for the sources within a two-mile distance from the joint boundaries of the four Commerce railyards.

1. Mobile Sources

For the off-site mobile sources, the analysis focused on 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 two-mile distance from the joint boundaries of the four Commerce railyards are included in the analysis. The estimates do not include the diesel PM emissions generated from other modes such as extended idling, starts, tire and break wear, 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. Within a two-mile distance from the joint boundaries of the four Commerce railyards, off-site diesel PM emissions are predominantly generated by mobile sources which emit around 113 tons per year. The majority of the off-site diesel PM emissions are from diesel-fueled heavy duty trucks traveling on freeways I-5, I-710, CA-60, I-10 and major local streets.

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.

The diesel PM off-site 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-10. For the year 2005, the total diesel PM emissions are estimated at about 113.2 tons per year with 99% from heavy-heavy duty and medium heavy duty trucks. The two truck classifications account for about 92.7 and 19 tons per year, respectively.

Table III-10: Diesel PM Emissions for Off-site Mobile Sources by Vehicle Types.

Vehicle Types of Off-Site Mobile Diesel PM Sources	Gross Vehicle Weight (pounds)	Tons per Year	Percent of Total
Light-Heavy Duty Diesel Trucks	8,501-14,000	1.5	1%
Medium-Heavy Duty Diesel Trucks	14,001-33,000	19.0	17%
Heavy-Heavy Duty Trucks	> 33,000	92.7	82%
Total	**-**	**113.2**	**100%**

As shown in Table III-11, the four freeways, I-5, I-710, CA-60, I-10 contribute approximately 75.3 tons per year of diesel PM emissions, which account for over 66% of total mobile sources diesel PM emissions. The methodology for mobile diesel PM emission estimation is presented in Appendix A.

ARB staff also estimates the diesel PM emissions by HHD trucks traveling between the UP Commerce Railyard gate and the major freeway (I-710). These emissions are estimated at about 1.37 tons per year, which are not part of railyard diesel PM emissions, but contribute about 1.2% of the off-site diesel PM emissions. The detailed methodology and calculations are presented in Appendix E.

Table III-11: Off-site Mobile Source Diesel PM Emissions by Freeways

Sources	Diesel PM Emissions	
	Tons per year	Percent of Total Off-site Mobile Sources
I-5 Freeway	40.0	35%
I-710 Freeway	15.1	13%
CA-60 Freeway	15.5	14%
I-10 Freeway	4.7	4%
Local Streets	37.9	34%
Total	**113.2**	**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 two-mile distance from the joint boundaries of the four Commerce 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 a two-mile distance from the joint boundaries of the four Commerce railyards, the diesel PM emissions from stationary sources are estimated at about 0.19 tons per year, or less than 1% of the total off-site diesel PM emissions. Three major stationary sources, Los Angeles City Department of General Services, City of Vernon Light & Power Department, and Los Angeles County Sheriff's Department contribute almost 300 pounds per year of the diesel PM emissions.

ARB staff also evaluated other toxic air contaminant (TACs) emissions around the BNSF Commerce Eastern Railyard. There are 2,620 stationary TAC sources identified within the two-mile distance from the joint boundaries of the four Commerce railyards. The total emissions of TACs other than diesel PM emitted from these stationary sources were estimated at about 210 tons per year. Over 100 TAC species are identified among these emissions, in which ammonia, toluene and methyl chloroform are three major contributors with emissions estimated at 57, 25, and 24 tons per year, respectively.

Not all of these TACs are identified as carcinogens. According to ARB' *Risk Reduction Plan to Reduce Particulate Matter Emissions from Diesel-Fueled Engines and Vehicles* (ARB, 2000), diesel PM, 1,3-butadiene, benzene, carbon tetrachloride, formaldehyde

are defined as the top 5 cancer risk contributors, which account for 95% of the state's estimated potential cancer risk levels (ARB, 2000). This study also concluded that diesel PM contributes over 70% percent of the state's estimated potential cancer risk levels, which are significantly higher than other TACs (ARB, 2000). Among the off-site TACs emissions, the top 5 cancer risk contributors other than diesel PM were estimated at about 1.6 tons per year.

The Office of Environmental Health Hazard Assessment (OEHHA) has calculated an inhalation cancer potency factor (CPF) for each hazardous compound. The four compounds listed here are given a weighing factor by comparing each compound's CPF to the diesel PM CPF. This factor is multiplied by the estimated actual emissions for that compound, which gives the potency weighted toxic emission as shown in Table III-12. As seen in Table III-12 the potency weighted toxic emissions for these TACs are about 0.07 tons per year, which is substantially less than off-site diesel PM emissions.

Cancer potency factors (CPF) are expressed as the upper bound probability of developing cancer 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 detailed methodology of off-site stationary source emissions is presented in Appendix B.

Table III-12: Potency Weighted Toxic Emissions from Significant Off-Site Stationary Sources Surrounding BNSF Commerce Eastern Railyard.

Compound	Cancer Potency Factor	Weighted Factor	Actual Emission (tons/year)	Potency Weighted Toxic Emission (tons/year)
Diesel PM	1.1	1	113.2	**113.2**
1,3-Butadiene	0.6	0.55	0.007	**0.0037**
Benzene	0.1	0.09	0.435	**0.0392**
Carbon Tetrachloride	0.15	0.14	0.001	**0.0001**
Formaldehyde	0.021	0.02	1.159	**0.0220**
Total (non-diesel PM)	**-**	**-**	**1.602***	**0.065***

*Numbers may not add up precisely due to rounding.

In addition, ARB staff evaluated the potential cancer risk levels caused by the use of gasoline in the South Coast Air Basin. Table III-13 shows the emissions of four major carcinogen compounds of gasoline exhausts in South Coast Air Basin in the year of 2005 (ARB, 2006a). As indicated in Table III-13, the potency weighted emissions of

these four toxic air contaminants from gasoline sources are estimated at about 816 tons per year, or about 11% of diesel PM emissions in South Coast Air Basin. If only gasoline-powered vehicles are considered, the potency weighted emissions of these four TACs are estimated at about 438 tons per year, or about 6% of diesel PM emissions in the Basin. Hence, gasoline-powered vehicular sources are not included in the analysis.

Table III-13: Emissions of Major Toxic Air Contaminants from Gasoline Exhausts in South Coast Air Basin

Compound	TACs Emissions (tons/year)			
	From All Sources	Potency Weighted**	From Gasoline Vehicles	Potency Weighted**
Diesel PM	*7,446*	***7,446***	-	-
1,3-Butadiene	695	**382**	420	**231**
Benzene	3,606	**325**	2,026	**182**
Formaldehyde	4,623	**92**	1,069	**21**
Acetaldehyde	1,743	**16**	314	**3**
Total (non-diesel PM)	10,668	**816**	3,829	**438**

*: Based on cancer potency weighted factors.

IV. AIR DISPERSION MODELING FOR THE BNSF COMMERCE EASTERN RAILYARD

In this chapter, ARB staff presents the air dispersion modeling performed to estimate the transport and dispersion of diesel PM emissions resulting from the sources in and around the BNSF Commerce Eastern Railyard. A description of the air quality modeling parameters is listed, including air dispersion model selection, emission source characterizations, meteorological data, model receptor network, and building wake effects. ARB staff also describes model input preparation and output presentation.

A. Air Dispersion Model Selection

Air dispersion models are often used to simulate atmospheric processes for applications where the spatial scale is in the tens of meters to tens of kilometers. Selection of air dispersion models depends on many factors, such as characteristics of emission sources (point, area, volume, or line), the type of terrain (flat or complex) at the emission source locations, and source-receptor relationships. For the BNSF Commerce Eastern Railyard, ARB staff selected the U.S. EPA's newly approved air dispersion model AERMOD to estimate the impacts associated with diesel PM emissions in and around the railyard. AERMOD stands for American Meteorological Society / Environmental Protection Agency Regulatory Model Improvement Committee (**AER**MIC) **MOD**EL. It is a state-of-science air dispersion model and is a replacement for its predecessor, the U.S. EPA Industrial Sources Complex (ISC) air dispersion model.

AERMOD has become a U.S. EPA regulatory dispersion model specified by the *U.S. EPA Guideline for Air Quality Methods (*40 CFR Part 51, Appendix W*)* (U.S. EPA, 2005). AERMOD is also the recommended model in the ARB's *Health Risk Assessment Guidance for Railyard and Intermodal Facilities* (ARB, 2006d).

AERMOD is a steady-state plume model that incorporates current concepts about 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. These approaches have been designed to be physically realistic and simple to implement.

B. Source Characterization and Parameters

The emission sources from the locomotives and other mobile sources at the BNSF Commerce Eastern Railyard are characterized as either a point source or a volume source depending on whether they are stationary or moving. When a mobile source is stationary, such as when it is idling or undergoing load testing, the emissions are simulated as a series of point sources. Model parameters for point sources include emission source height, diameter, exhaust temperature, exhaust exit velocity, and emission rate.

When a mobile source is traveling, the emissions are simulated as a series of volume sources to mimic the initial lateral dispersion of emissions by the exhaust stack's movement through the atmosphere. Key model parameters for volume sources include emission rate (strength), source release height, and initial lateral and vertical dimensions of volumes.

The emissions from all 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.

The emission rates for individual locomotives are a function of locomotive type, notch setting, activity time, duration, and operating location. Emission source parameters for all locomotive model classifications at the railyard include emission source height, diameter, exhaust temperature, and exhaust velocity. Detailed information on the emission source parameters is presented in ENVIRON International Corporation Report. Because the stationary locomotives were not uniformly distributed throughout the railyard, 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 BNSF Railway.

C. Meteorological Data

In order to run AERMOD, the following hourly surface meteorological data are required: wind speed, wind direction, ambient temperature, ceiling height, and opaque cloud cover. In addition, the daily upper air sounding data need to be provided (U.S.EPA, 2004b).

These meteorological variables are important to describe the air dispersion in the atmosphere. The wind speed determines how rapidly the pollutant emissions are diluted and influences the rise of emission plume in the air, thus affecting downwind concentrations of pollutants. Wind direction determines where pollutants will be transported. The difference of ambient temperature and the emission releasing temperature from sources determines the initial buoyancy of emissions. In general, the greater the temperature difference, the higher the plume rise. The opaque cloud cover and upper air sounding data are used in calculations to determine other important dispersion parameters. These include atmospheric stability (a measure of turbulence and the rate at which pollutants disperse laterally and vertically) and mixing height (the vertical depth of the atmosphere within which dispersion occurs). The greater the mixing height is, the larger the volume of atmosphere is available to dilute the pollutant concentration.

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.

In this study, to ensure consistency between the UP and BNSF air dispersion modeling analyses for railyards in the Commerce area, the meteorological data used for BNSF Commerce Eastern Railyard was the same as that selected by UP for their nearby Railyards (ENVIRON, 2006). The area surrounding the BNSF Commerce Eastern Railyard is generally flat and would not be expected to exhibit significant variations in wind patterns within relatively short distances. The dominant terrain features/water bodies that may influence wind patterns in this part of the Los Angeles Basin include the hills to the north and east and the Pacific Ocean further to the west. Meteorological stations that collect wind speed, wind direction, temperature, and pressure data that may be appropriate for AERMOD located within a 10km radius of the BNSF Commerce Eastern Railyard include: Lynwood, Los Angeles-North Main, and Pico Rivera stations, operated by ARB; and Los Angeles Downtown University of Southern California (USC) Campus station, operated by National Weather Service (NWS).

Windrose: a rose-like shape plot that depicts wind speed and direction patterns to illustrate prevailing wind conditions.

ENVIRON evaluated these four meteorological stations and identified that the Pico Rivera station and Los Angeles-North Main Street station appear to be influenced by local terrain variation due to the nearby hills (local topography). Based on ARB criteria for representativeness (ARB, 2006d), the Lynwood station was chosen as the most representative meteorological station for the BNSF Commerce Eastern Railyard. However, the Lynwood station did not record temperature and cloud cover data from 2000 to 2005. Therefore, hourly wind speed and direction data from the Lynwood station, and temperature and cloud cover data from the Los Angeles downtown USC station were selected to be used in the AERMOD. The upper air sounding data were chosen from the San Diego-Miramar NAS stations (ENVIRON, 2006). Detailed meteorological data selection is discussed in *Meteorological Data Selection and Processing Methodology for 2006 BNSF Designated Rail Yards* (ENVIRON, 2006).

