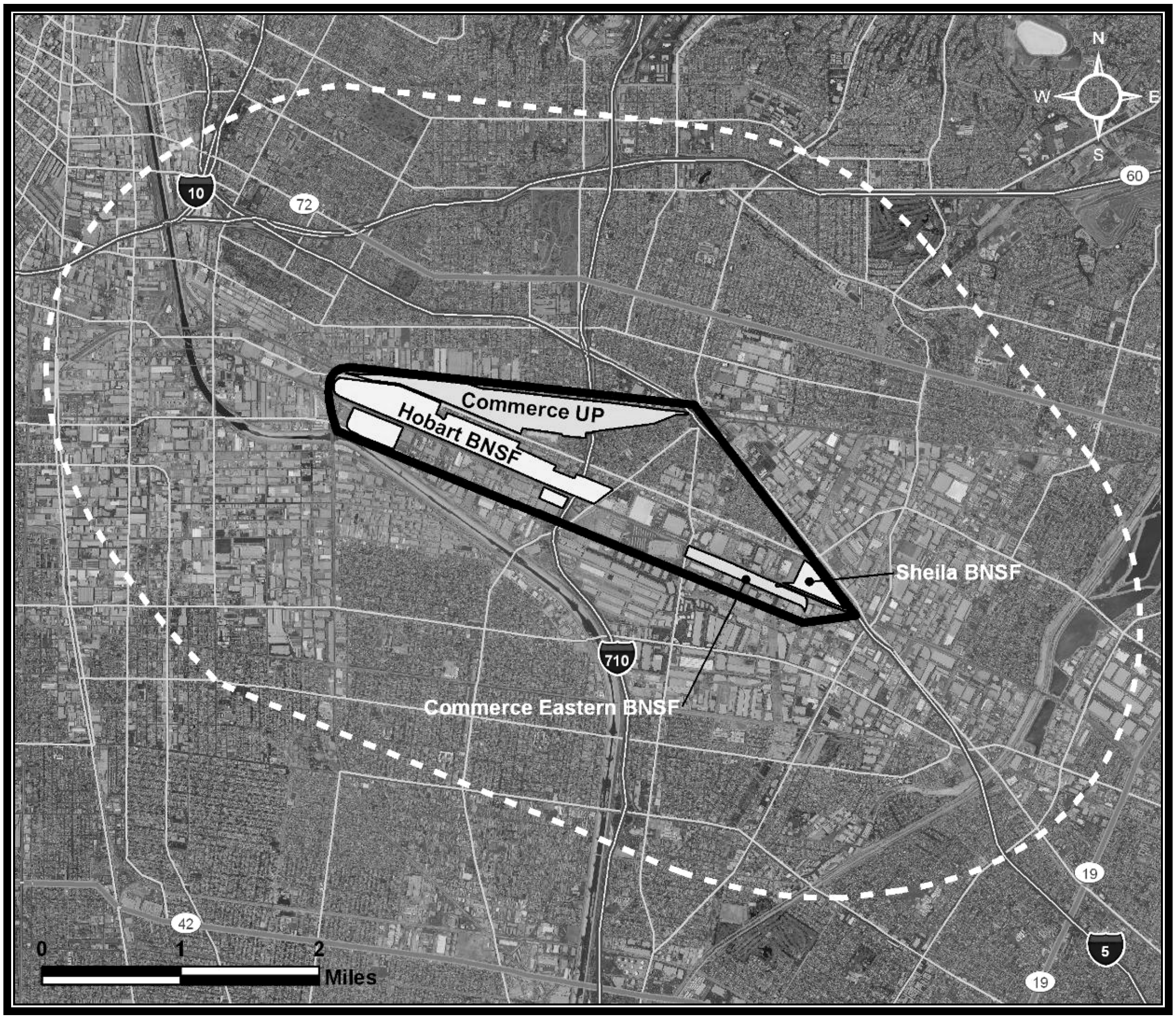
California Environmental Protection Agency

Air Resources Board

Health Risk Assessment
For the Four Commerce Railyards



Stationary Source Division
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California Environmental Protection Agency

Air Resources Board

Health Risk Assessment For the Four Commerce Railyards

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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 following four railyards located in Commerce, California, and are operated by both Union Pacific Railroad (UP) and BNSF Railway (BNSF):

- UP Commerce Railyard: 4341 East Washington Blvd., Commerce
- BNSF Hobart Railyard: 3770 East Washington Blvd., Commerce
- BNSF Mechanical Sheila Railyard: 6300 East Shelia St., Commerce
- BNSF Commerce Eastern Railyard: 2818 Eastern Ave., Commerce

The study focused on the railyard's emissions from locomotives, on-road trucks, off-road vehicles, cargo handling equipment, portable equipment, and stationary sources. Also evaluated were mobile and stationary sources with significant emissions surrounding the four Commerce railyards. The four Commerce railyards cover a triangular area. The two larger railyards, UP Commerce and BNSF Hobart, lie side by side, as do the two smaller railyards (BNSF Sheila and BNSF Commerce Eastern), the latter pair of railyards are located approximately one mile to the southeast of the two larger railyards. In order to cover the zone of significant health impacts associated with emissions from all four of the 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.

This study complements the individual HRAs prepared for the four Commerce railyards. The individual HRAs are presented in separate reports and can be accessed from the following ARB website: http://www.arb.ca.gov/railyard/hra/hra.htm. Because of the proximity of these railyards to one another, the cumulative impact analysis is presented in this report.

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. By mass, approximately 94% of these particles are less than 2.5 microns in diameter ($PM_{2.5}$). Because of their tiny size, diesel PM particles are readily respirable, and can penetrate deep into the lung and enter the bloodstream, carrying with them an array of toxins. 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,

[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.

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 the study conducted by South Coast Air Quality Management District: *Multiple Air 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.

In 2005, ARB entered into a statewide railroad pollution reduction agreement (Agreement) with UP and BNSF (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 requires the railyard HRAs to be prepared based on ARB's experience in preparing the Roseville Railyard Study (2004a), and the *ARB Health Risk Assessment Guidance for Railyard and Intermodal Facilities* that the ARB staff developed in 2006 (see http://www.arb.ca.gov/railyard/hra/hra.htm) (ARB, 2006b). Three out of four railyards in the Commerce area are designated railyards subject to the Agreement and the HRA requirements. BNSF Sheila Railyard was not included explicitly in the original agreement because it was assumed to be the part of the BNSF Commerce Complex.

A. What are Health Risk Assessments (HRAs)?

A health risk assessment (HRA) uses mathematical models to evaluate the health impacts from exposure to certain chemical or toxic air contaminants released from a facility or found in the air. 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: the air pollution emission inventory, the air dispersion modeling, and an assessment of associated health 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, ARB staff estimated about 1,300 premature deaths per year due to diesel exhaust exposure in 2000 (ARB Research Division, and Lloyd and Cackette, 2001). The total diesel PM emission from all of the sources in the South Coast Air Basin is about 7,750 tons per year in 2005 (ARB, 2006c). Diesel PM emissions in 2005 from the four Commerce railyards are estimated at about 40 tons per year, which is about 0.5% of total 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 to be about 1,760 tons per year, which resulted in an estimated 29 premature deaths per year (ARB, 2006d).

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,

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[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.

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.

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 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 in order to avoid underestimation of risk to the public. As indicated by the OEHHA Guidelines, the Tier-1 evaluation is useful in comparing risks among a number of facilities and similar sources. Thus, the risk estimates should not be interpreted as a literal prediction of disease incidence in the affected communities but more as a tool for comparison of the relative risk between one facility and another. 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.

OEHHA is in the process of updating the current health risk assessment guidelines, and the ARB and UP and BNSF agreed to evaluate the non-cancer health impacts using an interim methodology. This was used in the Diesel Particulate Matter Exposure Assessment Study for the Ports of Los Angeles and Long Beach (ARB, 2006d) to estimate PM mortality. This will serve as a short-term and interim effort until OEHHA can complete its update of the Guidelines.

As soon as the HRAs are final, both the ARB and Railroads in cooperation with the SCAQMD staff, local citizens and others will begin a series of meetings to identify and implement measures to reduce emissions from railyard sources.

B. Who prepared the Combined HRA for the Four Commerce Railyards?

Under the Agreement, ARB worked with the 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 *ARB Rail Yard Emissions Inventory Methodology* (ARB, 2006e), and *Health Risk Assessment Guidance for Railyard and Intermodal Facilities* (ARB, 2006b), provide guidelines for the identification, modeling, and evaluation of the toxic air contaminants (TACs) from Designated Railyards throughout California.

