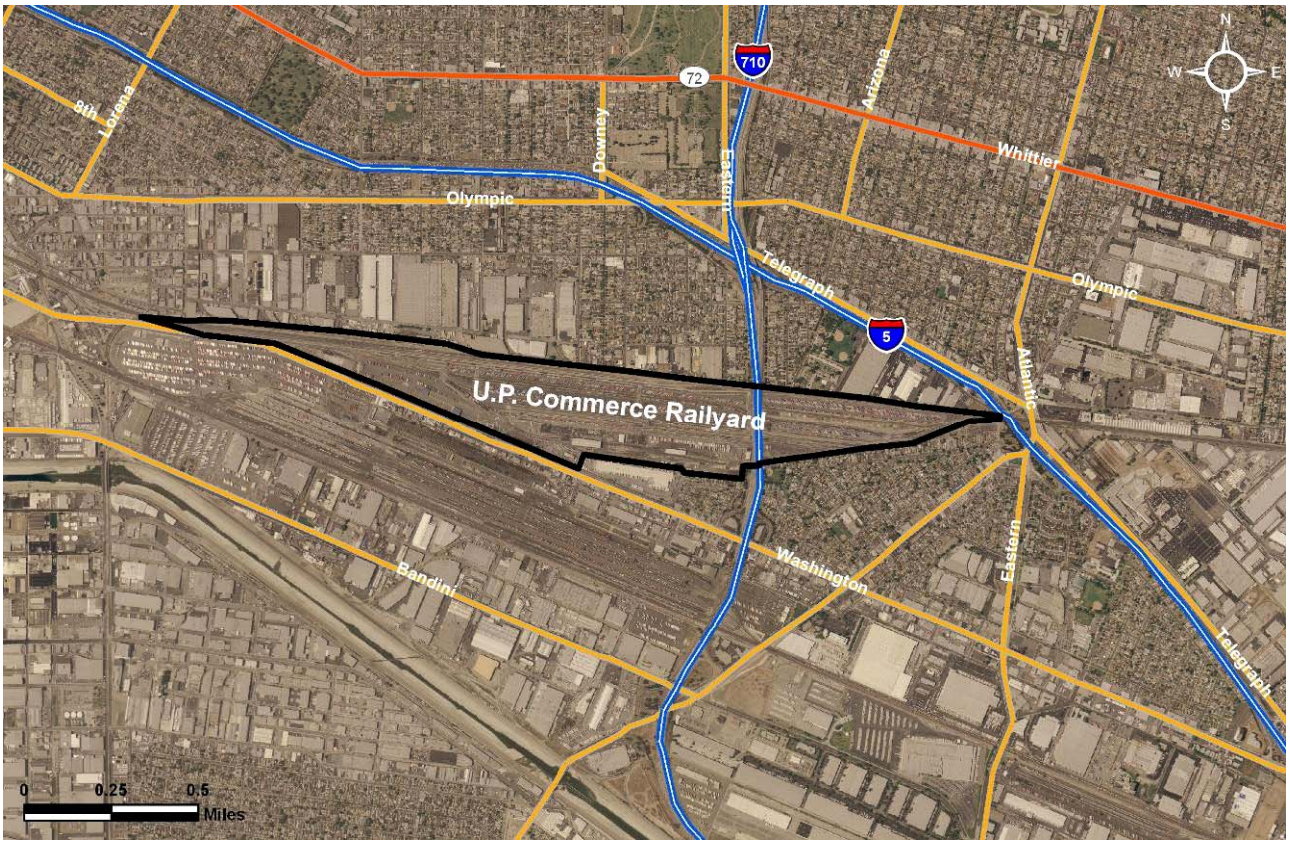
California Environmental Protection Agency

Air Resources Board

Draft Health Risk Assessment for the Union Pacific Railroad Commerce Railyard



Stationary Source Division
Release Date: May 23, 2007

California Environmental Protection Agency
Air Resources Board

Draft Health Risk Assessment for the Union Pacific Railroad Commerce Railyard

Principal Author
Jing Yuan, Ph.D.