It should be noted that Commerce is substantially closer to the major elevated terrain features to the north than the Lynwood meteorological site, resulting in the possibility that prevailing winds at the railyard (and the areas of higher concentrations) are shifted from the northeast to more easterly directions.

According to ARB railyard health risk assessment guidelines (ARB, 2006d), five years of the meteorological data are recommended to be used in the air toxic health risk assessment. For this study, four years (2002 through 2005) of meteorological data from Lynwood and USC stations were processed (ENVIRON, 2006 available). The detailed procedures of meteorological data preparation and the quality control procedures are documented in the modeling report by ENVIRON International Corporation.

Figure IV-1 presents the wind rose and Figure IV-2 provides the wind class frequency distributions for the meteorological data used in the BNSF Commerce Eastern Railyard

air dispersion modeling. The yearly average wind speed is 1.3 meter per second. The prevailing wind over the modeling domain blows from southwest to northeast.

Figure IV-1: Windrose Plot for BNSF Commerce Eastern Railyard from Lynwood Station In 2005

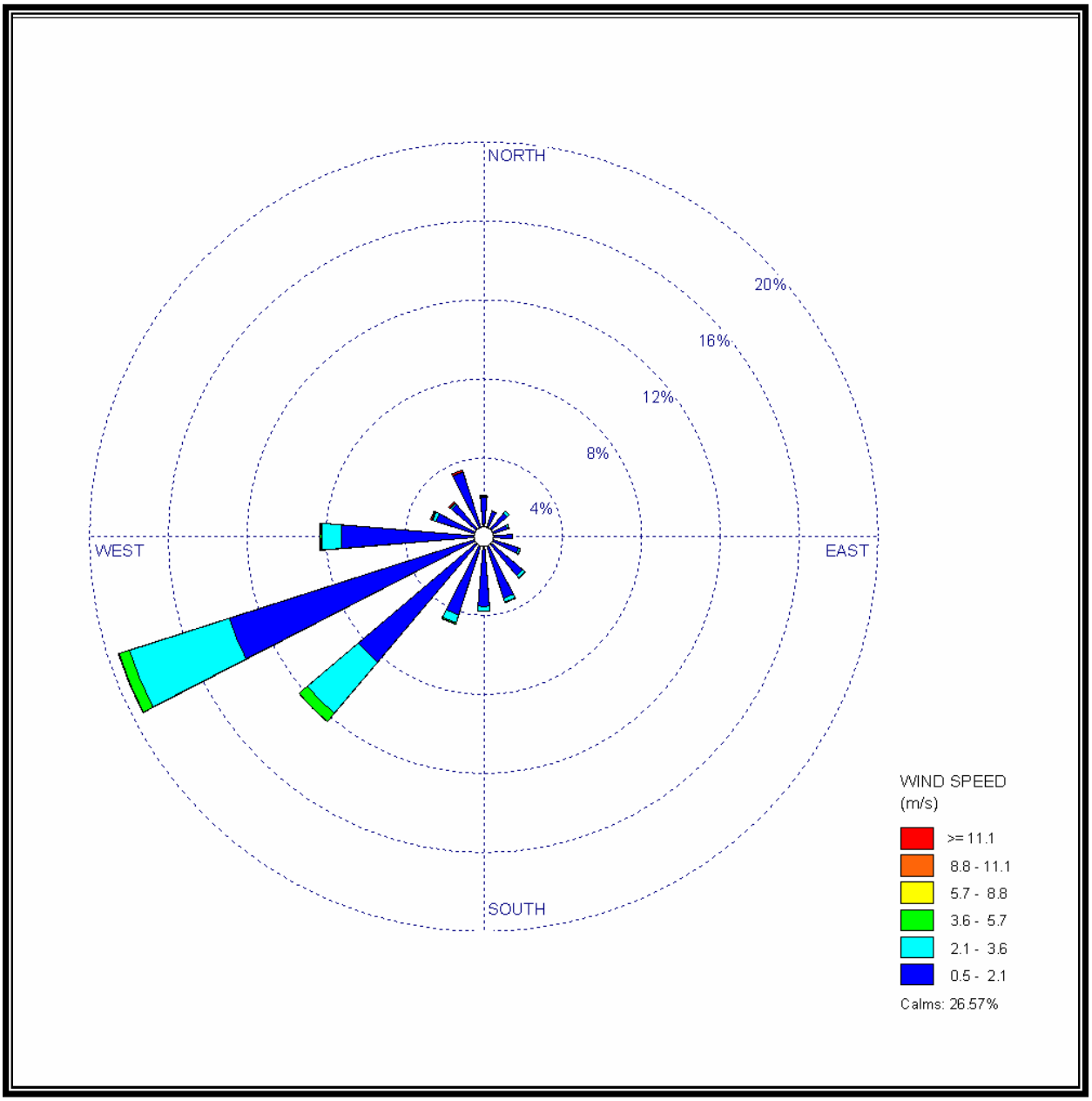
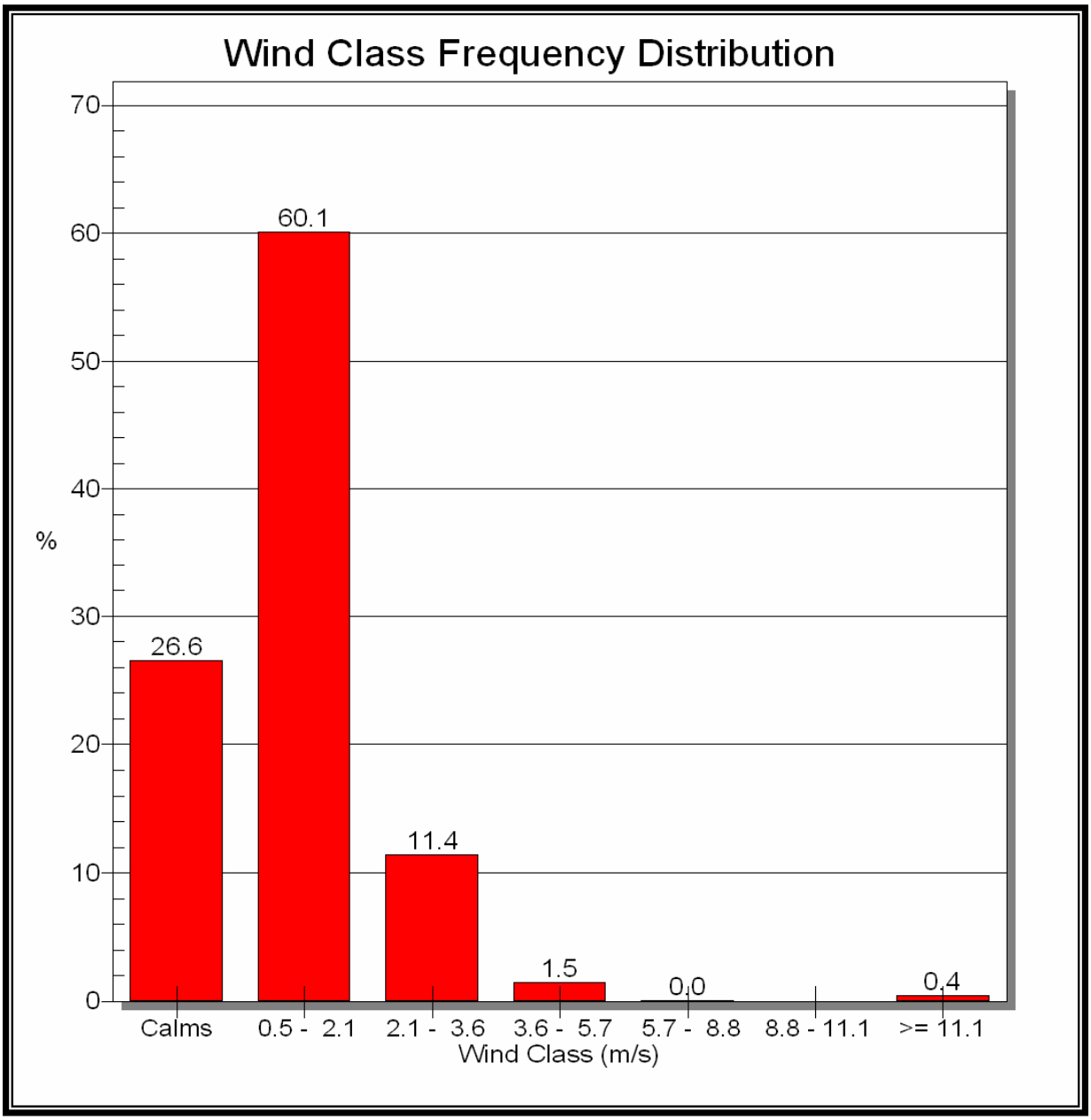


Figure IV-2: Wind Class Frequency Distribution for the BNSF Commerce Eastern Railyard from the Lynwood Meteorological Station for 2002– 2005.



The detailed procedures of meteorological data preparation and quality control are described in ENVIRON International Corporation Report.

D. Model Receptors

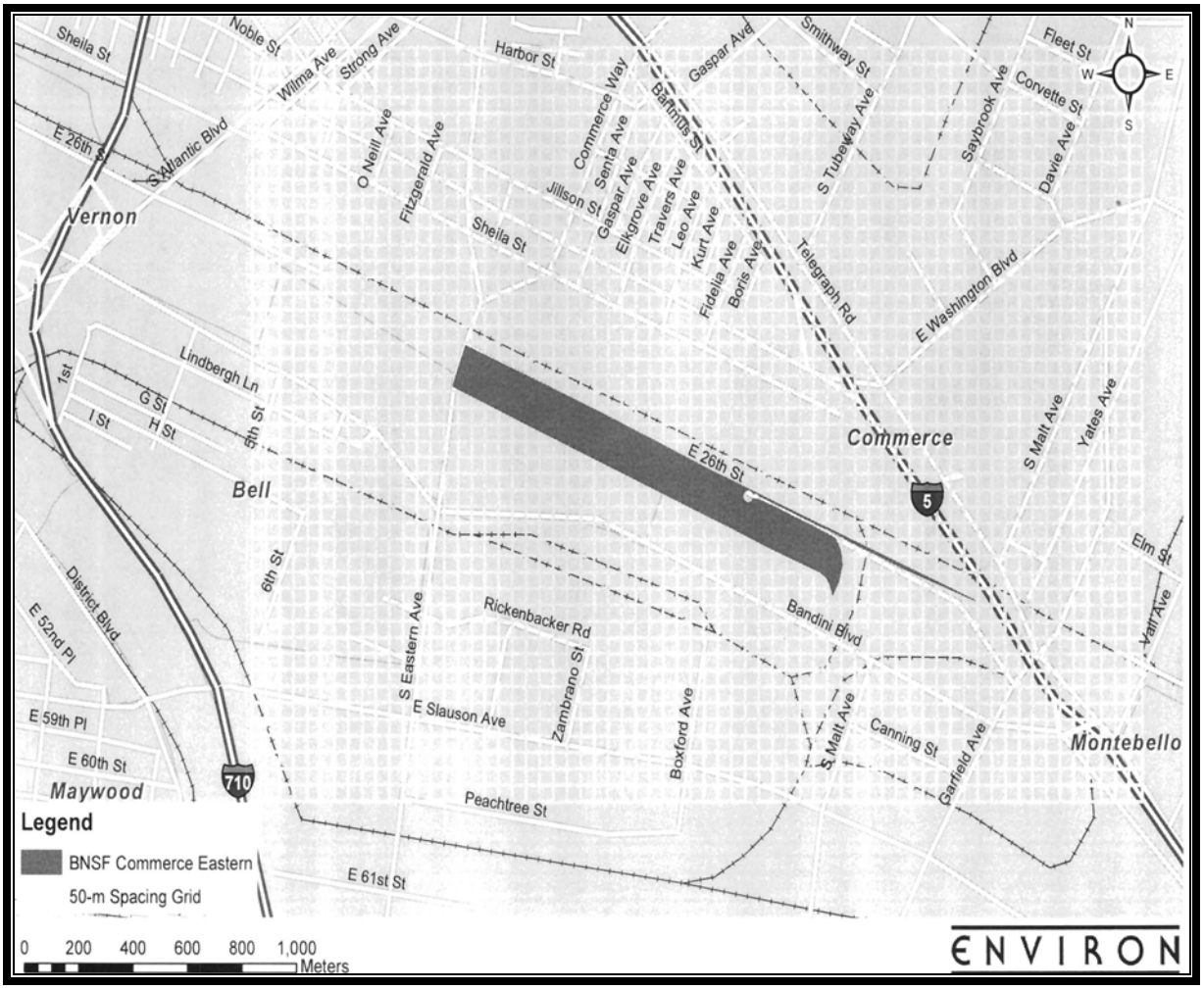
Model receptors are the defined discrete locations where concentrations are estimated by the dispersion model. A Cartesian UTM grid receptor network is used in this study where an array of points are identified by their x and y coordinates. This receptor network is capable of identifying the emission sources within the railyard with respect to

the receptors in the nearby residential areas. The modeling domain is defined as a 20 x 20 kilometer region, which covers the yard in the center of domain and extends to the surrounding areas. To better characterize different dispersive levels of concentrations from the railyard, different modeling grid structures were defined:

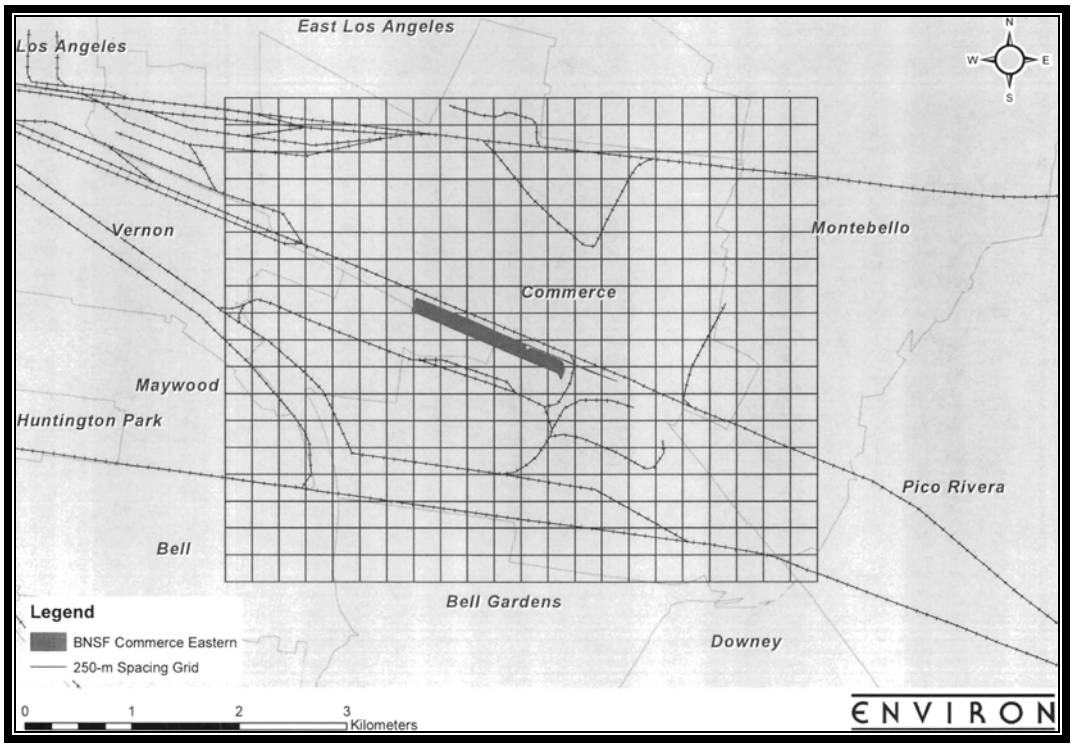
- A fine grid receptor network within 500 m (m: meter) of the facility boundary with receptor spacing of 50 m apart.
- A medium grid receptor network between 1500 m with receptor spacing of 250 m apart.
- A coarse receptor network between 8500 m with receptor spacing of 500 m apart.

Figure IV-3: The Receptor Grid Networks of Air Dispersion Modeling at the BNSF BNSF Commerce Eastern Railyard

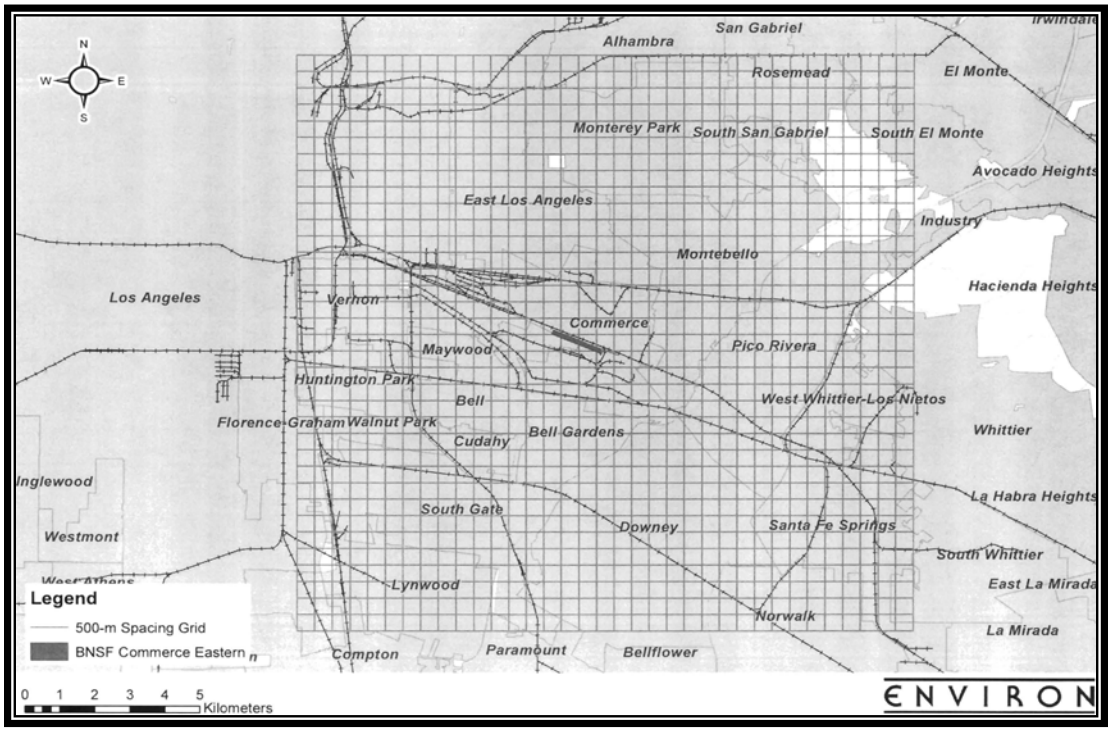
A: Fine Grid



B: Medium Grid



C: Coarse Grid



E. Building Wake Effects

If pollutant emissions are released at or below the "Good Engineering Practice" height as defined by U.S. EPA Guidance (U.S. EPA, 2004a), 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--Plume Rise Model Enhancements-- to account for potential building-induced aerodynamic downwash effects. In this study, the building downwash effects were considered. Detailed treatments of building downwash effects can be found from ENVIRON International Corporation Report.

F. Model Implementation Inputs

AERMOD requires four types of basic implementation inputs: control, source, meteorological, and receptor. Control inputs are required to specify the overall job control options for the model run, such as dispersion option, pollutant species, averaging time, etc. Source inputs require source identification and source type (point or volume). Each source type requires specific parameters to define the source. For example, the required inputs for a point source are emission rate, release height, emission source diameter, exhaust exit temperature, and exhaust exit velocity.

Meteorological and receptor inputs have been discussed in Sections C and D. The requirements and the format of input files to the AERMOD are documented in the user's guide of AERMOD (U.S. EPA, 2004b). The model input files for this study is provided in ENVIRON International Corporation Report.

V. HEALTH RISK ASSESSMENT OF THE BNSF COMMERCE EASTERN RAILYARD

This chapter discusses how to characterize potential cancer and non-cancer risks associated with exposure to toxic air contaminants (TACs), especially diesel PM, emitted in and around the BNSF Commerce Eastern Railyard. In addition, the detailed health risk assessment (HRA) results are presented and the associated uncertainties are discussed qualitatively.

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A. ARB Railyard Health Risk Assessment Guidelines

The railyard HRA follows *The Air Toxics Hot Spots Program Risk Assessment Guidelines* published by the Office of Environmental Health Hazard Assessment (OEHHA), and is consistent with ARB's UP Roseville Railyard Study. The Office of Environmental Health Hazard Assessment (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 a risk assessment when site-specific information is available and is more representative than the Tier 1 point-estimates.
- Tier 3: a stochastic approach for exposure assessment when the data distribution is available.
- Tier 4: also a stochastic approach, but allows for utilization of site-specific data distribution.

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 percetile breathing rate is a value such that the breathing rates from 65 percent of population are less or equal to it.

The draft Health Risk Assessment is based on the yard specific emission inventory and air dispersion modeling predictions. The Office of Environmental Health Hazard Assessment (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 in 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 Office of Environmental Health Hazard Assessment (OEHHA) guidelines (OEHHA, 2000). 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.

The ARB has also developed draft *Health Risk Assessment Guidance for Railyard and Intermodal Facilities* to help ensure that the air dispersion modeling and HRA performed for each railyard meet the OEHHA guidelines.

B. Exposure Assessment

Exposure assessment is a comprehensive process that integrates and evaluates many variables. Three process components have been identified to have significant impacts 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 defined exposure duration. Meteorological conditions can also have a critical impact on the resultant ambient concentration of a toxic pollutant, with higher concentrations found along the predominant wind direction and under calm wind conditions. An individual's proximity to the emission plume, how long he or she breathes the emissions (exposure duration), and the individual's breathing rate play key roles in determining potential risk. The longer the exposure time for an individual is, the greater the potential risk for the individual is estimated. . The risk assessment adopted in this study generally assumes that the receptors 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 pollutant concentration of diesel PM, the cancer risk will decrease proportionately. Children have a greater risk than adults because they have greater exposure on a per unit body weight basis and also because of other factors.

Diesel PM is not the only toxic air contaminant (TAC) emitted from the BNSF Commerce Eastern Railyard. A relatively small amount of gasoline TACs are generated from some of the gasoline fleet vehicles and two of the track maintenance vehicles. However, the total amount of these TACs emissions is about <1 pound per year, which are significantly less than the diesel PM emissions in the railyard. In addition, most of these TACs are not identified as carcinogen (OEHHA, 2003). Therefore, these TACs have substantially lower levels of potential cancer risks as compared to diesel PM, the predominant emissions at the BNSF Commerce Eastern Railyard. Detailed results and analysis are presented in ENVIRON International Report.

ARB staff also evaluated other toxic air contaminant (TACs) emissions around the BNSF Commerce Eastern Railyard. There are 2,620 stationary toxic air contaminant sources identified within the two-mile distance from the joint boundaries of the four Commerce railyards. The total emissions of toxic air contaminant s, other than diesel PM emitted from these stationary sources, were estimated at about 210 tons per year. Over 100 toxic air contaminant species are identified among these emissions, in which ammonia, toluene and methyl chloroform are the three major contributors with emissions estimated at 57, 25, and 24 tons per year, respectively. 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% percent of the state's estimated potential cancer risk levels, which are significantly higher than other TACs (ARB, 2000). Among the off-site TACs emissions, the top 5 cancer risk contributors (without diesel PM) were estimated at about 1.6 tons per year.