Using the guidelines, the railroads and their consultants (Environ International Corporation for BNSF, Sierra Research, and Air Quality Management Consulting for UP) developed the emission inventories and performed the air dispersion modeling for operations that occurred within each of the designated railyards. The base year of the analysis was 2005.

ARB staff was responsible for reviewing and approving the railroad's submittals, identifying significant sources of emissions near the railyards and modeling the impacts of those sources, and preparing the railyard health risk assessments. ARB staff was also responsible for releasing the draft HRAs to the public for comment and presenting them at community meetings. After reviewing public comments on the draft HRAs, ARB staff made revisions as necessary and appropriate, and is now releasing the HRAs in final form. Ultimately, the information derived from the railyard HRAs is to be used to help identify the most effective mitigation measures that could be implemented to further reduce railyard emissions and public health risks.

II. SUMMARY

Below is a summary of the four Commerce railyards operations, emissions, air dispersion modeling, and health risk assessment results.

A. General Description of the Commerce Railyards and the Surrounding Areas

The four Commerce railyards encompass about 530 acres and are located approximately 4 miles southeast of downtown Los Angeles:

- UP Commerce Railyard and BNSF Hobart Railyard occupy a larger area (about 450 acres) and are located across from each other on Washington Blvd.
- A mile further southeast, BNSF Sheila Railyard and BNSF Commerce Eastern Railyard occupy about 80 acres, and are located diagonally across from each other.

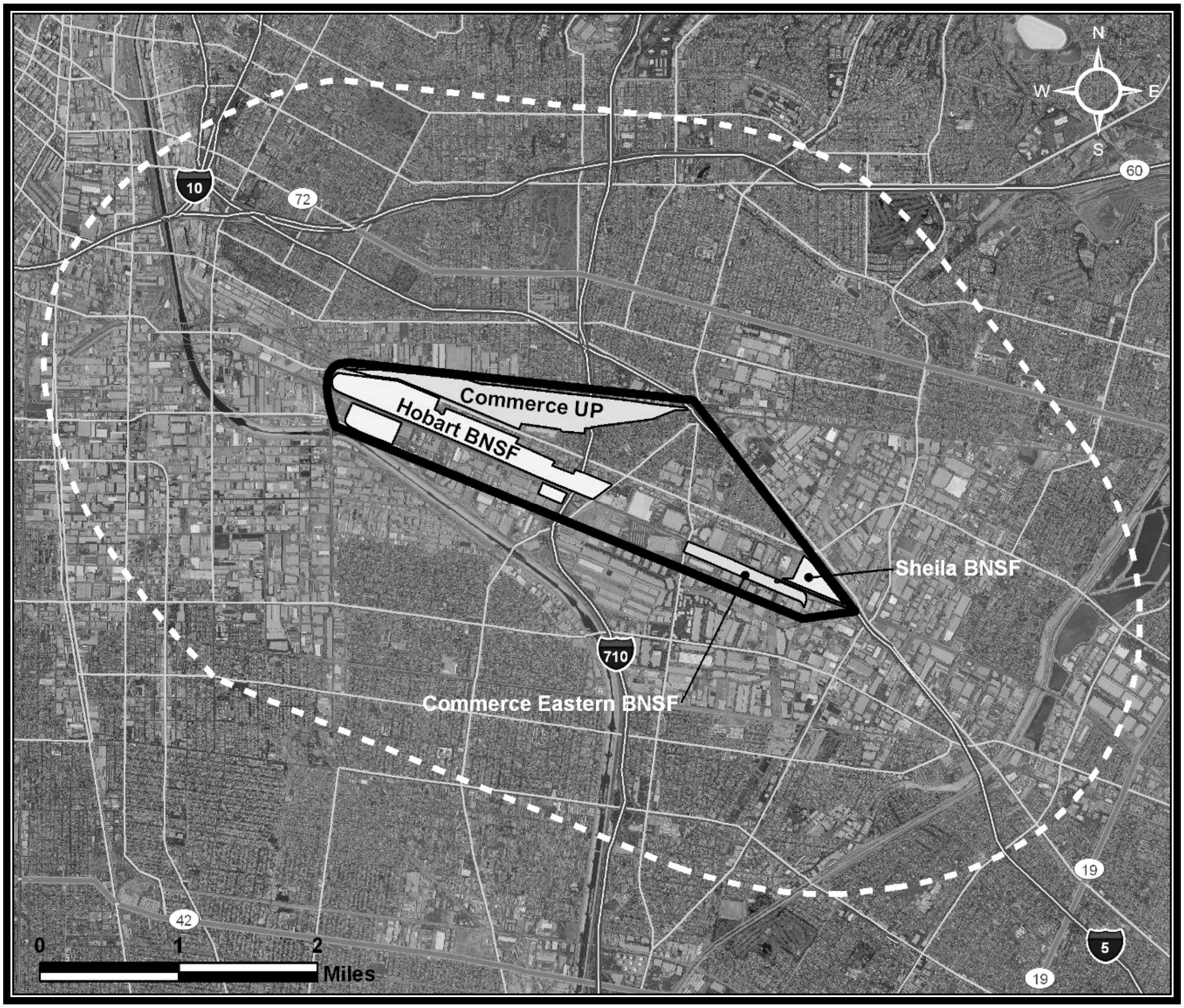
The four Commerce railyards cover a triangular area surrounded by both residential and commercial properties, as well as several major freeways as shown in Figure II-1. An overpass of I-710 bisects the UP Commerce and BNSF Hobart railyards. I-5 runs along BNSF Commerce Eastern Railyard on the east and CA-60 is about a mile north from all four railyards. Residential housing is located near the four railyards, and some residences are located within a few feet of the railyard fence lines. Several schools are also located in the vicinity of the railyards.

Facilities and activities within the railyards are described below.

- **The UP Commerce Railyard** supports intermodal activities. It includes classification tracks, a gate complex for inbound and outbound intermodal truck traffic, intermodal loading and unloading tracks, a locomotive service track, a locomotive maintenance shop, a freight car repair shop, an on-site wastewater treatment plant, and various buildings and facilities supporting railroad and contractor operations.
- **The BNSF Hobart Railyard** is the largest intermodal railyard in the United States. It supports intermodal and classification activities with locomotive switching, locomotive line haul, cargo handling equipment, track maintenance equipment, portable engines, on-road fleet vehicles, on-road container trucks, transportation refrigeration units (TRUs), and permitted stationary source activities. An adjacent mainline runs south of the Hobart railyard and supports freight trains and commuter lines for both Metrolink and Amtrak.
- **The BNSF Sheila Mechanical Railyard** is mainly a maintenance and repair shop serving mostly the BNSF Hobart Railyard. It consists of a locomotive fueling platform, diesel engine repair facility (operated by General Electric), railcar repair building, storage areas, equipment service areas, and an administration building. The main railway line runs south and west of the classification yard and includes freight and commuter (Amtrak and Metrolink) operations along the same lines.

- **The BNSF Commerce Eastern Railyard** is primarily a small intermodal facility with a focus on local domestic containers. It lies diagonally opposite and across from the BNSF Sheila Mechanical Railyard. The BNSF Commerce Eastern Railyard supports intermodal and a small amount of classification activities with very few trains loaded each day.

Figure II-1: Four Commerce Railyards and Surrounding Areas



B. What are the diesel PM emissions in and around the four Commerce Railyards?

In 2005, the combined diesel PM emissions from the four Commerce railyards (on-site emissions) and other significant emission sources within a two-mile distance from the joint boundaries of the four railyards (off-site emissions) are estimated at about 155 tons per year:

- 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 73% of the total diesel PM emissions). About 0.2 tons per year or 400 pounds per year of estimated diesel PM emissions are from stationary sources.
- The four Commerce railyards diesel PM emissions are estimated at about 41.8 tons per year, which accounts for about 27% of the combined diesel PM emissions from railyards and off-site sources within the two-mile perimeter.

The total on-site and off-site diesel PM emissions are shown in Table II-1.

Table II-1: Total On-site and Off-site Diesel PM Emissions in the Vicinity of Four Commerce Railyards

	Emissions (tons per year)	Percentage
On-site	41.8†	27%
Off-site	113.2	73%
Total	155	100%

† An error of cargo handling equipment emissions was found after the modeling was completed. The applicable change in emissions was believed to be de minimis; consequently, the modeling was not re-performed.

1. Railyards Emission Sources

The diesel PM emission sources for all four of the Commerce railyards are presented below.