Contributing Authors
Stationary Source Division:
Eugene Yang, Ph.D., P.E.
Chan Pham
Hector Castaneda

Planning and Technical Support Division:
Nicole Dolney
Beth Schwehr
Anthony Servin, P.E.
Stephen Zelinka
Johnnie Raymond

Reviewed by

ARB Executive Office:
Michael H. Scheible, Deputy Executive Officer

ARB Stationary Source Division:
Robert D. Fletcher, Chief, Stationary Source Division
Dean C. Simeroth, Chief, Criteria Pollutants Branch
Harold Holmes, Manager, Engineering Evaluation Section

The staff of the Air Resources Board has prepared this report. Publication does not signify that the contents reflect the views and policies of the Air Resources Board, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

This page left intentionally blank

Acknowledgements

Air Resources Board staff extends its appreciation to the representatives of Union Pacific Railroad and their consultants, Sierra Research and Air Quality Management Consulting, for preparing the railyard emissions inventories and air dispersion modeling simulations.

Union Pacific Railroad:
Lanny Schmid**,** Jon Germer, Brock Nelson, James Diel, Duffy Exon.

Sierra Research:
Gary Rubenstein, Brenda Douglass, Eric Walther, Ph.D.

Air Quality Management Consulting:
Robert G. Ireson, Ph.D.

This page left intentionally blank

Table of Contents

I. INTRODUCTION 1

A. WHY IS ARB CONCERNED ABOUT DIESEL PM EMISSIONS? 1

B. WHY EVALUATE DIESEL PM EMISSIONS AT THE UP COMMERCE RAILYARD? 2

C. WHAT ARE HEALTH RISK ASSESSMENTS (HRAS)? 2

D. WHO PREPARED THE UP COMMERCE RAILYARD HRA? 4

E. HOW IS THIS REPORT STRUCTURED? 4

II. SUMMARY 5

A. GENERAL DESCRIPTION OF THE UP COMMERCE RAILYARD 5

B. WHAT ARE THE PRIMARY OPERATIONS AT THE UP COMMERCE RAILYARD? 5

C. WHAT ARE THE DIESEL PM EMISSIONS IN AND AROUND THE UP COMMERCE RAILYARD? 6

1. Railyard 8
2. Surrounding Sources 9

D. WHAT ARE THE POTENTIAL CANCER RISKS FROM THE UP COMMERCE RAILYARD? 12

E. WHAT ARE THE ESTIMATED NON-CANCER RISKS NEAR THE UP COMMERCE RAILYARD? 18

F. WHAT ARE THE ESTIMATED HEALTH RISKS FROM OFF-SITE EMISSIONS? 19

G. CAN STUDY ESTIMATES BE VERIFIED BY AIR MONITORING? 20

H. WHAT ACTIVITIES ARE UNDERWAY TO REDUCE DIESEL PM EMISSIONS AND PUBLIC HEALTH RISKS? 20

III. UP COMMERCE RAILYARD DIESEL PM EMISSIONS 24

A. UP COMMERCE RAILYARD DIESEL PM EMISSIONS SUMMARY 24

1. Locomotives 28
2. Cargo Handling Equipment 29
3. On-Road Diesel-Fueled Trucks 30
4. TRUs and Reefer Cars 31
5. Heavy Equipment 32

B. CURRENT APPLICABLE DIESEL FUEL REGULATIONS AND THEIR BENEFITS TO THE RAILYARDS 32

1. California Air Resources Board (CARB) Diesel Fuel Specifications 32
2. U.S. EPA On-Road Diesel Fuel Specifications 33
3. U.S. EPA Non-Road Diesel Fuel Specifications 33
4. What are the Current Properties of In-Use Diesel Fuel? 34
5. Diesel Fuels Used by California-Based Locomotives 34