The OEHHA has estimated an inhalation cancer potency factor (CPF) for individual chemicals and some chemical mixtures such as whole diesel exhaust. Diesel PM contains many individual cancer causing chemicals. The individual cancer causing chemicals from diesel exhaust are not separately evaluated so as to avoid double counting. The four compounds listed here are given a weighing factor by comparing each compound's CPF to the diesel PM CPF. This factor is multiplied by the estimated emissions for that compound, which gives the potency weighted toxic emission as shown in Table V-1. As shown in the table, the potency weighted toxic emissions for these TACs are about 0.07 tons per year, or about 140 pounds per year, which are substantially less than diesel PM emissions, and are not included in the report. Detailed results and analysis are presented in Appendix B. As such, the health impacts in this study primarily focus on the risks from the diesel PM emissions.

Table V-1: Potency Weighted Toxic Emissions from Significant Off-Site Stationary Sources Surrounding BNSF Commerce Eastern Railyard

Compound	Cancer Potency Factor	Weighting Factor	Actual Emission (tons/year)	Potency Weighted Toxic Emission (tons/year)
Diesel PM	1.1	1	113.2	**113.2**
1,3-Butadiene	0.6	0.55	0.007	**0.0037**
Benzene	0.1	0.09	0.435	**0.0392**
Carbon Tetrachloride	0.15	0.14	0.001	**0.0001**
Formaldehyde	0.021	0.02	1.159	**0.0220**
Total (non-diesel PM)	-	-	**1.602**	**0.065***

*: Numbers may not add precisely due to rounding.

In addition, ARB staff evaluated the potential cancer risk levels caused by the use of gasoline in the South Coast Air Basin. Table V-2 shows the emissions of four major carcinogen compounds of gasoline exhausts in South Coast Air Basin in the year of 2005 (ARB, 2006a). As indicated in Table V-2, the potency weighted emissions of these four toxic air contaminants from all types of gasoline sources are estimated at about 816 tons per year, or about 11% of diesel PM emissions in South Coast Air Basin. If only gasoline-powered vehicles are considered, the potency weighted emissions of

these four TACs are estimated at about 438 tons per year, or about 6% of diesel PM emissions in the Basin. Hence, gasoline-powered vehicular sources are not included in the analysis.

Table V-2: Emissions of Major Toxic Air Contaminants from Gasoline Exhausts in South Coast Air Basin

Compound	TACs Emissions (tons/year)			
	From All Sources	Potency Weighted**	From Gasoline Vehicles	Potency Weighted**
Diesel PM	*7,446*	***7,446***	-	-
1,3-Butadiene	695	**382**	420	**231**
Benzene	3,606	**325**	2,026	**182**
Formaldehyde	4,623	**92**	1,069	**21**
Acetaldehyde	1,743	**16**	314	**3**
Total (non-diesel PM)	10,668	**816**	3,829	**438**

*: Based on cancer potency weighting factors.

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 entitled *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 PM CPF for assessing cancer risk is described in the OEHHA Guidelines (OEHHA, 2003). The potential cancer risk is estimated by multiplying the inhalation dose by the CPF of diesel PM, i.e., 1.1 $(mg/kg\text{-}day)^{-1}$.

C. Risk Characterization

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

Exposures to pollutants that were originally emitted into the air can also occur via different pathways as a result of 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 in this study because the risk contributions by other pathways of exposure are insignificant relative to the inhalation pathway. It should be noted that the background or ambient diesel PM concentrations are not incorporated into the risk quantification in this study. Therefore, the estimated

potential health risk in the study should be viewed as risk level above those due to the background impacts.

Because the risk characterization is an integrated process from a series of procedures, the overall associated uncertainties are also linked to the uncertainty from each procedural component. Additional details and associated uncertainty on the risk characterization are provided in the Toxic Hot Spot Program Risk Assessment Guidelines (OEHHA, 2003), and discussed in Section D.

In the following sections, the predicted cancer and non-cancer risk levels resulting from on-site and off-site emissions are presented.

1. *Risk Characterization Associated with On-Site Emissions*

a) Cancer Risk

> 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 potential cancer risk levels associated with the estimated diesel PM emissions at the BNSF Commerce Eastern Railyard are displayed by using **isopleths,** based on the 80th percentile breathing rate and 70 year exposure duration for residents. For this analysis, ARB staff elected to present the cancer risk isopleths focusing on risk levels of 10, 25, 50, 100, 250, and 500 in a million. Both Figure V-1I and Figure V-2I present these isopleths. Figure V-1 focuses on the near source risk levels and Figure V-2 focuses on the more regional impacts. In each figure, the risk isopleths are overlaid onto a satellite image of the Commerce area surrounding the BNSF Commerce Eastern Railyard, to better illustrate the land use (residential, commercial, industrial, or mixed use) of these impacted areas.

The OEHHA Guidelines specify that, for health risk assessments, the cancer risk for the maximum exposed individual at the point of maximum impact be reported. The point of maximum impact, which is defined as the receptor point with the highest cancer risk level outside of the railyard boundary, is predicted to be located on the north side right next to the yard fence line. The maximum individual cancer risk (MICR) is estimated to be 700 chances in a million at this point. The land use in the vicinity of the point of maximum impact is for industrial use. In the residential area, the highest potential cancer risk is estimated at about over 100 chances in a million. 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 yard. Therefore, given the estimated emissions, modeling settings and the assumptions applied to the risk assessment, the point of maximum impact location and maximum individual cancer risk is uncertain and should not be interpreted as a literal prediction disease incidence but more as a tool for comparison. The estimated point of maximum impact location and maximum individual cancer risk value may not be replicated by air monitoring.

As indicated by Figure V-I at the BNSF Commerce Eastern Railyard, the area with the greatest impact have an estimated potential cancer risk over 500 in a million, occurring at a very small area right next to the north side of the railyard fence line. Majority of the BNSF Commerce Eastern Railyard activities takes place in this area shown in Appendix F. At locations 400 yards outside of the BNSF Commerce Eastern Railyard boundary, the estimated cancer risks are lowered to about 250 cases in a million. At about a half mile from the BNSF Commerce Eastern Railyard boundaries, the estimated cancer risk is 100 in a million, and within a mile of the railyard boundary the estimated cancer risks are lowered to about 50 in a million as shown in figure V-2. At about two miles from the BNSF Commerce Eastern Railyard, the estimated cancer risks are lowered to about 10 in a million. Within three miles of the railyard boundaries the estimated cancer risks are 5 in a million or lower

It is important to understand that these risk levels represent the predicted risks (due to the BNSF Commerce Eastern Railyard diesel PM emissions) above the existing background risk levels. For the broader South Coast Air Basin, the estimated regional background risk level is estimated to be 720 in a million caused by diesel PM and about 1,000 in a million caused by all toxic air pollutants in the year of 2000 (ARB, 2006a).

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-age 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 Liters/Kilogram-day) and exposure for an 8-hour workday, five days a week, and 245 days a year.

Table V-3 shows the equivalent risk levels of 70- and 30-year exposure durations for exposed residents; and 40- and 9-year exposure durations for workers and school-age children, respectively. As Table V-3 shows, the 10 in a million isopleth line in Figure V-2 would become 4 in a million for exposed population with a shorter residency of 30 years, 2.5 in a million for exposed school-age children, and 2 in a million for off-site workers.

To conservatively communicate the risks, ARB staff presents the estimated cancer risk isopleths all based on 70 year resident exposure duration, even for those impacted industrial areas where no resident lives.

Table V-3: Equivalent Potential Cancer Risk Levels for 70-, 40-, 30- and 9-Year Exposure Durations

Exposure Duration (years)	Equivalent Risk Level (Chance in a million)					
70	10	25	50	100	250	500
30	4	11	21	43	107	214
9*	2.5	6.3	12.5	25	63	125
40‡	2	5	10	20	50	100

* Exposure duration for school-aged children.
‡ Exposure duration for off-site workers.

The residential areas near the BNSF Commerce Eastern Railyard are located north of the railyard. Areas located East, South and West are predominately industrial areas. Based on the 2000 U. S. Census Bureau's data the zone of impact with the estimated cancer risk over 10 cases in a million encompasses approximately 4,820 acres with 35,080 residents in this area. Table V-4 presents the exposed population and area coverage size for various impacted zones of cancer risks. Over the course of an average year, the prevailing wind patterns around the BNSF Commerce Eastern Railyard move from southwest to northeast directions where much of the areas are industrial lands. However, there is a small residential area located directly (about ¼ mile) northeast of the railyard located east of City hall, north of Washington blvd, and west of I-5. These predominate prevailing wind patterns significantly reduce the potential cancer risks associated with the BNSF Commerce Eastern Railyard diesel PM emissions by significantly reducing population exposure to those emissions.

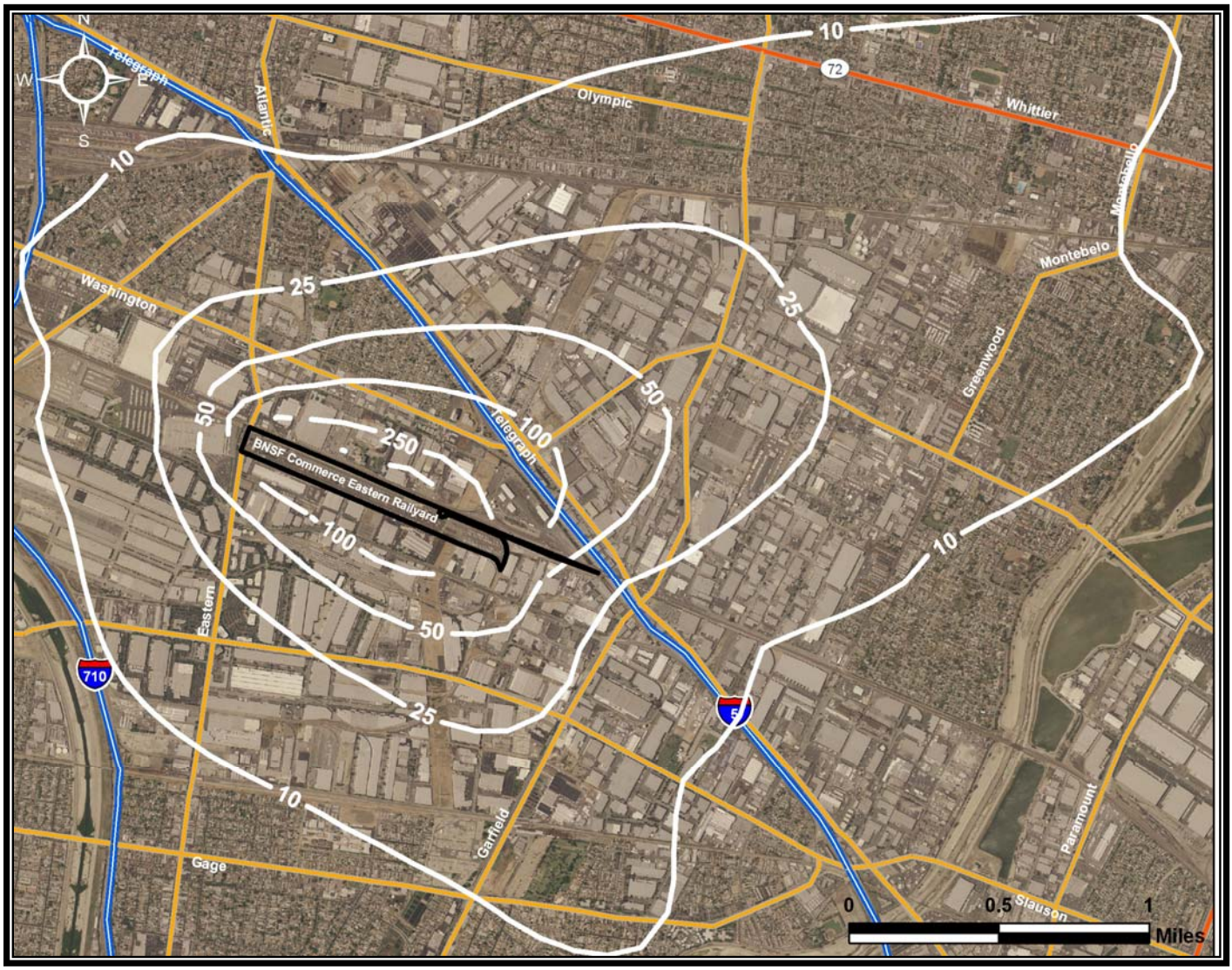
Table V-4: Estimated Impacted Areas and Exposed Population associated with Different Cancer Risk Levels Caused by Railyard Diesel PM Emissions

Estimated Risk (cases per million)	Impacted Area (Acres)	Estimated Population Exposed*
10 - 25	**3,300**	**32,100**
26 - 50	**900**	**1,360**
51 - 100	**350**	**670**
100 - 250	**270**	**950**

Based on 2000 Census Data

Figure V-1: Estimated Near-Source cancer Risks (case per million people) From the BNSF Commerce Eastern Railyard

Figure V-2: Estimated Regional Cancer Risks (chances per million) from the BNSF Commerce Eastern Railyard.



b) 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 called the dose-response assessment. According to the OEHHA guidelines, dose-response information for non-carcinogens is presented in the form of Reference Exposure Levels (RELs). OEHHA has developed chronic RELs for assessing non-cancer health impacts from long-term exposure.