- **UP Commerce Railyard emission sources are**: locomotives, on-road diesel-fueled container trucks, on-road fleet vehicles, cargo handling equipment (CHE), heavy equipment, transport refrigeration units (TRUs) and refrigerated rail cars (reefer cars), several stationary sources (fuel storage tanks, sand tower, waste water treatment plant, and emergency generator), and portable equipment.
- **BNSF Hobart Railyard emission sources are**: locomotives, on-road diesel-fueled container trucks, on-road fleet vehicles, cargo handling equipment,

heavy equipment, transport refrigeration units (TRUs) and refrigerated rail cars (reefer cars), portable equipment, track maintenance equipment, and several stationary sources (gasoline dispensing and storage facility, and emergency generators).

- **BNSF Mechanical Sheila Railyard emission sources are**: locomotives, portable equipment, track maintenance equipment, diesel fuel storage tanks, wastewater treatment plant, gasoline dispensing and storage facility, fire suppression system, and emergency generator.
- **BNSF Commerce Eastern Railyard emission sources are**: Locomotives, cargo handling equipment, on-road container trucks, and on-road fleet vehicles.

All four of the facilities operate 24 hours a day and 365 days a year. The railyards 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 Rail Yard Emissions Inventory Methodology* (ARB, 2006e).

As shown in Table II-2, within the railyards:

- Locomotives are the largest diesel PM emission source operating in the four Commerce railyards. Locomotives contribute about 13.6 tons per year, or about 33% of the total railyards' diesel PM emissions. Of the emissions from locomotives, freight and through trains (line-haul locomotives) and yard operations (primarily switch locomotives moving rail cars within the railyard) contribute about 9.3 tons per year. Locomotive service and testing activities account for 3.7 tons per year, and commuter trains contribute a small portion at about 0.6 tons per year of the diesel PM emissions.
- The second largest sources of emissions are diesel-fueled trucks and other vehicles. These sources contribute about 13.2 tons per year, or 32% of the total diesel PM emissions from the four Commerce railyards.
- Cargo handling equipment (CHE) operating within the yard, such as cranes and yard hostlers, emit about 9.4 tons per year of diesel PM, (about 22% of the total).
- The remaining on-site diesel PM emissions are about 5.5 tons per year (13% of the total), and are due to a variety of other sources including heavy equipment, transport refrigeration units (TRUs), refrigerated rail cars, and stationary sources.

Table II-2: Four Commerce Railyards Diesel PM Emissions (tons per year)

ON-SITE SOURCES	UP Commerce	BNSF Hobart	BNSF Sheila	BNSF Eastern	Total	% of Total
LOCOMOTIVES	**4.9**	**5.9**	**2.3**	**0.6**	**13.6**	**33%**
- Freight & Through Trains	*1.3*	*3.2*	*0.12*	*0.3*	*4.9*	*12%*
- Switch Locomotives	*1.9*	*2.2*	*0.1*	*0.2*	*4.4*	*11%*
- Service/Testing	*1.7*	*-*	*2.0*	*-*	*3.7*	*9%*
- Commuter Rail Operations	*-*	*0.5*	*0.03*	*0.02*	*0.6*	*1%*
ON-ROADTRUCKS	**2**	**10.1**	**-**	**1.1**	**13.2**	**32%**
CHEs	**4.8**†	**4.2**†	**-**	**0.4**†	**9.4**	**22%**
OTHERS (Heavy Equipment, TRUs, Off-road Vehicles, etc.*)*	**0.4**	**3.7**	**0.4**	**1.0**	**5.5**	**13%**
TOTAL	**12.1**	**23.9**	**2.7**	**3.1**	**41.8**	
% of Total	**29%**	**57%**	**7%**	**7%**		**100%***

*Numbers may not add up precisely due to rounding.

† An error of cargo handling equipment emissions was found after the modeling was completed. The applicable change in emissions was believed to be de minimis; consequently, the modeling was not re-performed.

The diesel PM emissions from the two larger railyards, UP Commerce and BNSF Hobart are estimated at about 36 tons per year, or 86% of total diesel PM emissions from the four railyards. The two smaller railyards, BNSF Sheila and Commerce Eastern, generate about 5.8 tons per year of diesel PM emissions, or 14% of the total diesel PM emissions from the four railyards.

Diesel PM is not the only toxic air contaminant (TAC) emitted at the four Commerce railyards. A relatively small amount of gasoline TACs is generated from gasoline storage tanks, gasoline-fueled equipment, and gasoline-fueled vehicles and engines, including isopentane, toluene, benzene, etc. Some other TACs, such as xylene, are emitted from the wastewater treatment plant. The detailed emission inventories for these TACs are documented in the emission inventories reports from ENVIRON International Corporation and Sierra Research (see http://www.arb.ca.gov/railyard/hra/hra.htm).

The total amount of these toxic air contaminants emissions is about 0.1 tons (about 210 pounds per year), compared to the 42 tons per year of the diesel PM emissions in the railyards. In addition, adjusting these emissions on a cancer potency weighted basis for their toxic potential (see a similar analysis for off-site air toxic contaminants in Table II-3), shows that these non-diesel PM toxic air contaminants have substantially less potency weighted emissions as compared to diesel PM (about 210 pounds per year vs 42 tons per year). Hence, only diesel PM emissions are presented in the on-site emission analysis.

2. Surrounding Sources

ARB staff evaluated significant mobile and stationary sources of diesel PM emissions surrounding the four Commerce Railyards. The Health Risk Assessment study for the UP Roseville Railyard (ARB, 2004a) indicated that the potential cancer risks associated with on-site diesel PM emissions is substantially reduced beyond a one-mile distance from the railyard. Therefore, in most of the railyard HRA studies, ARB staff analyzed the significant diesel PM emission sources within a one-mile distance from the railyard property boundary, where on-site emissions have significant health impacts. However, there are four railyards located in the city of Commerce (UP Commerce, BNSF Hobart, BNSF Commerce/Eastern, and BNSF Sheila Mechanical railyards). In order to cover the zone of significant health impacts associated with emissions from all four of the 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-1

> ***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.

ARB staff analyzed the significant off-site emission diesel PM sources based on two categories: mobile and stationary. For the off-site mobile sources, the analysis focused on on-road heavy duty diesel trucks, as these are the primary sources of diesel PM emissions 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, 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 source 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, which emit about 113 tons per year, as shown in Table II-1. 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. There are also some stationary sources, but they generate less than 400 pounds per year of 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 about 300 pounds per year of the off-site diesel PM emissions. These off-site diesel PM emissions do not include those from the four railyards located in the City of Commerce.

Diesel PM emissions from sources in the four Commerce Railyards and the sources within a two-mile distance from the joint boundaries of the four Commerce railyards are summarized in Table II-1 and Table II-2.

ARB staff also evaluated other toxic air contaminant (TACs) emissions around the four Commerce railyards. There are 2,620 stationary toxic air contaminant sources that were identified within the two-mile distance from the joint boundaries of the four Commerce Railyards. The total emissions of toxic air contaminants, 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' *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) are estimated at about 1.6 tons per year.

The Office of Environmental Health Hazard Assessment (OEHHA) has estimated an inhalation cancer potency factor (CPF) for individual chemicals and some chemical mixtures such as whole diesel exhaust. Diesel 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

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

diesel PM CPF. This factor is multiplied by the estimated emissions for that compound, which gives the cancer 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, substantially less than the diesel PM emissions.

In addition, ARB staff evaluated the potential cancer risk levels contributed by the use of gasoline 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, 2006c). 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 816 tons per year, which is equivalent to 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, equivalent to about 6% of total diesel PM emissions in the Air Basin. Hence, gasoline-powered vehicular sources are not included in the analysis.

Table II-3: Potency Weighted Toxic Emissions from Significant Off-Site Stationary Sources Surrounding the four Commerce Railyards

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	**0.0221**
Total (non-diesel PM)	**-**	**-**	**1.60***	**0.065***

* Numbers may not add precisely due to rounding.

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

Table II-4: Emissions of Major Toxic Air Contaminants from Gasoline Exhausts in the 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.

C. What are the estimated potential cancer risks from the Four Commerce Railyards?

The ARB developed *Health Risk Assessment Guidance for Railyard and Intermodal Facilities* (ARB, 2006b) 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 OEHHA, and is consistent with the methodologies used for the UP Roseville Railyard Study (ARB, 2004a) performed by ARB staff.