6. What are the Potential Overall Benefits from the Use of Lower Sulfur Diesel Fuels? ... 35

C. OFF-SITE DIESEL PM EMISSIONS SUMMARY ... 36

1. Mobile Sources ... 36

2. Stationary Sources ... 38

IV. AIR DISPERSION MODELING FOR THE UP COMMERCE RAILYARD ... 41

A. AIR DISPERSION MODEL SELECTION ... 41

B. SOURCE CHARACTERIZATION AND PARAMETERS ... 41

C. METEOROLOGICAL DATA ... 42

D. MODEL RECEPTORS ... 45

E. BUILDING WAKE EFFECTS ... 47

F. MODEL IMPLEMENTATION INPUTS ... 48

V. HEALTH RISK ASSESSMENT OF THE UP COMMERCE RAILYARD ... 49

A. HEALTH RISK ASSESSMENT GUIDELINES ... 49

B. EXPOSURE ASSESSMENT ... 50

C. RISK CHARACTERIZATION ... 52

1. Risk Characterization Associated with On-Site Emissions ... 53

2. Risk Characterization Associated with Off-Site Emissions ... 61

3. Risks to Sensitive Receptors ... 63

D. UNCERTAINTY AND LIMITATIONS ... 64

1. Emission Inventory ... 64

2. Air Dispersion Modeling ... 65

3. Risk Assessment ... 66

VI. REFERENCES ... 68

LIST OF TABLES

Table II-1: Comparison of Diesel PM Emissions from Eleven Railyards (tons per year) 8
Table II-2: UP Commerce Railyard and Surrounding Areas Diesel PM Emissions in 2005 11
Table II-3: Potency Weighted Toxic Emissions from Significant Off-Site Stationary Sources Surrounding UP Commerce Railyard 12
Table II-4: Emissions of Major Toxic Air Contaminants from Gasoline Exhausts in South Coast Air Basin 12
Table II-5: Equivalent Potential Cancer Risk Levels for 70-, 40-, 30- and 9-Year Exposure Durations 15
Table II-6: Estimated Impacted Areas and Exposed Population Associated with Different Cancer Risk Levels Estimated for Railyard Diesel PM Emissions 15
Table II-7: Estimated Impacted Areas and Exposed Population Associated with Different Cancer Risk Levels Estimated for Off-Site Diesel PM Emissions 20
Table III-1: UP Commerce Railyard Activities 25
Table III-2: Summary of the UP Commerce Railyard Diesel PM Emissions 25
Table III-3: Locomotive Diesel PM Emissions 29
Table III-4: Cargo Handling Equipment Diesel PM Emissions 30
Table III-5: UP Commerce Railyard On-Road Truck Diesel PM Emissions 31
Table III-6: California Diesel Fuel Standards 32
Table III-7: U.S. EPA Diesel Fuel Standards 34
Table III-8: Average 1999 Properties of Reformulated Diesel Fuel 34
Table III-9: Off-site Mobile Source Diesel PM Emissions by Vehicle Type 37
Table III-10: Off-site Mobile Source Diesel PM Emissions by Freeways 38
Table III-11: Potency Weighted Toxic Emissions from Significant Off-Site Stationary Sources Surrounding UP Commerce Railyard 39
Table III-12: Emissions of Major Toxic Air Contaminants from Gasoline Exhausts in South Coast Air Basin 40
Table V-1: Potency Weighted Toxic Emissions from Significant Off-Site Stationary Sources Surrounding UP Commerce Railyard 51
Table V-2: Emissions of Major Toxic Air Contaminants from Gasoline Exhausts in South Coast Air Basin 52
Table V-3: Equivalent Potential Cancer Risk Levels for 70-, 40-, 30- and 9-Year Exposure Durations 54
Table V-4: Estimated Impacted Areas and Exposed Population Associated with Different Cancer Risk Levels Estimated for Railyard Diesel PM Emissions 55
Table V-5: Estimated Impacted Areas and Exposed Population Associated with Different Cancer Risk Levels Estimated for Off-Site Diesel PM Emissions 61
Table V-6: Estimated Number of Sensitive Receptors in Various Levels of Cancer Risks associated with On-Site Diesel PM Emissions 64

LIST OF FIGURES

Figure II-1: UP Commerce Railyard and Surrounding Areas 6
Figure II-2: Off-Site Two-Mile Joint Boundaries (Dashed Line) of the Four Commerce Railyards 7
Figure II-3: Estimated Near-Source Cancer Risks (chances per million people) from the UP Commerce Railyard 14
Figure II-4: Estimated Regional Cancer Risks (chances per million people) from the UP Commerce Railyard 16
Figure II-5: Estimated Cancer Risk Levels from Off-site Diesel PM Emissions 17
Figure II-6: Comparison of Estimated Potential Cancer Risks from the UP Commerce Railyard and the Regional Background Risk Levels 18
Figure III-1: The UP Commerce Railyard Emission Source Locations 27
Figure IV-1: Wind Rose Plot for Lynwood Station in 2005 44
Figure IV-2: Wind Class Frequency Distribution Plot for Lynwood Station Data in 2005 45
Figure IV-3: Fine and Medium Grid Receptor Networks 46
Figure IV-4: Coarse Grid Receptor Networks 47
Figure V-1: Estimated Near-Source Cancer Risks (chances per million people) from the UP Commerce Railyard 56
Figure V-2: Estimated Regional Cancer Risks (chances per million people) from the UP Commerce Railyard 57
Figure V-3: Estimated Non-Cancer Chronic Risk Health Hazard Index from the UP Commerce Railyard 60
Figure V-4: Estimated Cancer Risk Levels from Off-site Diesel PM Emissions 62
Figure V-5: Estimated Non-Cancer Chronic Health Hazard Index from Off-site Diesel PM Emissions 63