A chronic REL is a concentration level, expressed in units of micrograms per cubic meter ($\mu g/m^3$) 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 (OEHHA 2003).

The methodology for developing chronic RELs is fundamentally the same as that used by U.S.EPA in developing the inhalation Reference Concentrations (RfCs) and oral Reference Doses (RfDs). Chronic RELs 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 (OEHHA 2003).

A substantial number of epidemiologic studies have found a strong association between exposure to ambient particulate matter and adverse health effects (CARB, 2002). For diesel PM, OEHHA has determined a chronic REL of 5 $\mu g/m^3$, with the respiratory system as the hazard index target (OEHHA 2003).

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

The significance of exceeding the REL 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 (OEHHA, 2003).

It is important to note that 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.

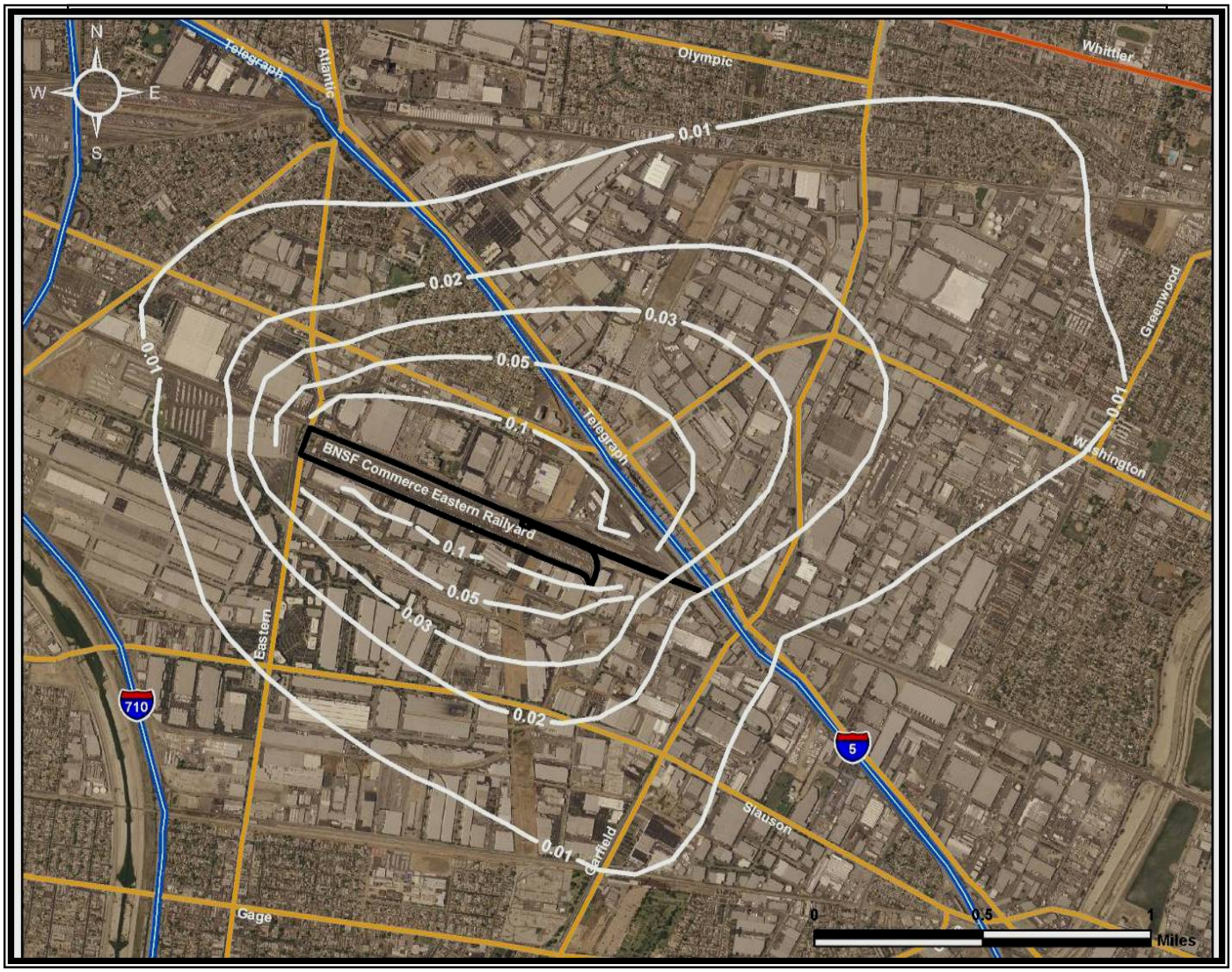
The hazard index (HI) is then calculated by taking the annual average diesel PM concentration, and dividing by the chronic REL of 5$\mu g/m^3$. An HI value of one or greater indicates an exceedance of the chronic REL.

As part of this study, ARB staff conducted an analysis of the potential non-cancer health impacts associated with exposures to the model-predicted levels of directly emitted diesel PM from on-site sources within the modeling domain. The HI values were calculated, and then plotted as a series of isopleths in Figure V-3. As can be seen, the potential non-cancer chronic health hazard index from diesel PM emissions at the BNSF

Commerce Eastern Railyard are estimated to be less than 0.4. According to OEHHA Guidelines (OEHHA, 2003) these levels indicate that the potential non-cancer chronic public health risks are less likely to happen. When all of the four Commerce Railyard studies are completed, the downwind diesel PM from the other Commerce Railyards may affect and overlap certain areas near the BNSF Commerce Eastern Railyard and possibly increase the levels of non-cancer risk.

Figure V-3 presents the spatial distribution of non-cancer chronic risks by health hazard index isopleths that rage from 0.1 to 0.01around the railyard facility. The zone of impact where non-cancer chronic health hazard indexes are over 0.01 is an estimated 1,579 acres.

Figure V-3: Estimated Non-Cancer Chronic Risk Health Hazard Index From the BNSF Commerce Eastern Railyard



c) Non-Cancer Acute Risk

According to the OEHHA guidelines, an acute reference exposure level (REL) is an exposure that is not likely to cause adverse health effects in a human population, including sensitive subgroups, exposed to that 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 a single pollutant 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 REL. 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 REL. However, acrolein is primarily used as a chemical intermediate in the manufacture of adhesives and paper. It has also been found as a byproduct of any burning process, such as fire, and tobacco smoke. Acrolein is a chemically reactive and unstable compound, and easily reacts with a variety of chemical compounds in the atmosphere. Compared to the other compounds in 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 are much higher levels of uncertainties associated with hourly-specific emission data and estimated maximum concentrations, which are essential to assess 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.

The cumulative impacts (cancer and non-cancer risks) from all four Commerce railyards are presented in a separate report.

2. *Risk Characterization Associated with Off-Site Emissions*

ARB staff evaluated the impacts from off-site pollution sources near the BNSF Commerce Eastern Railyard facility using the U.S. EPA-approved AERMOD dispersion model. Specifically, off-site mobile and stationary diesel PM emission sources located within a two-mile distance from the joint boundaries of the four Commerce railyards were included. Diesel PM off-site emissions used in the off-site modeling runs consisted of about 113.2 tons per year from roadways and 0.2 tons per year from stationary facilities, representing emissions for 2005. The diesel PM emissions from all of four Commerce Railyards are not analyzed in the off-site air dispersion modeling. The same meteorological data and coarse receptor grid system used for on-site air dispersion modeling was used for the off-site modeling runs.

The estimated potential cancer risks and non-cancer chronic health hazard index associated with off-site diesel PM emissions are illustrated in Figure V-4 and Figure V-5. As indicated in Figure V-4, the zone of impacts of estimated cancer risks

associated with off-site diesel PM emissions is significantly larger than that of the BNSF Commerce Eastern Railyard. Because the diesel PM emissions from the significant off-site sources are equivalent to 35 times of the BNSF Commerce Eastern Railyard diesel PM emissions. Figure V-5 illustrates that the non-caner chronic health risks associated with off-site diesel PM emissions are insignificant.