The United States Environmental Protection Agency (U.S. EPA) recently approved a new state-of-science air dispersion model called AERMOD (**A**merican Meteorological Society/**E**PA **R**egulatory Model Improvement Committee **MOD**EL). This model 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 AERMOD meteorological data selection criteria, four meteorological stations around the Commerce Railyards were evaluated. The data from the most representative meteorology stations, Lynwood Station operated by South Coast Air Quality Management District (SCAQMD) and University of Southern California (USC) Station operated by National Weather Service (NWS), were 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 risks levels associated with the estimated diesel PM emissions at the four Commerce Railyards are displayed by using 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. Figure II-2 and Figure II-3 present these isopleths. Figure II-2 focuses on the near source risk levels and Figure II-3 focuses on the more regional impacts. In each figure, the risk isopleths are overlaid onto a satellite image of the Commerce area surrounding the four Commerce Railyards to better illustrate the land use (residential, commercial, industrial, or mixed use) of these impacted areas.

As described in the previous chapter, the two larger railyards, UP Commerce and BNSF Hobart, account for 86% of the total diesel PM emissions compared with 14% from the two smaller yards, BNSF Sheila and BNSF Commerce Eastern.

The OEHHA Guidelines specify that, for health risk assessments, the cancer risk for the maximum exposure at the point of maximum impact be reported. The point of maximum impact, which is defined as a location or the receptor point with the highest cancer risk level outside the facility (railyard) boundary, with or without residential exposure, is predicted to be located at East Washington Boulevard, between the northwest edges of the BNSF Hobart and the UP Commerce railyards fence lines, directly downwind of high emission density areas for the prevailing southwesterly wind. The cancer risk at the point of maximum impact (PMI) is estimated to be about 3,000 chances in a million according to 2000 census data. The land use in the vicinity of the point of maximum impact is primarily zoned as an open land or for transportation or industrial use. There is no residential areas where the risk exceeds 1,000 chances per 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, there are great uncertainties associated with the estimation of the point of maximum impact and maximum individual cancer risk. These indications should not be interpreted as a literal prediction of disease incidence but more as a tool for comparison. In addition, the estimated point of maximum impact and maximum individual cancer risk may not be replicated by air monitoring.

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

Figure II-2 focuses on the near-source risks levels and Figure II-3 focuses on the more regional impacts of all four railyards:

- The area with the estimated potential cancer risk of over 500 chances in a million occurs mostly at the north-northeast side of the UP Commerce railyard fence line, due to prevailing wind direction. The residential area (Ayers-Leonis Triangle and Bandini) located between the UP Commerce and BNSF Hobart railyards also has an estimated potential risk of over 500 chances per million.
- There are the two "islands" of the isopleths with estimated cancer risks over 250 chances per million within approximately half mile from the two larger railyards and about 400 yards from the two smaller railyards' boundaries.

- The estimated cancer risk decreases to about 100 chances per million about one to two miles from the railyard boundaries.
- The risk further decreases to 50 in a million at about 2 miles from the railyards.
- The risk lowers to 25 in a million at approximately a 3-4 mile distance from the railyard boundaries.
- At about 4 miles from the railyard boundaries, the estimated cancer risk decreases to 10 in a million or lower.

Figure II-2: Estimated Potential Near-Source Cancer Risks (chances per million people) from the Four Commerce Railyards

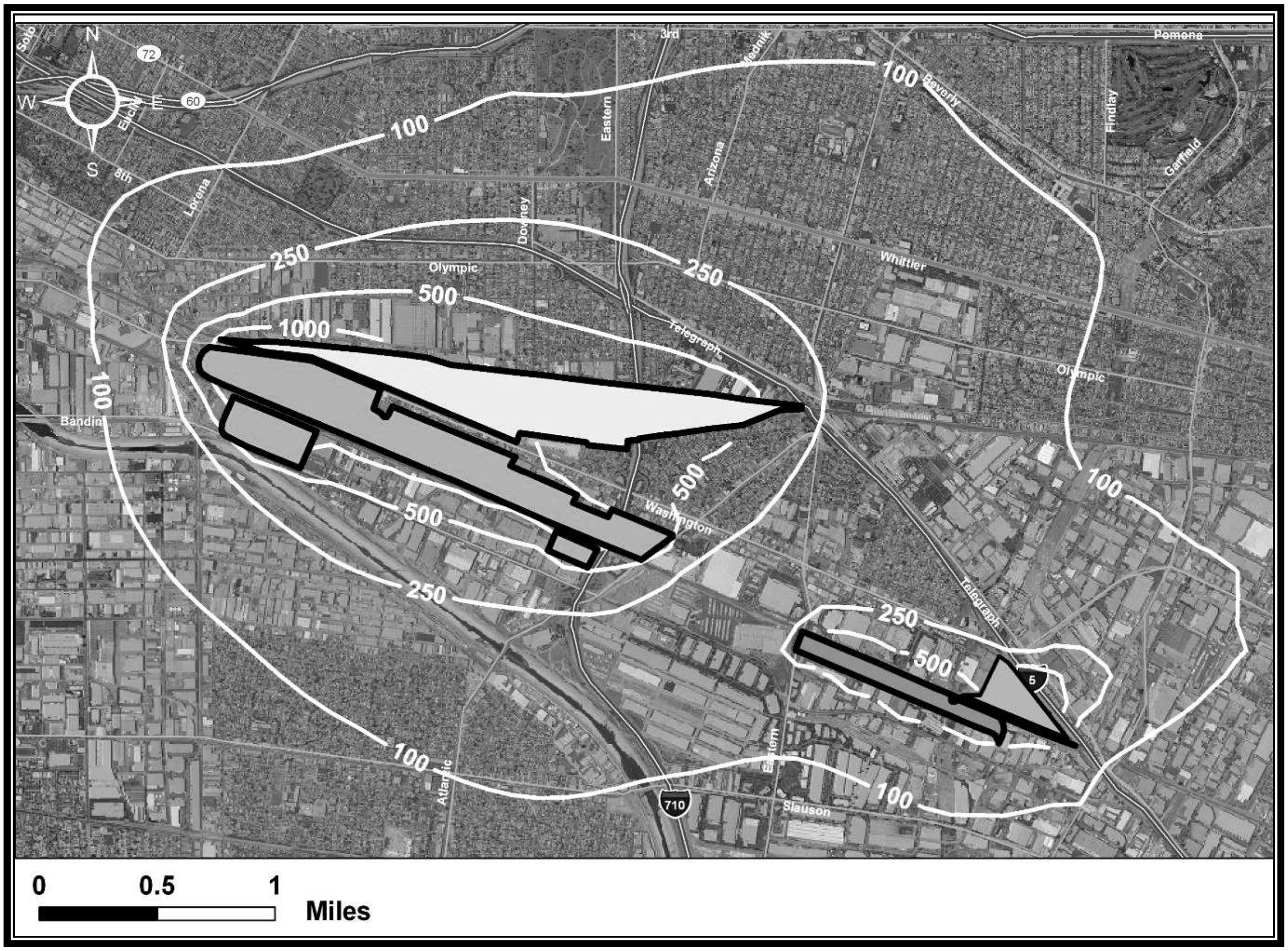
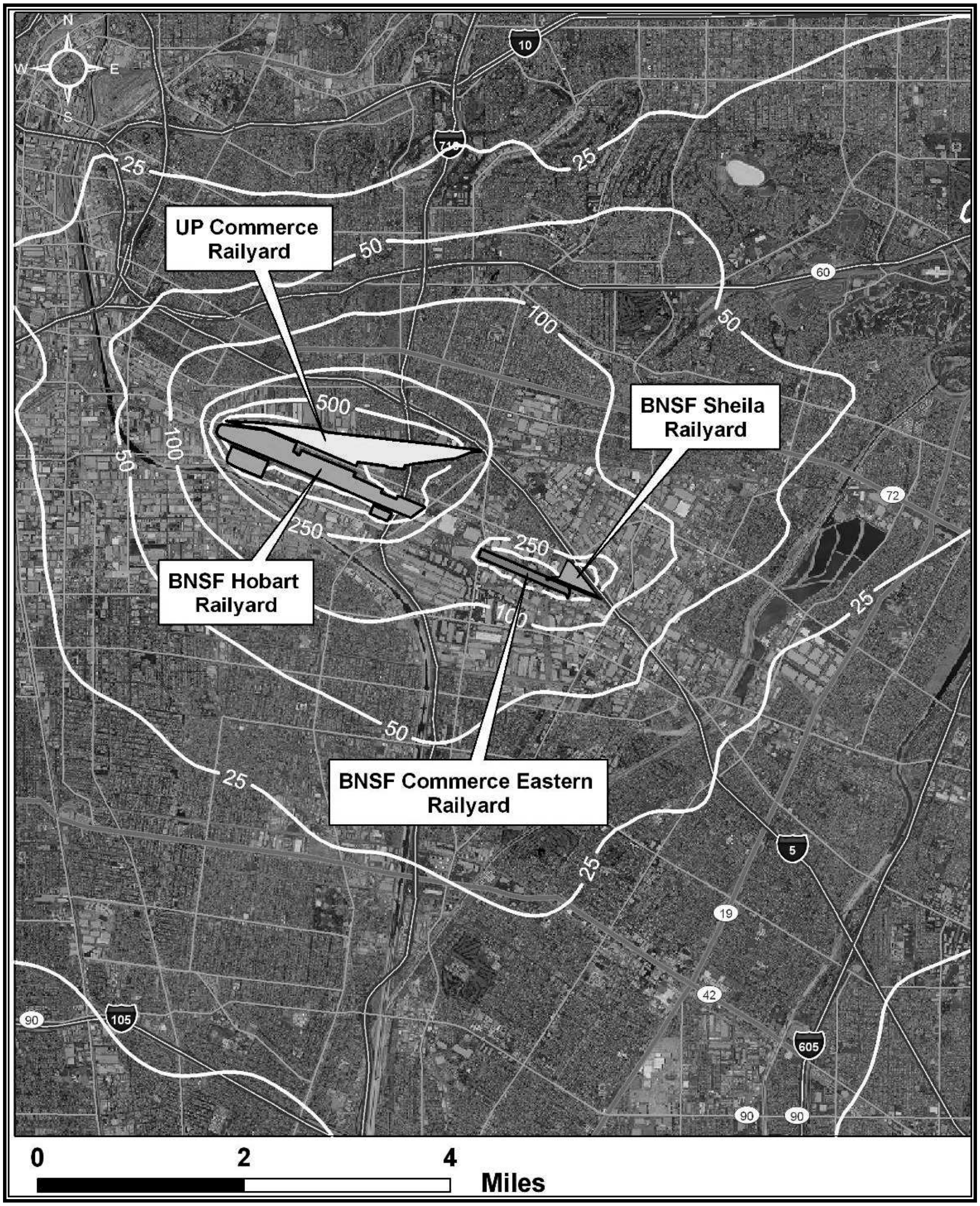