APPENDICES

A. METHODOLOGY FOR ESTIMATING OFF-SITE DIESEL PM MOBILE SOURCE EMISSIONS

B. METHODOLOGY FOR ESTIMATING OFF-SITE DIESEL PM STATIONARY SOURCE EMISSIONS

C. IMPACTS FROM OFF-SITE DIESEL PM EMISSION SOURCES

D. TABLE OF LOCOMOTIVE DIESEL PM EMISSION FACTORS

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

This page left intentionally blank

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 Union Pacific Railroad's (UP) railyard located in Commerce, California. 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 surrounding the UP Commerce Railyard. There are four railyards located in the city of Commerce (UP Commerce, BNSF Hobart, BNSF Commerce/Eastern, and BNSF Sheila Mechanical Railyard). 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[*] (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 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 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.

[*] 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.

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

In 2005, the ARB entered into a statewide railroad pollution reduction agreement (Agreement) with Union Pacific Railroad Company (UP) and BNSF Railway Company (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 UP Roseville Railyard HRA study in 2004, and the ARB draft *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, 2006d). The UP Commerce Railyard is one of the designated railyards subject to the Agreement and the HRA requirements.

C. What are Health Risk Assessments (HRAs)?

A health risk assessment use 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)[†] 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 sources in the South Coast Air Basin is about 7,750 tons per year in 2005 (ARB, 2006a). Diesel PM emissions in 2005 from the UP Commerce Railyard are estimated at about 11 tons per year, which is about 0.14% 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, 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 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

[†] 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.

often designed to be conservative on the side of health protection in order 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 UP Commerce Railyard HRA?

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 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, the railroads and their consultants (i.e., Sierra Research and Air Quality Management Consulting for the UP Commerce Railyard) 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 railroads' 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. 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 UP Commerce Railyard operations, emissions, air dispersion modeling, and health risk assessment results. Following the summary, the third chapter presents the details of the UP Commerce 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 UP Commerce 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 UP Commerce Railyard operations, emissions, air dispersion modeling, and health risk assessment results.

A. General Description of the UP Commerce Railyard

The Union Pacific (UP) Commerce railyard is located at 4341 East Washington Boulevard, Commerce, California, approximately 4 miles southeast of downtown Los Angeles (see Figure II-1). The UP Commerce Railyard runs directly parallel (for about a mile) and across Washington Boulevard from the largest intermodal railyard in the United States, BNSF Railway Hobart Railyard. The UP Commerce Railyard covers a triangular area surrounded by both residential and commercial properties, as well as several major freeways. An overpass for the I-710 freeway bisects the UP Commerce Railyard. To the south side of the railyard (on both side of the I-710 overpass), residences are located between the railyard fence line and Washington Boulevard. Bandini Elementary School is also located in this area. The north side of the UP Commerce Railyard is surrounded by commercial properties and residential housing. Residential properties are located north of the railyard on both sides of the I-710 freeway overpass, approximately 200 feet from the railyard.

Facilities within the railyard include: 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.