Figure V-4: Estimated Cancer Risk Levels from Off-site Diesel PM Emissions

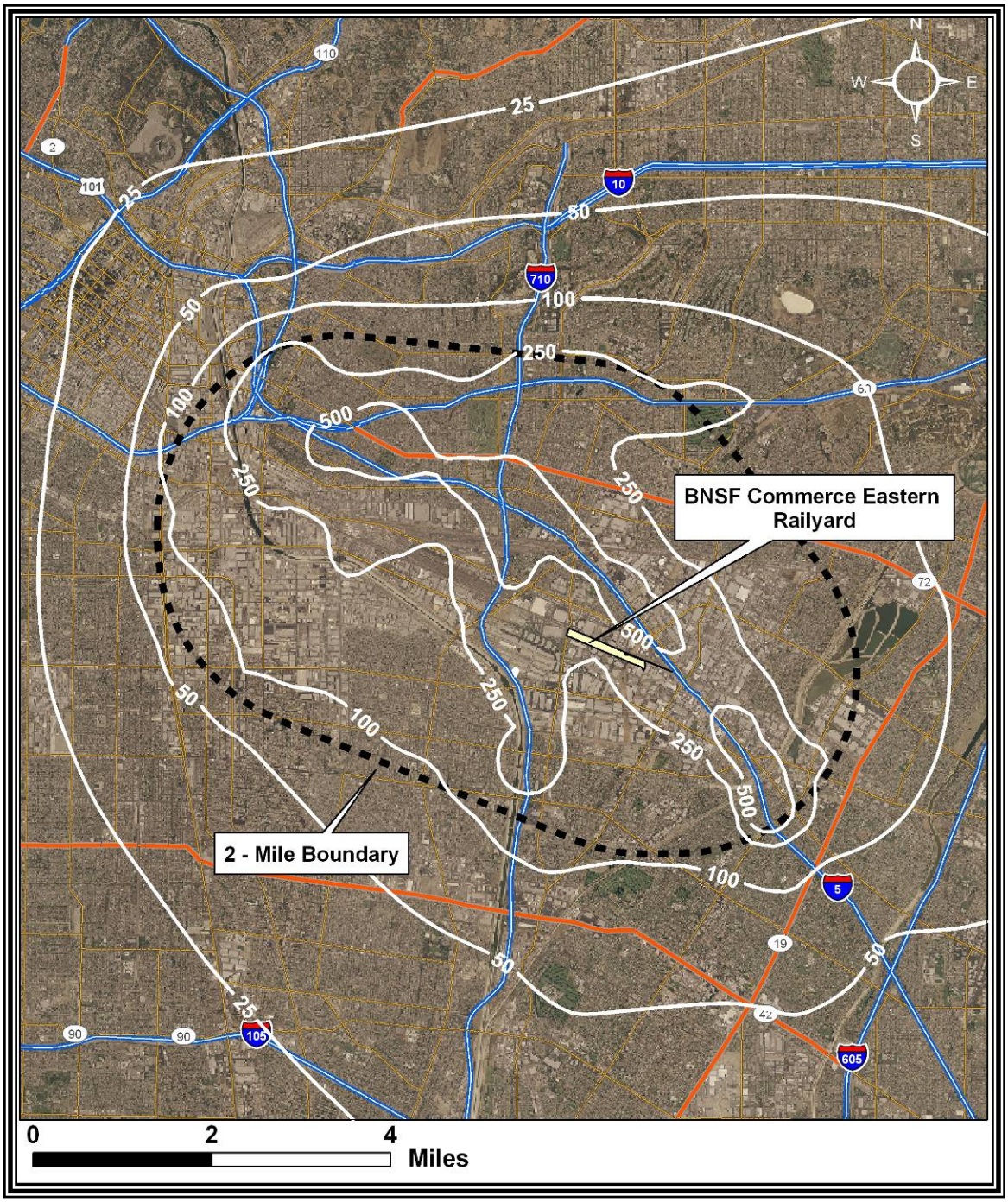
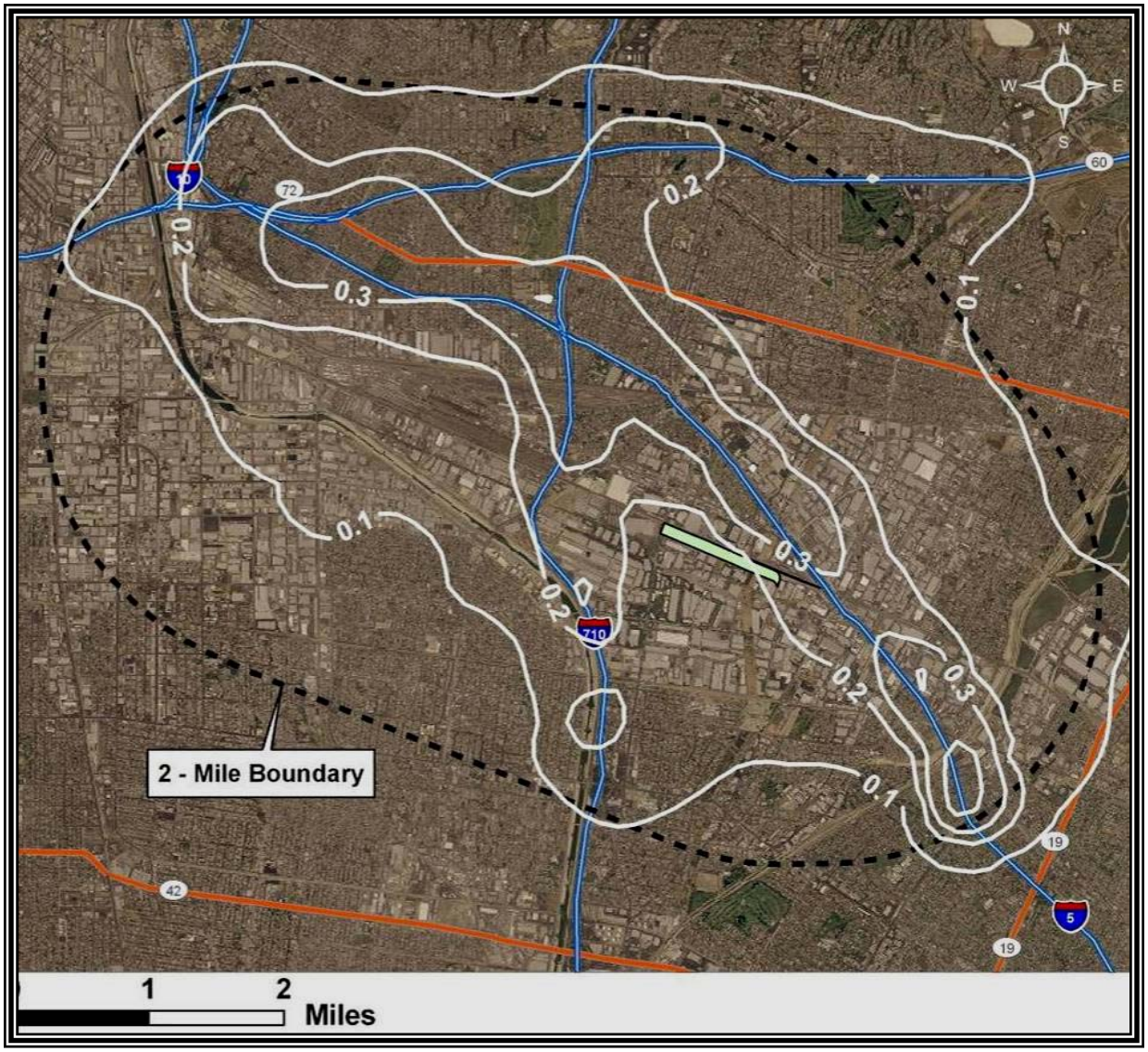


Figure V-5: Estimated Non-Cancer Chronic Health Hazard Index from Off-site Diesel PM Emissions



Based on the 2000 U.S. Census Bureau's data, the zone of impact of the estimated potential cancer risks above 100 cases in a million levels associated with off-site diesel PM emissions encompasses approximately 28,300 acres where about 430,000 residents live. For comparison with the BNSF Commerce Eastern Railyard health risks, the same level of potential cancer risks (100 cases in a million) associated with railyard diesel PM emissions covers about 270 acres where approximately 950 residents live. Detailed calculations and methodologies used in off-site air dispersion modeling are presented in Appendix C.

Table V-5 presents the exposed population and area coverage size for various impacted zones of cancer risks associated with off-site diesel PM emissions.

Table V-5: Estimated Impacted Areas and Exposed Population associated with Different Cancer Risk Levels Associated with Off-Site Diesel PM Emissions

Estimated Cancer Risk (cases per million)	Impacted Area (Acres)	Estimated Population Exposed
10 - 25	126,000*	650,000*
26 - 50	25,420*	529,000*
51 - 100	18,070*	303,000*
101 - 250	17,350	285,000
251 - 500	8,610	100,000
>500	2,330	45,000

*: Approximate estimates because partially these isopleths exceed the air dispersion model domain

3. *Risks to Sensitive Receptors*

Individuals who may be more sensitive to toxic exposures than the general population are distributed throughout the total population. These sensitive populations are identified as school-age children, teachers and elderly people. Typical sensitive receptors are schools, hospitals, day-care centers and elder care facilities. There are five sensitive receptors including two elementary schools, one high school, and three child care centers within one mile distance of the BNSF Commerce Eastern Railyard. Table V-6 shows the number of sensitive receptors in various levels of cancer risks associated with diesel PM emission from the BNSF Commerce Eastern Railyard, based on 70-year residential exposure duration.

Table V-6: Estimated Number of Sensitive Receptors in Various Levels of Cancer Risks associated with On-Site Diesel PM Emissions

Estimated Cancer Risk (cases per million)	Number of Sensitive Receptors
10 – 25	4
25 – 50	2

D. 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.

For locomotive sources at the BNSF Commerce Eastern Railyard, the activity rates include primarily the number of engines in operation and the time spent in different power 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 BNSF'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.

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, 2004) 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 BNSF'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 concentration approximately ten times 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 (1.3×10^{-4} to 2.4×10^{-3} $(\mu g/m^3)^{-1}$) and a risk factor of 3×10^{-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 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). It is important that the risk estimates generated in this study not be interpreted as the expected rates of disease in the exposed population, but rather as estimates of potential risk. Risk assessment is best viewed as a comparative tool rather than a literal prediction of diesel incidence in a community.

Moreover, 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 80th 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 FOR ESTIMATING OFF-SITE MOBILE SOURCES DIESEL PM 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 2-mile buffer of the combined Commerce yards and all links within a 1-mile buffer of all other yards 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[1]. 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

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 1) where speed-specific VMT is then matched to an emission factor from EMFAC to estimate total emissions from each vehicle type for each hour of the day. The working draft of EMFAC (version V2.23.7), rather than EMFAC2007, was used for this assessment because at the time this project was underway EMFAC2007 was not completed. The working draft of EMFAC (version V2.23.7), however, contains nearly all the revisions in EMFAC2007 that would affect these calculations

Table A-VI-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) 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[2]. 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[2] 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-VI-2) composed of a link identification code, hour of the day, 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.

Table A-VI-2 Activity Matrix Example

LINKID	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-VI-3):

Table A-VI-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 particulate matter (DPM) 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:

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

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

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.

LIMILATIONS 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, tire and break wear, 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.

References

1-SCAG Transportation Modeling", http://www.scag.ca.gov/modeling/ [Accessed January 2007].
2- 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

APPDENIX B

METHODOLOGY FOR ESTIMATING OFF-SITE SATIONARY SOURCES DIESEL PM 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. Because of the close proximity of railyards in the Commerce area, the four railyards (Commerce-BNSF, Commerce-UP-Main, Commerce-UP-Eastern, and Commerce-UP-Mechanical/Sheila) were enclosed in a combined polygon outline, and a two-mile buffer zone was then used around the combined polygon footprint.

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 US EPA stack defaults from the Emissions Modeling System for Hazardous Air Pollutants (EMS-HAP) program were

assigned. The U.S. E.P.A stack defaults are assigned based on the Source Classification Code (SCC) or Standard Industrial Classification (SIC) code of the operation. If an applicable US EPA default was not available, then a final generic default was applied. To ensure that the micro scale 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 micro scale modeling input files.

APPDENIX C

IMPACTS FROM OFF-SITE DIESEL PM EMISSION SOURCES

Impacts from off-site pollution sources near the BNSF Commerce Eastern Railyard facility were modeled using the U.S. EPA-approved AERMOD dispersion model. Specifically, off-site mobile and stationary diesel PM (DPM) emission sources located out to a distance of two miles from the perimeter of the BNSF Commerce Eastern Railyard were included. Other emission sources that were located immediately beyond the two mile zone from the facility, such as a high-volume freeway, have the potential to impact receptors in the modeling grid, but were not considered.

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

Table 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: 113.2 TPY DPM Stationary Sources: 0.2 TPY DPM	PTSD/MSAB
Receptor Grid	41x41 Cartesian grid covering 400 km^2 with uniform spacing of 500 meters. Grid origin: (380400, 3753500) in UTM Zone 11.	Environ
Meteorological Data	AERMET-Processed data for 2005 *Surface*: Lynwood and LA/USC *Upper Air*: San Diego Miramar	Environ
Surface Data	Albedo: 0.15 to 0.19 Bowen Ratio: 0.52 to 4.71 Surface Roughness: 0.87 to 0.97	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 1: Region Surrounding the BNSF Commerce Eastern Railyard facility with the Modeling Domain Indicated by the Black Outline