Figure II-3: Potential Estimated Regional Cancer Risks (chances per million people) from the Four Commerce Railyards



The OEHHA Guidelines recommend a 70-year lifetime exposure duration to evaluate the potential cancer risks for residents. Shorter exposure durations of 30 years and 9 years may also be evaluated for residents and school-aged children, respectively, as a supplement. These three exposure durations – 70 years, 30 years, and 9 years – all assume exposure for 24 hours a day, and 7 days a week. It is important to note that children, for physiological as well as behavioral reasons, children have higher rates of exposure than adults on a per unit body weight basis (OEHHA, 2003).

To evaluate the potential cancer risks for off-site workers, the OEHHA Guidelines recommend that a 40-year exposure duration be used, assuming workers have a different breathing rate 149 L kg^{-1} day^{-1} and exposure for an 8-hour workday, five days a week, 245 days a year.

Table II-5 shows the equivalent risk levels of 70- and 30-year exposure durations for exposed residents; and 40- and 9-year exposure durations for off-site workers and school-age children, respectively. As shown in Table II-5, the 10 in a million isopleth line in Figure II-4 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 II-5: Equivalent Potential Cancer Risk Levels for 70-, 40-, 30- and 9-Year Exposure Durations

Exposure Duration (years)	Equivalent Risk Level (Chances 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.

Table II-6: Estimated Impacted Areas and Exposed Population Associated with Different Cancer Risk Levels for the Four Commerce Railyards

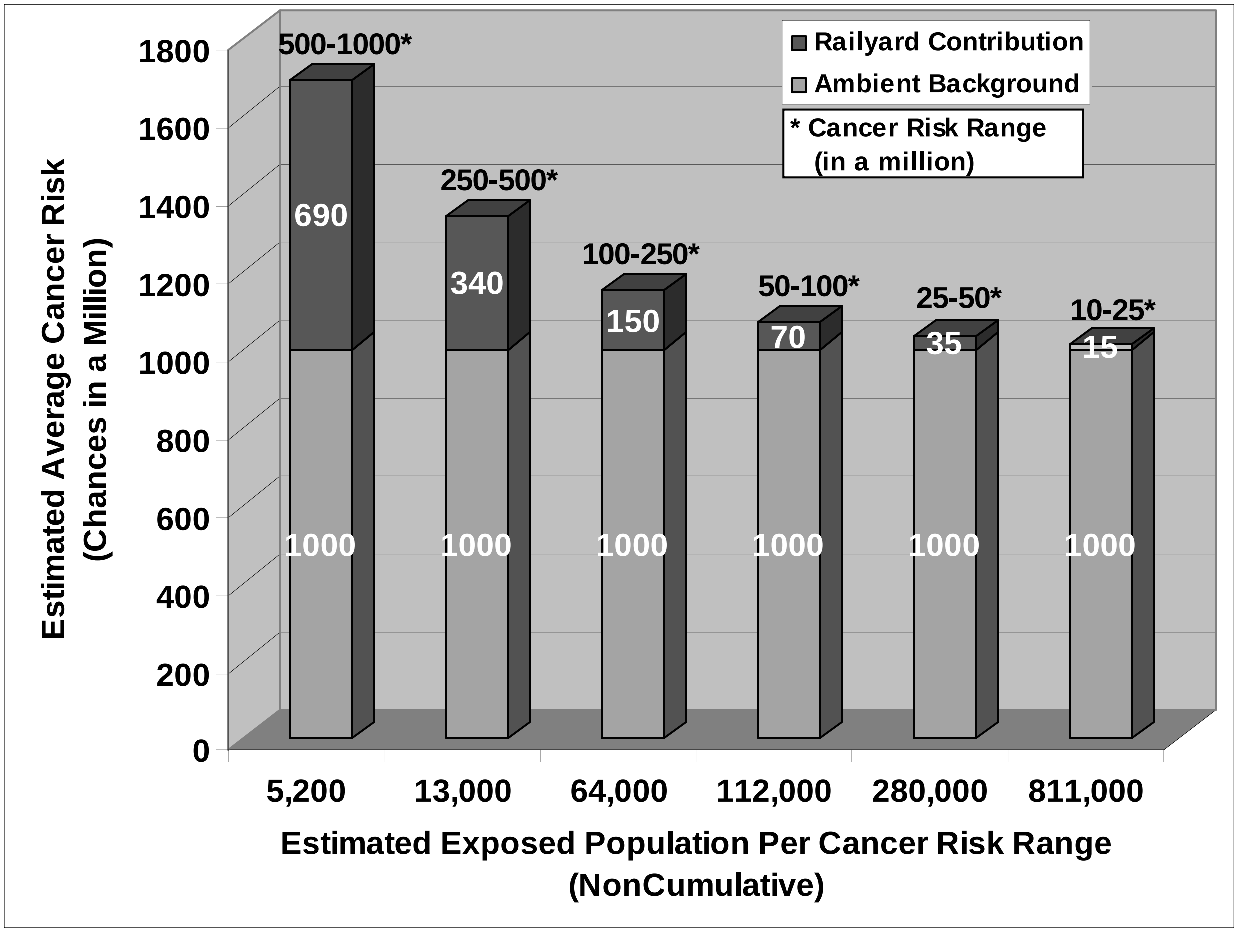
Estimated Cancer Risks (chances per million)	Estimated Area (acres)	Estimated Exposed Population
10 - 25	45,000*	811,000*
26 - 50	18,000*	280,000*
51 - 100	7,800	112,000
101 - 250	3,300	64,000
251 - 500	900	13,000
501 - 1000	550	5,200
Total	**76,000****	**1,285,200****

* Approximate estimates due to the fact that part of these isopleths exceeds the air dispersion model domain.
** Number may not add up due to rounding-off.

The four Commerce Railyards are located in the City of Commerce which has a population of about 13,000. The residential areas near the two larger railyards (UP Commerce and BNSF Hobart) are located mostly to the north and northeast of the railyard. The Ayers-Leonis community within the City of Commerce, with about 300 to 400 residents, is located in between the UP Commerce and the BNSF Hobart railyards and west of I-710, and has the highest estimated potential cancer risk of over 800 chances per million. Based on the 2000 U.S. Census Bureau's data, the zone of impact for an estimated risk of more than 10 chances per million encompasses approximately 76,000 acres, where about 1,300,000 residents live. Table II-6 presents the exposed population and impacted areas for various cancer risk ranges for the four Commerce railyards.