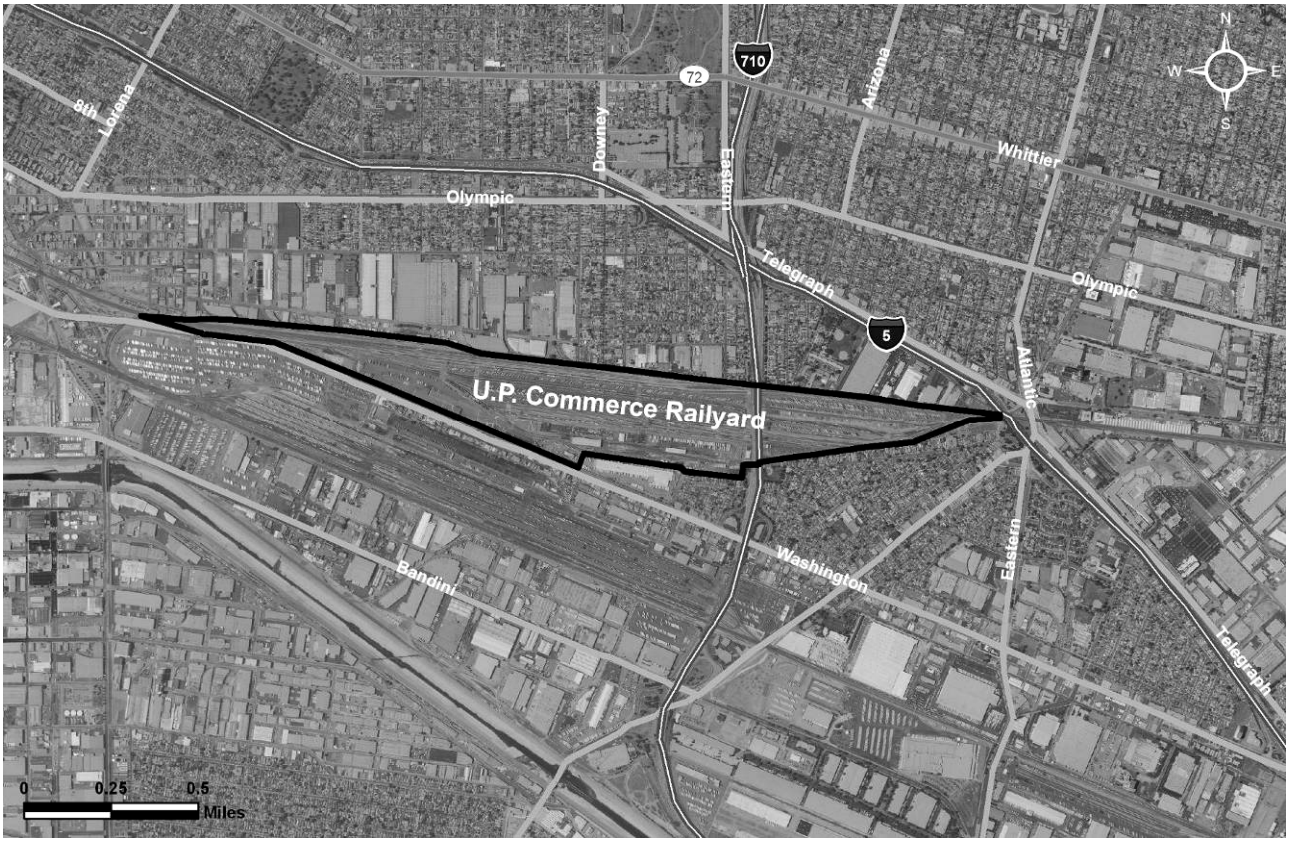
B. What are the primary operations at the UP Commerce Railyard?

The UP Commerce Railyard is a cargo handling facility with a focus on domestic containers, and processed an estimated 350,000 containers in 2005. Cargo containers and other freight are received, sorted, and distributed from the facility. Intermodal containers may arrive at the facility by truck to be loaded onto trains for transport to distant destinations, or arrive by train and unloaded onto chassis for transport by truck to local destinations. Cargo containers and chassis are also temporarily stored at the railyard. The railyard also includes facilities for crane and yard hostler maintenance, locomotive service and repair, and on-site wastewater treatment.

Activities at the UP Commerce Railyard include receiving inbound trains, switching rail cars, loading and unloading intermodal trains, storing intermodal containers and truck chassis, building and departing outbound trains, and repairing freight cars and intermodal containers/chassis. The railyard includes a bypassing main line with freight and passenger train traffic that is not part of the railyard operations.

Within the railyard, the primary locomotive operations are associated with arriving, departing, and servicing interstate line haul locomotives. Arriving and departing line