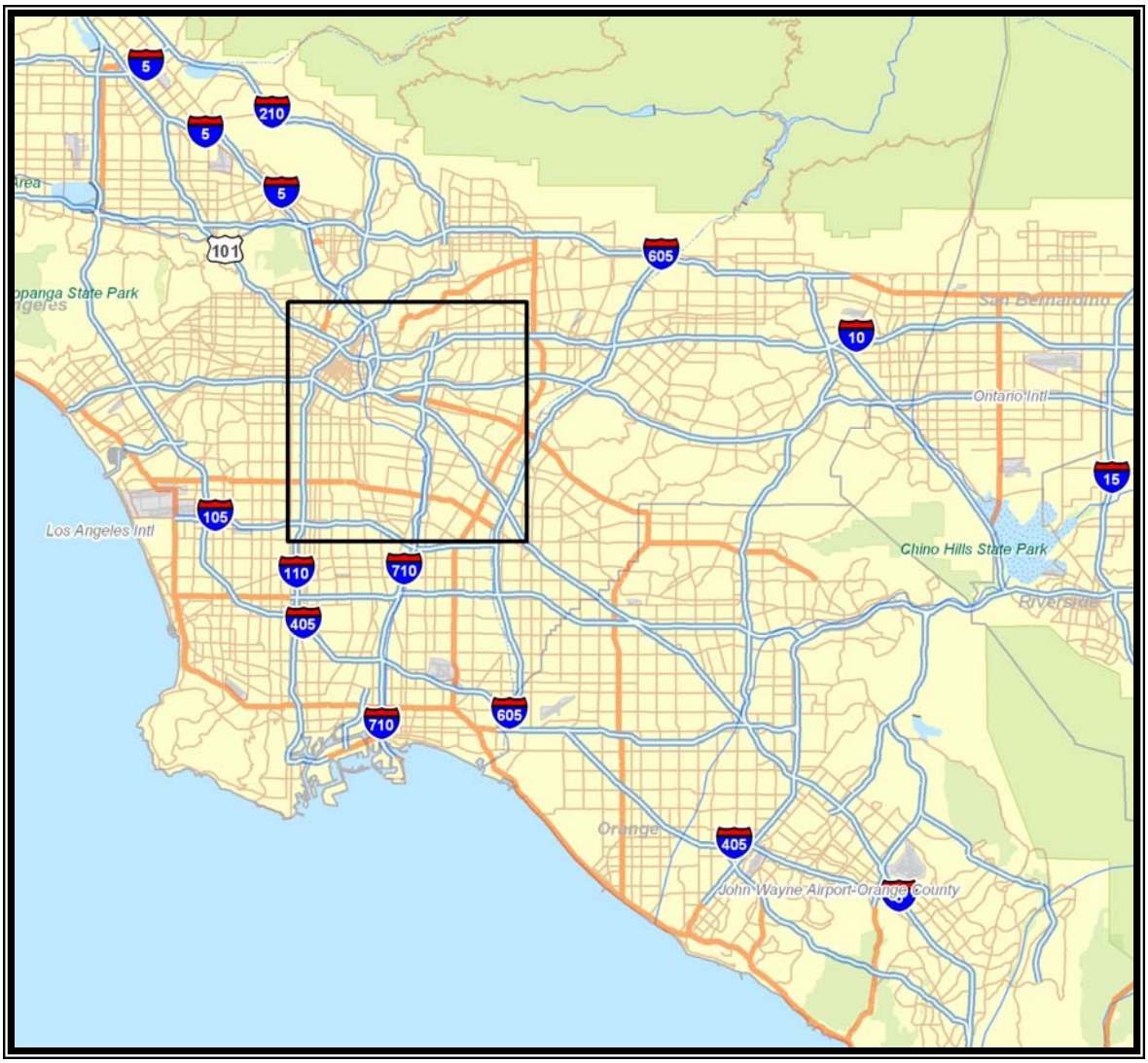
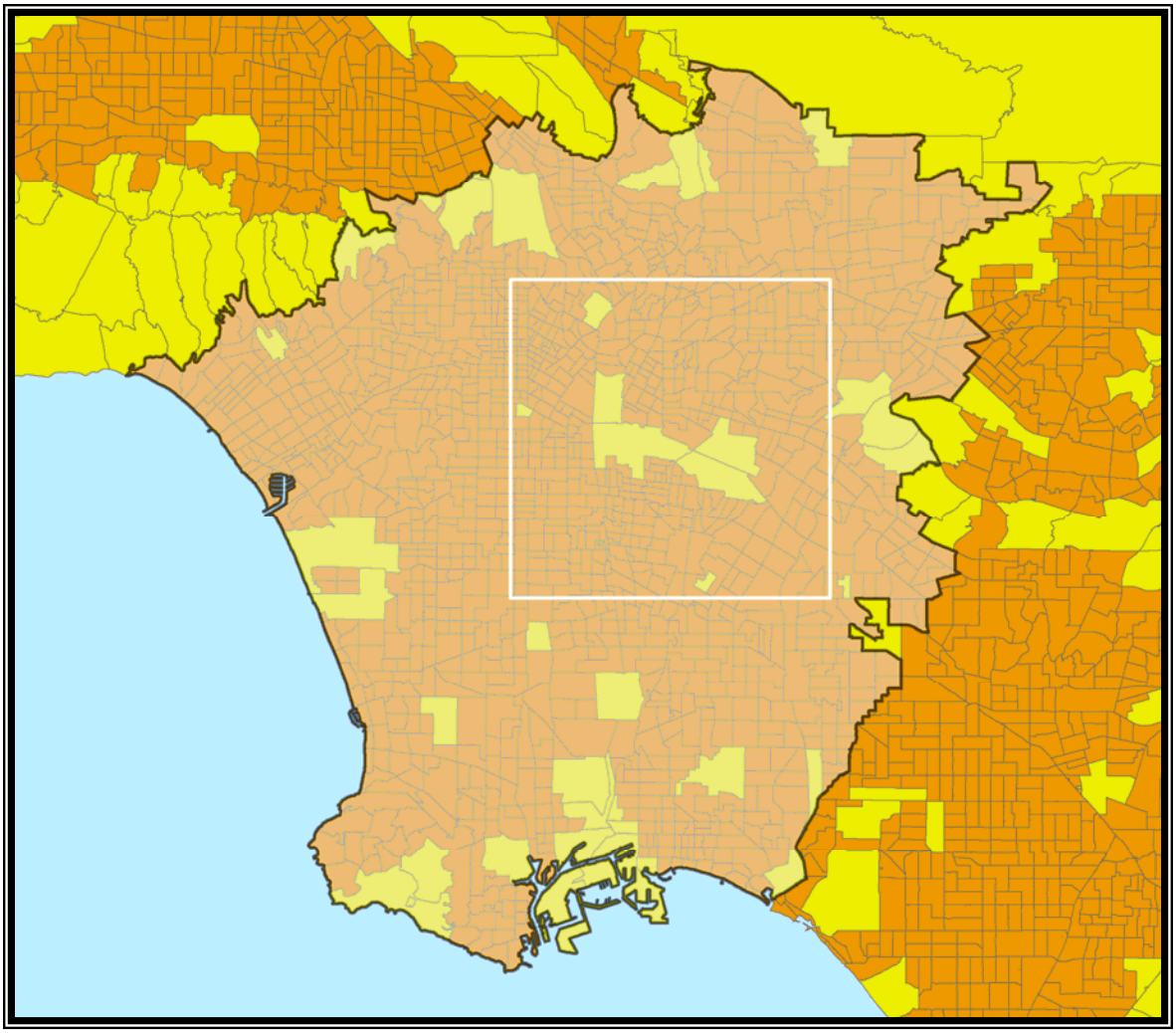


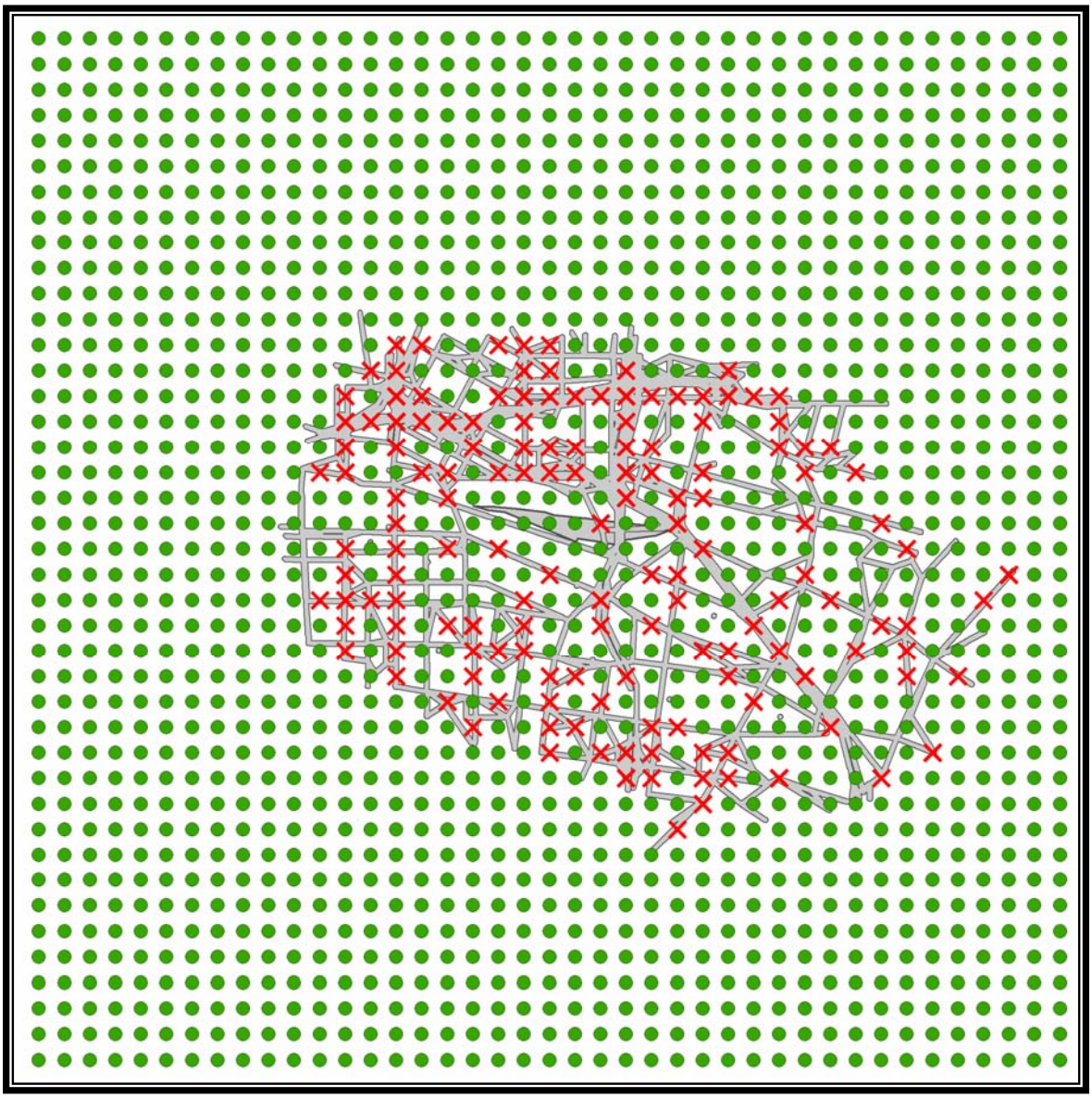
Figure 1 illustrates the region surrounding the BNSF Commerce Eastern Railyars modeling domain. The domain has dimensions 20 km x 20 km and contains a grid of 1681 receptors with a 500 meter uniform grid spacing.

Figure 2: BNSF Commerce Eastern Urban Population: Orange 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 BNSF Commerce Eastern model domain is in a region with considerable urbanization. The continuous urban area selected can be seen in Figure 2. The population in this selected area is 6,476,185.

Figure 3: BNSF Commerce Eastern receptor network including off-site sources and rail facility



The off-site stationary and on-road emission sources used in the BNSF Commerce Eastern model runs are plotted along with the receptor network in Figure 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 two miles of the perimeter of the rail yard facility. Diesel PM off-site emissions used in the off-site modeling runs consisted of 113.2 tons per year from roadways and 0.2 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 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 3. After removal, 1533 of the original 1681 receptors remained.

The same meteorological data used by Environ International Corporation was used for the off-site modeling runs. The data was compiled from the nearby Lynwood (33.922°N, 118.211°W) and Los Angeles/USC (34.02°N, 118.28°W) stations. Upper air data for the same time period was 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 2005.