It is important to understand that the risk levels from the four Commerce railyards represents the predicted risks above the existing background risk levels of diesel PM emissions in the region. Although emissions from the railyard also contribute to the regional background, the measurable effect is small. For the whole 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-4 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 500 in a million, the estimated average potential cancer risk above the regional background is 690 chances in a million. If you combine the background levels of 1,000 in a million with the elevated average estimated potential cancer risk of the four combine Commerce railyards, the residents living in that area would have a potential combined cancer risk of about 1,700 in a million.

Figure II-4: Comparison of Estimated Potential Cancer Risks from the Four Commerce Railyards and the Regional Background Risk Levels

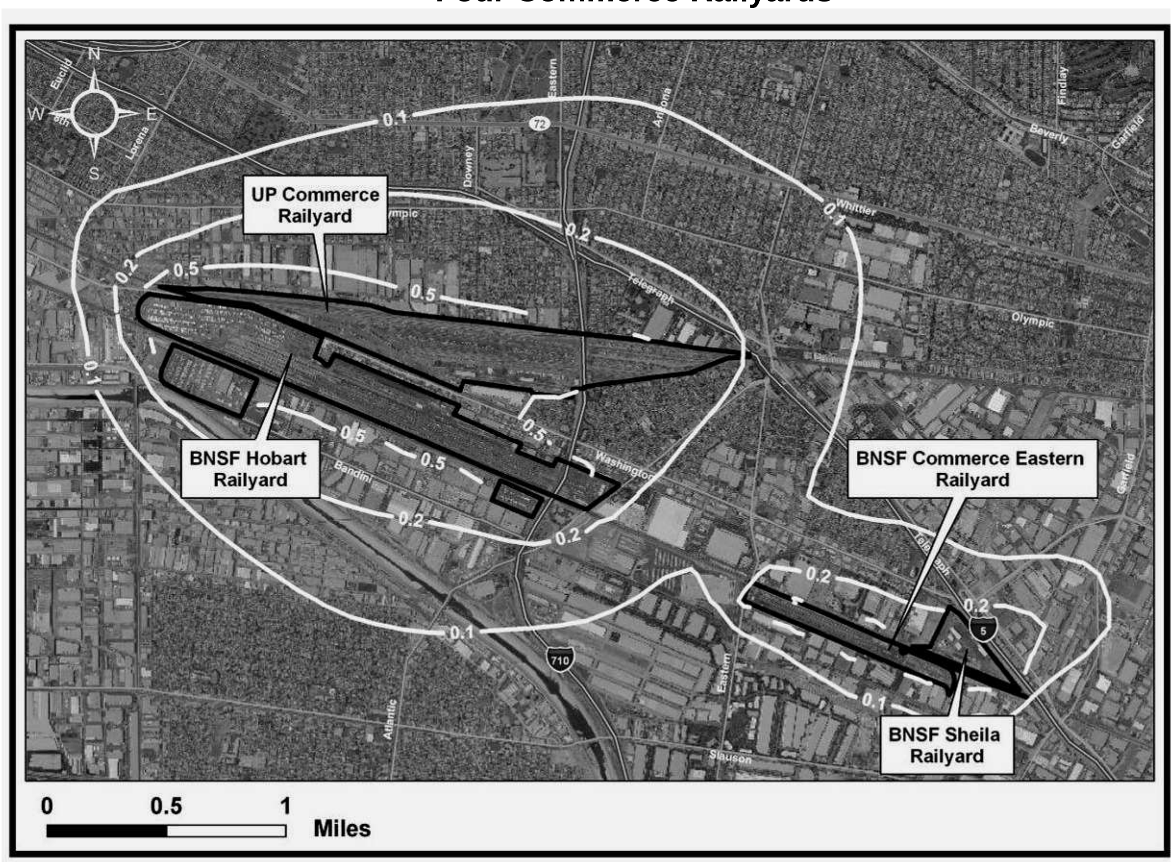


D. What are the estimated non-cancer health risks from the Four Commerce Railyards?

The potential non-cancer chronic health hazard index (HI) from the cumulative diesel PM emissions from the four Commerce railyards are estimated to be over 0.1 for about 3,300 acres (Figure II-5). The non-cancer chronic health hazard index is estimated to be about 0.5 within 100 yards from the UP Commerce and the BNSF Hobart railyards boundaries. According to OEHHA Guidelines (OEHHA, 2003), these levels indicate that potential non-cancer chronic public health risks are less likely to happen. A small region right next to the northwest side of the UP Commerce Railyard fence line has a hazard index value over 1.0. The land use of this region is identified as industrial.

Due to the uncertainties in the toxicological and epidemiological studies, diesel PM as a whole was not assigned a short-term acute reference exposure level (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 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 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.

Figure II-5: Estimated Non-Cancer Chronic Health Hazard Index from the Four Commerce Railyards



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

ARB staff evaluated the health impacts from off-site pollution sources near the four Commerce Railyards 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 was 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 the BNSF Hobart

Railyard and the other three railyards operating in the city of Commerce are not analyzed in the off-site air dispersion modeling. The estimated potential cancer risks and non-cancer chronic health hazard index associated with off-site diesel PM emissions are illustrated in Figure II-6 and Figure II-7 respectively. As indicated in Figure II-6, the zone of impacts of estimated cancer risks associated with off-site diesel PM emissions is significantly larger than that of the combined four Commerce Railyards. This result is expected because the diesel PM emissions from the significant off-site sources are equivalent to three times the four combined Commerce Railyards diesel PM emissions.

Based on the 2000 U.S. Census Bureau's data, the impact zone around the four Commerce railyards (due to off-site diesel PM emissions), with potential cancer risks above 100 chances in a million, is estimated at about 28,300 acres with about 430,000 residents as shown in Table II-7. For comparison with on-site potential risks, the same levels of above 100 chances in a million covers about 5,000 acres with approximately 82,000 residents.

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 (chances 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
Total	198,000**	1,912,000**

* Approximate estimates due to the fact that part of these isopleths exceeds the air dispersion model domain.

** Number may not add up due to rounding-off.

Figure II-6: Estimated Cancer Risk Levels associated with-site Diesel PM Emissions