Figure II-1: UP Commerce Railyard and Surrounding Areas



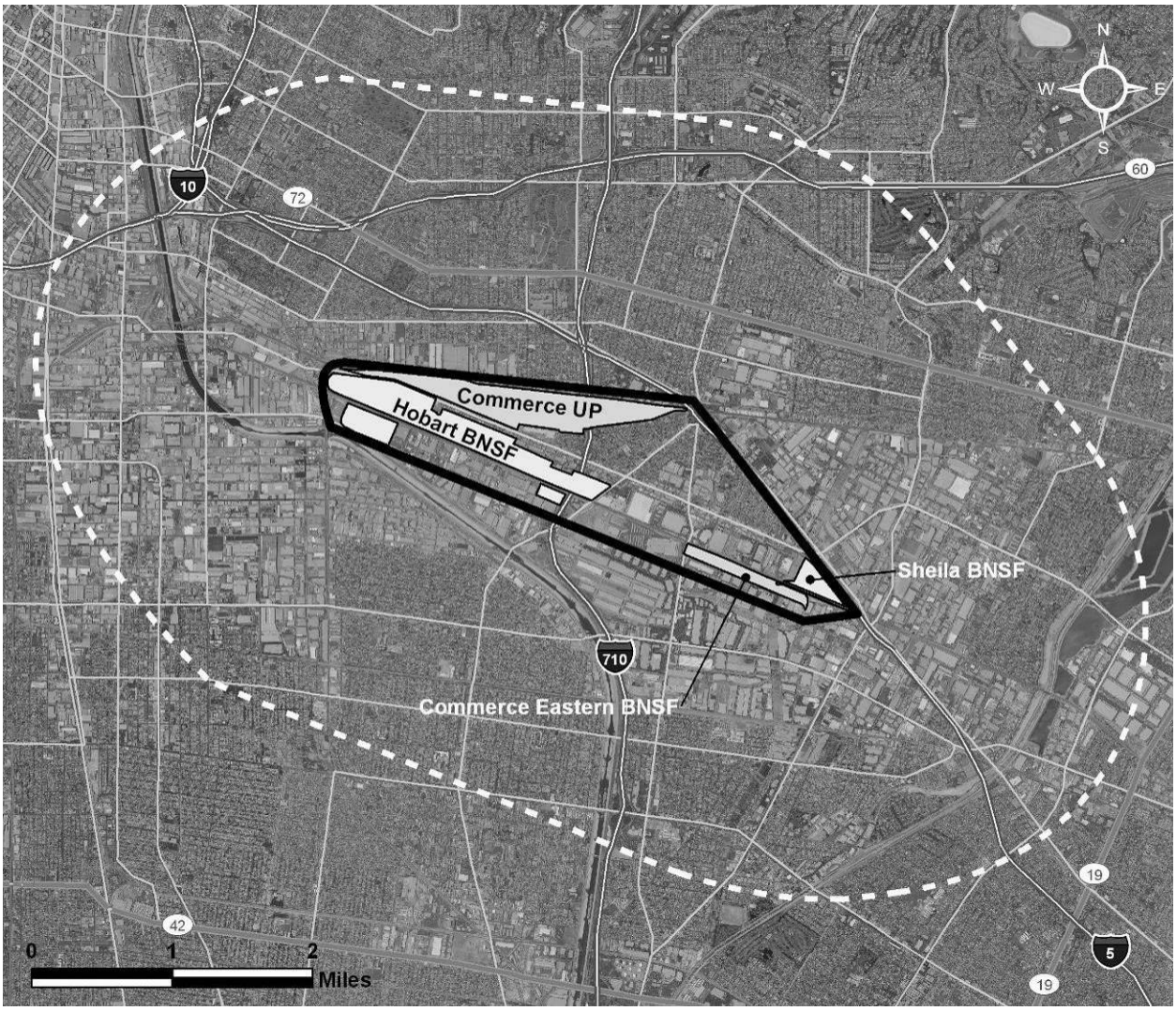
haul locomotives are fueled in the locomotive service area after arrival, and are sent back into the railyard or to other railyards after service. A locomotive maintenance shop also performs periodic and unscheduled maintenance on locomotives. Three switch locomotives (i.e., dedicated to moving rail cars within the railyard) also operate within the railyard— one on the west end of the railyard, and a pair on the east end of the railyard. They are used to move sections of inbound trains to appropriate areas within the railyard (e.g., intermodal rail cars go to the intermodal ramp for unloading and loading), and to move sections of outbound trains to tracks from which they will depart.

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

In 2005, the combined diesel PM emissions from the UP Commerce Railyard (on-site emissions) and other significant emission sources within a two-mile distance from the joint boundaries of the four Commerce railyards (off-site emissions) are estimated at about 124 tons per year (see Figure II-2), 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 91% of the total combined on-site and off-site diesel PM emissions. Off-site stationary sources contribute less than 400 pounds per year of the diesel PM emissions. The UP Commerce Railyard diesel PM emissions are estimated at about

11.2 tons per year, which accounts for about 9% of the total combined on-site and off-site diesel PM emissions.

Figure II-2: Off-Site Two-Mile Joint Boundaries (Dashed Line) of the Four Commerce Railyards



To provide a perspective on the railyards 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 UP Commerce Railyard ranks third among these eleven 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 25.1 tons per year.
‡ Not applicable.
§ Numbers may not add precisely due to rounding.

1. Railyard

The UP Commerce Railyard emission sources include, but are not limited to, locomotives, on-road diesel-fueled trucks, cargo handling equipment, heavy equipment, transport refrigeration units (TRUs) and refrigerated rail cars (reefer cars), and fuel storage tanks. The facility operates 24 hours a day, 365 days a year. The UP Commerce Railyard 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 the ARB draft *Rail Yard Emissions Inventory Methodology* (ARB, 2006c).