Figure 4: BNSF Commerce Eastern off-site sources and rail yard with modeled annual average concentrations from off-site sources in ug/m^3

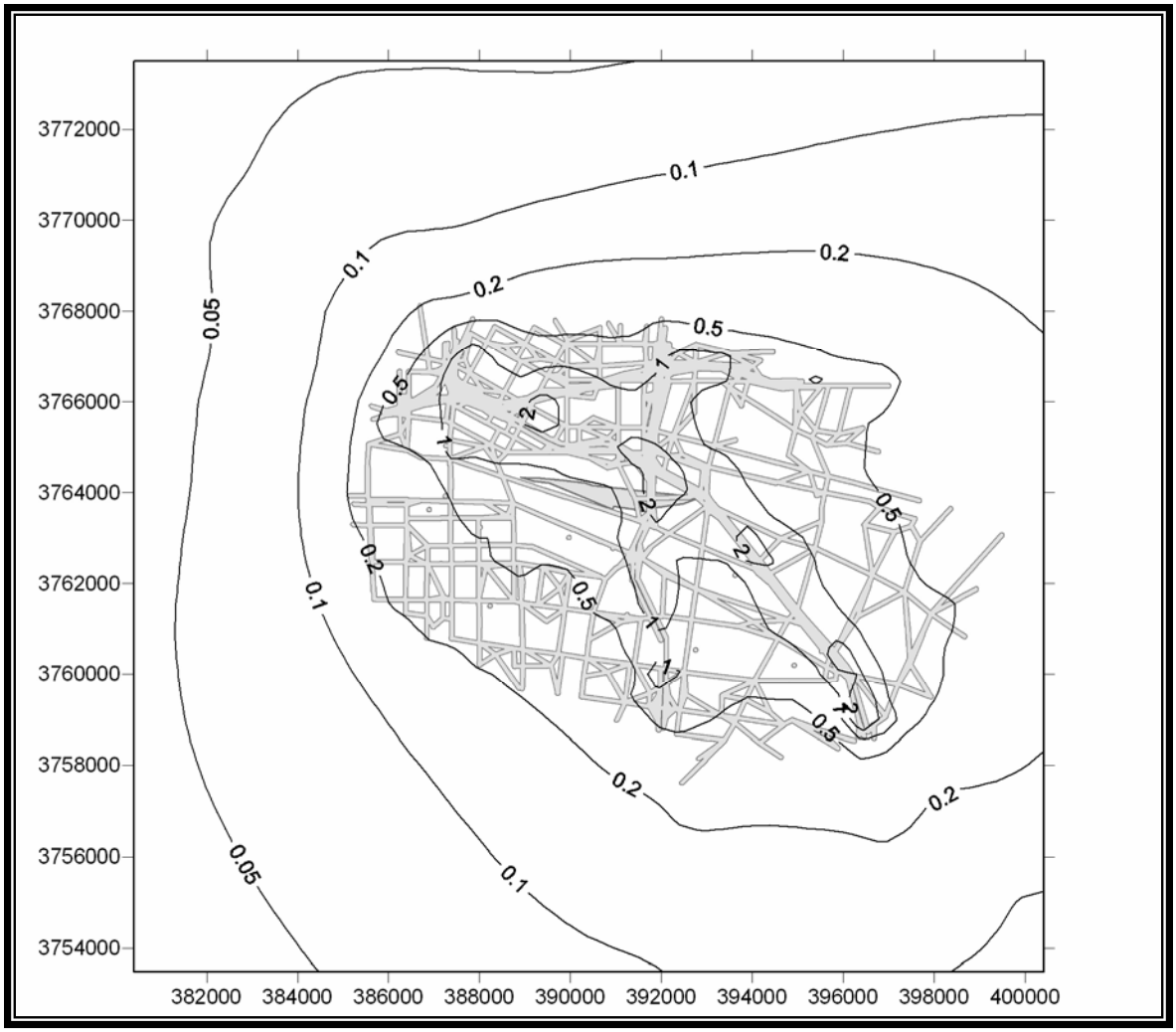


Figure 4 shows annual average diesel PM concentrations from the off-site emissions. Highest values occur near major freeways; the five highest concentrations at a receptor and their locations are provided in Table 2.

Table 2: BNSF Commerce Eastern maximum annual concentrations in ug/m^3

X	Y	Mobile	Stationary	Total (Off-site)
396400	3759000	3.380	0.0004	3.380
396400	3759500	3.339	0.0005	3.339
395900	3760500	2.944	0.0017	2.946
391400	3765000	2.747	0.0010	2.748
393900	3763000	2.617	0.0007	2.618

APPDENIX D

TABLE OF 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 2004), 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

METHODOLOGY FOR ESTIMATING DIESEL PM EMISSIONS FROM THE HHD TRUCKS TRAVELING BETWEEN THE INTERMODAL RAILYADS AND MAJOR FREEWAYS

Introduction:

Diesel-fueled heavy-heavy-duty (HHD) trucks (weight >33,001 pounds) traveling between the intermodal railyards and major freeways generate certain amount of diesel PM emissions, which contribute the off-site diesel PM emissions. Using the same methodology in estimating the off-site HHD trucks diesel PM emissions, ARB staff estimated the diesel PM emissions of HHD trucks traveling between the railyard gates and the freeways. Estimate of the diesel PM emissions from HHD diesel trucks can be performed based on average speed on the local streets, distances traveled locally between the gates and the freeways, truck count at the railyard gates, and the EMFAC model.

This analysis is conducted for the intermodal railyards whose diesel-fueled HHD trucks are a major contributor to the diesel PM emissions. At some railyards, HHD trucks also are idling or queuing outside of the railyards. These activities have been covered by the railyard on-site emission inventories and are not included in this analysis.

Methodology:

Estimating diesel PM emission from HHD diesel trucks can be performed by the following steps:

- Assume the average speed of trucks traveling on local streets between the railyard gates and the entrance/exit ramps of freeways.
- Select the most frequently traveled freeways for each railyard.
- Measure the distances from the gates to the ramps of selected freeways for each railyard using Google Earth Pro mapping tool.
- Use working draft of the EMFAC model to obtain emission factor.
- Calculate the associated diesel PM emissions.

Step 1: Assume average speed of trucks traveling between the railyard gates and the freeways

The speeds of HHD trucks traveling on local streets range from 5 mph (start from the gate) to 35 mph (enter the freeway) depending on the time of travel, traffic conditions, etc. ARB staff assumes these speeds are averaged at about 20 mph.

Step 2: Select the most frequently traveled freeways for each railyard

This step is based on the assumption that the truck traffic is more heavily concentrated on one freeway than the others. In accordance with the judgments of the railyard operators, ARB staff chose the most frequently traveled freeway for each intermodal railyard, as shown in Table 1.

Table 1: The Most Frequently Traveled Freeways by Railyards and the Distances from the Railyard Gates to the Freeways

Railyard	County	Most Frequently Traveled Freeway	Roundtrip Distance from Gate to Freeway (Miles)
UP Commerce	Los Angeles	I-710	2.6
BNSF Hobart	Los Angeles	I-710	2.6
BNSF Commerce/Eastern	Los Angeles	I-5	2.1
UP LATC	Los Angeles	I-5	0.7
UP Mira Loma	Los Angeles	SR-60	2.2
BNSF Richmond	Contra Costa	I-580	1.74

Step 3: Measure the distances from the railyard gates to the ramps of selected freeways using Google Earth Pro mapping tool.

The distances of the local streets from the railyard gates to the entrance/exit ramps of the selected freeways are estimated by Google Earth Pro mapping tools. The results are presented in Table 1.

Step4: Utilize working EMFAC Model to obtain emission factor

The working draft of EMFAC (V2.23.7), rather than EMFAC 2007, was used in the analysis as described in Appendix A. Emission factors based on vehicle type (in this case HHD diesel trucks), fuel type, and speed were developed by EMFAC. These are composite emission factors based on the model year distribution for each county as identified in Table 1, and are calculated in grams of emissions per mile traveled. The HHD emission factor matrices for Los Angeles County and Contra Costa County are shown in Table 2 and Table 3 respectively.

Table 2: HHD Emission Factor Matrix for Los Angeles County

Speed (mph)	HHD DSL EF (g/mi)
12	2.371
20	**1.277**
45	0.728
60	1.095

Table 3: HHD Emission Factor Matrix for Contra Costa County

Speed (Miles Per Hour)	HHD Diesel Emission Factor (Grams per Mile)
18	1.315
20	**1.176**
35	0.712
60	1.009

Step5: Calculate the HHD diesel PM emissions

The calculation of diesel PM emissions can be expressed by the following equation:

Total Emission (grams) = EF X (Volume X Distance Traveled)

EF represents diesel PM emission factor. The volume of trucks count at the railyard's gates was provided by the railyard activity data.

The emissions inventory developed by this methodology only included diesel PM emissions from running exhaust as it is the primary diesel source from on-road mobile sources. Emissions from other modes such as idling, starts, and tire and break wear were excluded due to the limited available data.

The estimated HHD diesel PM emissions for travel from the railyard gate to the most frequently traveled freeway are presented in Table 4 for each of the railyards.
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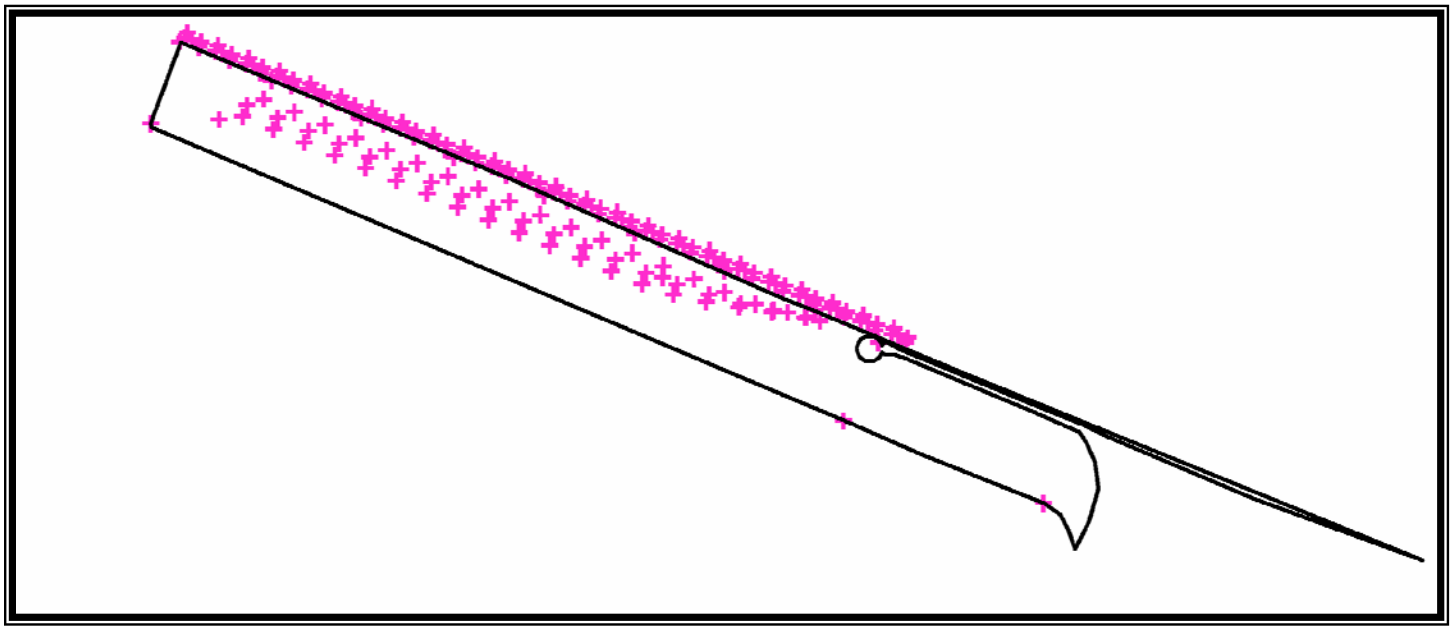
Table 4: Estimated HHD Diesel PM Emissions from Gate to Freeway**

Railyard	Route	Distance (Miles)		Truck Trips per Day	Diesel PM	
		One way	Round Trip		g/day***	tpy
BNSF Hobart	*Gate to I-710**	1.3	2.6	3533	11,730	**4.72**
UP Commerce	*Gate to I-710**	1.3	2.6	1026	3,406	**1.37**
BNSF Commerce/Eastern	*Gate to I-5**	1.05	2.1	557	1,495	**0.60**
UP Mira Loma	*Gate to SR-60**	1.1	2.2	321	901	**0.36**
UP LATC	*Gate to I-5**	0.35	0.7	512	457	**0.18**
BNSF Richmond	*Gate to I-580**	0.87	1.74	153	314	**0.13**
	Total					**7.36**

Notes: * Assumed all trucks take this route

** Assumed all trucks' speeds are 20 mph from gate to freeway

*** HHD Emission Factors at 20 mph: 1.277 g/mi for LA County and 1.176 g/mi for Contra Costa County

APPENDIX F

BNSF Commerce Eastern Emissions Allocations