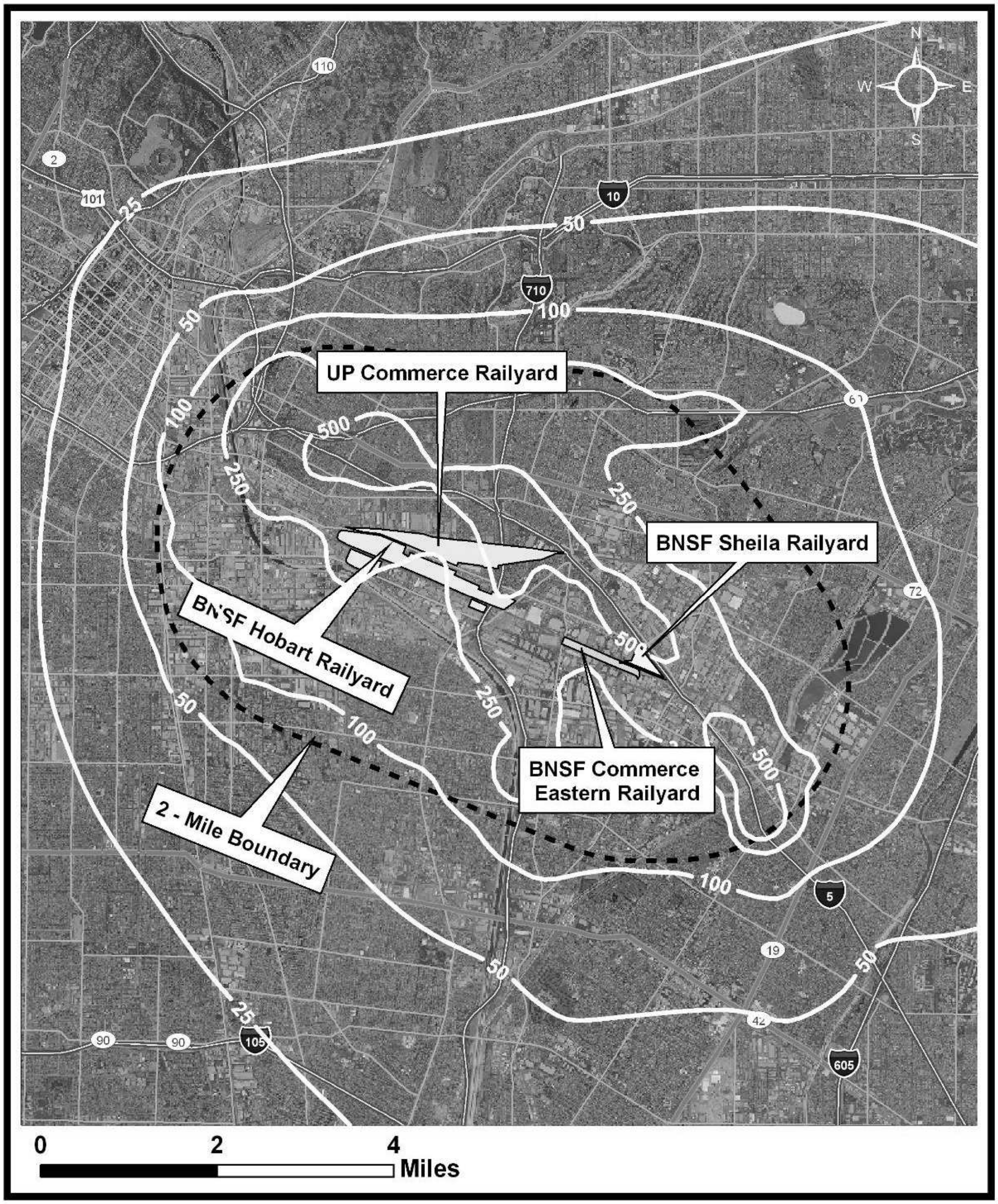
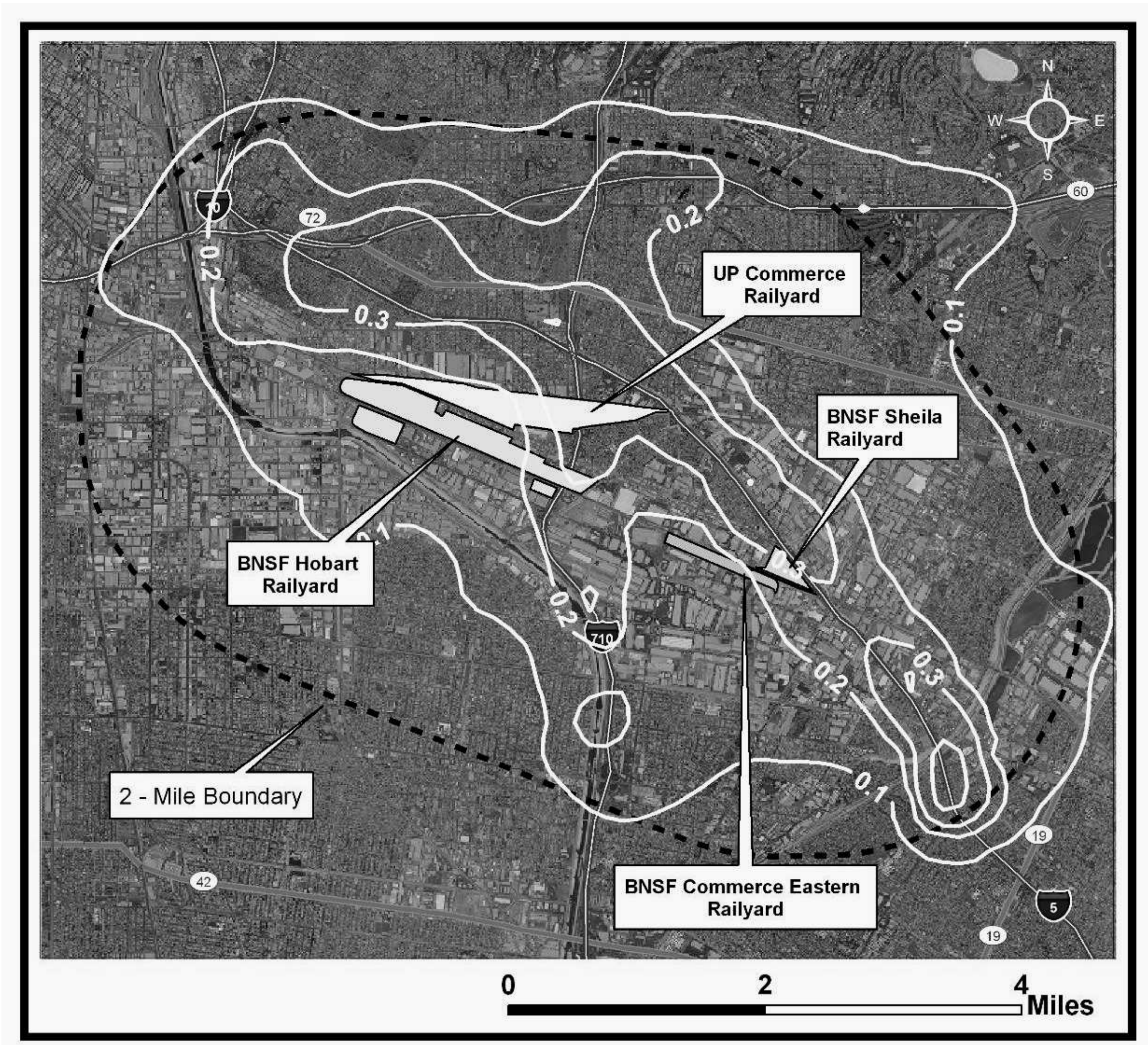


Figure II-7: Estimated Non-Cancer Chronic Health Hazard Index associated with Off-site Diesel PM Emissions within the Off-site Two-mile Joint Boundary.



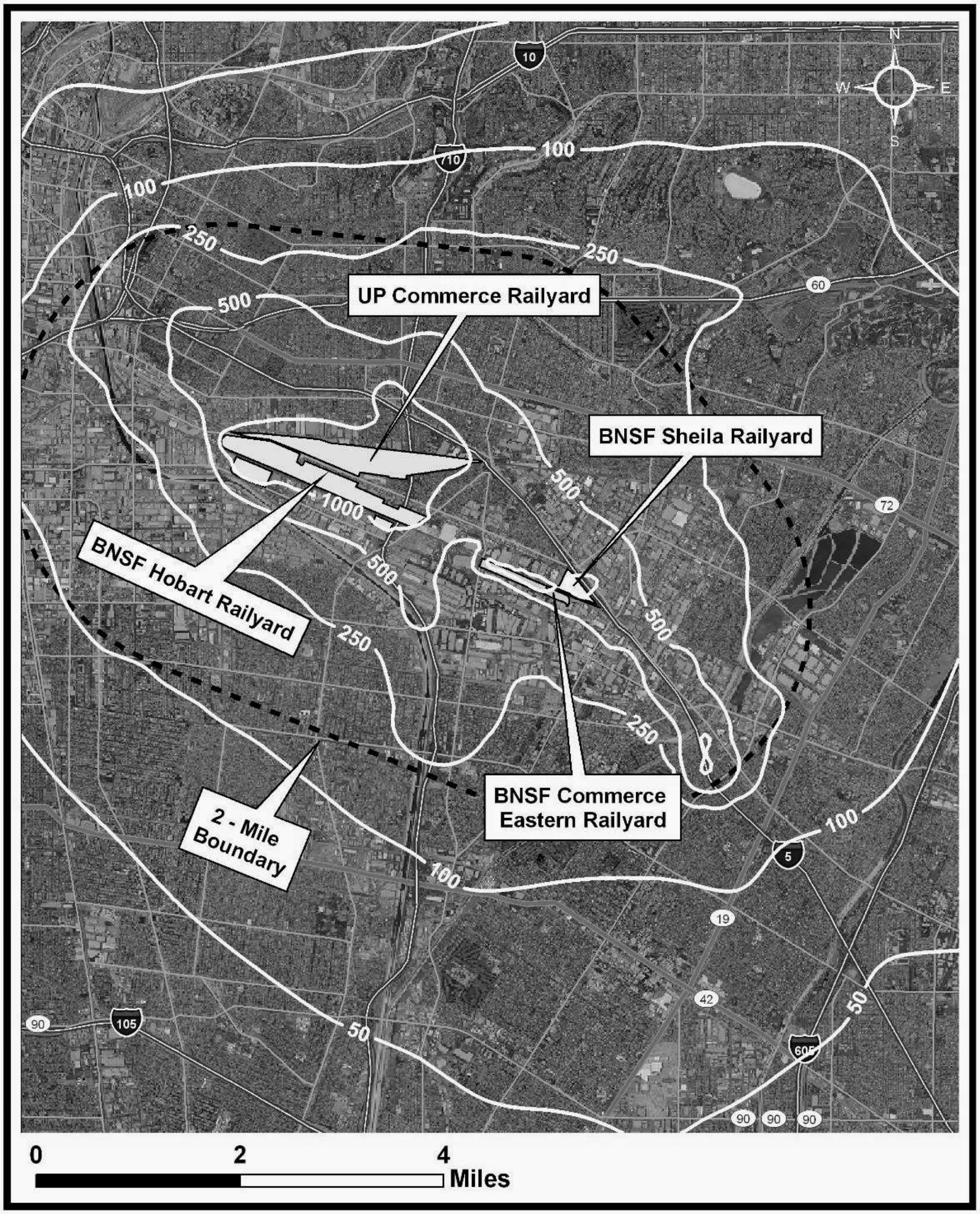
F. What are the Combined On-site and Off-site Total Diesel PM Emissions at the Four Commerce Railyards?