As indicated by Table II-2, locomotive operations within the railyard are responsible for an estimated 4.9 tons per year of diesel PM emissions (about 44% of the total on-site emissions). Of the emissions from locomotives, yard operations (primarily switch locomotives moving rail cars within the facility), contribute the largest amount of locomotive diesel PM emissions at about 1.9 tons per year. Locomotive service and testing activities account for 1.7 tons per year, and line haul freight and pass-through trains contribute 1.3 tons per year of the diesel PM emissions. Cargo handling equipment (CHE) operated within the yard, such as cranes and yard hostlers, emit about 3.9 tons per year of diesel PM, consisting of about 35% of the total on-site emissions. Diesel-fueled trucks and other vehicles contribute about 2 tons per year, which are about 18% of the total on-site diesel PM emissions. Locomotives, CHE, and

diesel-fueled trucks engaging in direct intermodal operations produce about 97% of the railyard diesel PM emissions. The remaining 3% of the on-site diesel PM emissions are generated by a variety of other sources including transport refrigeration units (TRUs), refrigerated rail cars, and heavy equipment.

Diesel PM is not the only toxic air contaminant (TAC) emitted in the UP Commerce Railyard. A relatively small amount of gasoline toxic air contaminants is generated from gasoline storage tanks and gasoline-powered vehicles and engines, including isopentane, toluene, benzene, etc. Some other toxic air contaminants, such as xylene, are emitted from the wastewater treatment plant. The detailed emission inventories for these TACs are presented in the *Toxic Air Contaminant Emissions Inventory and Dispersion Modeling Report for the Commerce Rail Yard, Los Angeles, California* (Sierra Research, 2007). The total amount of these toxic air contaminants emissions is about 0.07 tons or 140 pounds per year, compared to the 11 tons per year of the diesel PM emissions in the railyard.

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 on Table II-3), these non-diesel PM toxic air contaminants have less than a thousandth of the potency weighted emissions as compared to diesel PM (0.0007 vs. 11.23 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 UP Commerce Railyard. The Health Risk Assessment study for the UP Roseville Railyard (ARB, 2004a) indicated that 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 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.

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 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 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 which emit around 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. There are some stationary sources that 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 other three railyards located in the city of Commerce.

Diesel PM emissions from sources in the UP Commerce Railyard and the 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 UP Commerce 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 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's *Risk Reduction Plan to Reduce Particulate Matter Emissions from Diesel-Fueled Engines and Vehicles* (ARB, 2000), diesel PM, 1,3-butadiene, benzene, carbon tetrachloride, and formaldehyde are defined as the top 5 potential cancer risk contributors, based on ambient concentrations. These TACs account for 95% of the State's estimated potential cancer risk levels. This study also concluded that diesel PM contributes over 70% of the state's estimated potential cancer risk levels, which are significantly higher than other TACs (ARB, 2000). Among the off-site TACs emissions, the top 5 cancer risk contributors (without diesel PM) are estimated at about 1.6 tons per year.

Table II-2: UP Commerce Railyard and Surrounding Areas Diesel PM Emissions in 2005

DIESEL PM EMISSION SOURCES	UP Commerce Railyard		Off-site Emissions*	
	Tons/Year	Percentage	Tons/Year	Percentage
LOCOMOTIVES	**4.9**	**44%**	-	-
- Switch Locomotives (conducting yard operations)	*1.9*	*17%*	-	-
- Service/Testing	*1.7*	*15%*	-	-
- Freight & Through Trains	*1.3*	*12%*	-	-
CARGO HANDLING EQUIPMENT	**3.9**	**35%**	-	-
ON-ROAD TRUCKS	**2.0**	**18%**	-	-
OTHERS (Heavy Equipment and TRUs)	**0.4**	**3%**	-	-
OFF-SITE MOBILE SOURCES (e.g., heavy duty trucks, etc.)	**-**	-	**113.2**	**100 %**
OFF-SITE STATIONARY SOURCES (e.g., public facilities, public utilities, etc.)	**-**	-	**0.2**	**< 1%**
TOTAL	**11.2**	**100%**	**113.4**	**100%**

*: Exclude emissions occurring at the other three railyards in the Commerce area.

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 weighting 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 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, which is substantially less than the diesel PM emissions.

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 $(mg/kg\text{-}day)^{-1}$.

In addition, ARB staff evaluated the potential cancer risk levels caused 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, 2006a). As indicated in Table II-4, the cancer 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 II-3: Potency Weighted Toxic Emissions from Significant Off-Site Stationary Sources Surrounding UP Commerce 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‡	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.