The combined on-site and off-site total diesel PM emissions at the four Commerce Railyards are estimated at 153 tons per year. The associated potential cancer risks levels are shown in Figure II-8. As can be seen from Figure II-8:

- The potential cancer risks are highest near the areas surrounding the two larger railyards (the UP Commerce and BNSF Hobart railyards) and two major freeways (I-5 and I-710) with an estimated cancer risk of about 1,000 chances per million. These potential cancer risks are mostly located to the north-northeast of the two larger railyards boundaries and are influenced by prevailing wind direction. Two smaller "islands" of 1,000 chances per million also surround each smaller railyard (the BNSF Sheila and BNSF Commerce Eastern railyards).

- The estimated 500 chances per million cancer risk level covers an area encompassing all four railyards and the two major freeways I-5 and I-710.
- The 250 chances per million cancer risk level cover a larger area which includes CA-60.

Figure II-8: Estimated Cancer Risk Levels of Total Diesel PM Emissions from On-site and Off-site Sources Near the Four Commerce Railyards



G. Modeling Receptors Networks

The modeling domain is defined as a 15 x 17.5 km (km: kilometers) region, which covers the railyard in the center of the domain and extends to the surrounding areas. To better capture the different concentration gradients surrounding the railyard area, ARB staff utilized a receptor grid network of 100 meter spacing (100m x 100m).

H. Risks to Sensitive Receptors

Certain individuals may be more sensitive to toxic exposures than the general population. These sensitive populations are identified as school-age children and seniors. The sensitive receptors may include schools, hospitals, day-care centers and elder care facilities. There are 45 such sensitive receptors around all of the four Commerce railyards, within the distance of two miles from the railyards' boundaries (as shown in Table II-8).

Table II-8: Number of Sensitive Receptors in Various Levels of Cancer Risks Associated with On-Site Diesel PM Emissions

Estimated Cancer Risk (chances per million)	Number of Sensitive Receptors
50 – 100	7
100 – 250	25
250 – 500	11
> 500	2

III. REFERENCES

ARB, 1998. For the "Proposed Identification of Diesel Exhaust as a Toxic Air Contaminant". April, 1998
http://www.arb.ca.gov/regact/diesltac/diesltac.htm

ARB, 2000. Risk Reduction Plan to Reduce Particulate Matter Emissions from Diesel-Fueled Engines and Vehicles, Staff Report, October, 2000.
http://www.arb.ca.gov/diesel/documents/rrpFinal.pdf

ARB, 2004a. Roseville Railyard Study, October, 2004.
http://www.arb.ca.gov/diesel/documents/rrstudy.htm

ARB, 2004b. ARB Recommended Interim Risk Management Policy for Inhalation-Based Residential Cancer Risk, March, 2004.
http://www.arb.ca.gov/toxics/harp/rmpolicyfaq.htm

ARB, 2005. ARB/Railroad Statewide Agreement: Particulate Emissions Reduction Program at the California Rail Yards. Sacramento, CA. June, 2005.
http://www.arb.ca.gov/railyard/ryagreement/ryagreement.htm

ARB, 2006a. Emission Reduction Plan for Ports and Goods Movement in California. March, 2006.
http://www.arb.ca.gov/planning/gmerp/gmerp.htm

ARB, 2006b. ARB Health Risk Assessment Guidance for Railyard and Intermodal Facilities. July, 2006.
http://www.arb.ca.gov/railyard/hra/hra.htm

ARB, 2006c. The California Almanac of Emission & Air Quality, 2006 edition.
http://www.arb.ca.gov/aqd/almanac/almanac06/almanac06iu.htm

ARB, 2006d. Diesel Particulate Matter Exposure Assessment Study for the Ports of Los Angeles and Long Beach, Final Report. April, 2006.
ftp://ftp.arb.ca.gov/carbis/msprog/offroad/marinevess/documents/portstudy0406.pdf

ARB, 2006e. ARB Rail Yard Emissions Inventory Methodology. July, 2006.
http://www.arb.ca.gov/railyard/hra/hra.htm

ENVIRON, 2006. Meteorological Data Selection and Processing Methodology for 2006 BNSF Designated Rail Yards. Emeryville, CA. July, 2006.
http://www.arb.ca.gov/railyard/hra/hra.htm

Krewski, D., Burnett, R.T., Goldberg, M.S., Hoover, K., Siemiatycki, J., Jarret, M., Abrahamowicz, M., White, W.H., Reanalysis of the Harvard Six Cities Study and the

American Cancer Society Study of Particulate Air Pollution and Mortality, Special Report, Health Effects Institute, Cambridge, MA, 2000.

Lloyd, A.C., Cackette, T.A., 2001. Diesel Engines: Environmental Impact and Control. *Journal of Air & Waste Management Association,* **51**, pp. 809-847.

OEHHA, 2000. Air Toxics Hot Spot Program Risk Assessment Guidelines: Part IV-Technical Support Document for Exposure Analysis and Stochastic Analysis. Office of Environmental Health Hazard Assessment. September, 2000.

OEHHA, 2002. Air Toxics Hot Spot Program Risk Assessment Guidelines: Part II-Technical Support Document for Describing Available Cancer Potency Factors. Office of Environmental Health Hazard Assessment. December, 2002.

OEHHA, 2003. Air Toxics Hot Spots Program Risk Assessment Guidelines: The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments. Office of Environmental Health Hazard Assessment. August, 2003.

Pope, C.A, III; Thun, M.J.; Namboodiri, M.M.; Dockery, D.W.; Evans, J.S.; Speizer, F.E.; Heath, J.C.W. 1995. Particulate Air Pollution as a Predictor of Mortality in a Prospective Study of U.S. Adults, *Am. J. Respir. Crit. Care. Med*. **151**, pp. 669-674.

Pope, C.A, III; Burnett, R.T.; Thun, M.J.; Calle, E.E.; Krewski, D.; Ito, K.; Thurston, G.D. 2002. Lung Cancer, Cardiopulmonary Mortality, and Long-Term Exposure to Fine Particulate Air Pollution, *J. Am. Med. Assoc.,* **287**, pp. 1132-1141.

Pope, C.A, III; Burnett, R.T.; Thurston, G.D.; Thun, M.J.; Calle, E.E.; Krewski, D.; Godleski., J.J. 2004. Cardiovascular Mortality and Long-Term Exposure to Particulate Air Pollution: Epidemiological Evidence of General Pathophysiological Pathways of Disease, *Circulation,* **109**, pp. 71-77.

SCAQMD, 2000. Multiple Air Toxics Exposure Study in the South Coast Air Basin (MATES-II), Final Report, March, 2000.

U.S. EPA, 2004a. User's Guide for the AMS/EPA Regulatory Model – AERMOD. Report No. EPA-454/B-03-001. Office of Air Quality Planning and Standards. Emissions Monitoring and Analysis Division, Research Triangle Park, NC. September, 2004.

U.S. EPA, 2004b. User's Guide for the AERMOD Meteorological Preprocessor. Report No. EPA-454/B-03-002. Office of Air Quality Planning and Standards. Emissions Monitoring and Analysis Division, Research Triangle Park, NC. September, 2004.

U.S. EPA, 2005. Federal Register, Part III, 40 CFR part 51, Vol. 70, No. 216, November 9, 2005.