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	**816**	3,829	**438**

**: Based on cancer potency weighting factors.

D. What are the potential cancer risks from the UP Commerce 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*

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

Risk Assessment Guidelines (OEHHA, 2003) published by the 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 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 UP Commerce Railyard were evaluated and the data from the 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.

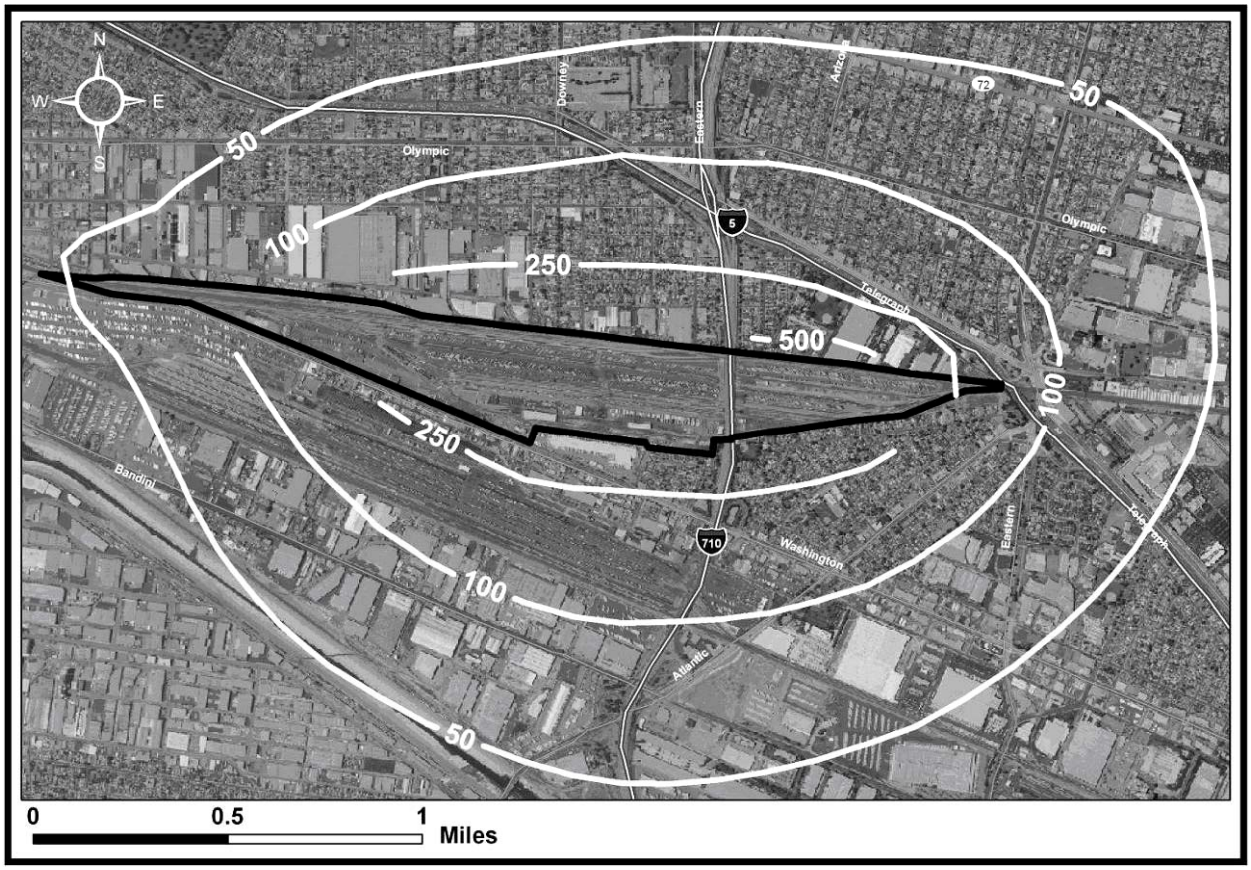
The potential cancer risks levels associated with the estimated diesel PM emissions at the UP Commerce Railyard are displayed by using isopleths. For this analysis, ARB staff elected to present the cancer risk isopleths focusing on risk levels of 10, 25, 50, 100, 250, and 500 in a million. Figure II-3 and Figure II-4 present these isopleths. Figure II-3 focuses on the near source risk levels 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 UP Commerce 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 facility boundary, is predicted to be located at the north side of the railyard fence line, between freeway I-710 and I-5 (see Figure II-3). The maximum individual cancer risk is estimated to be about 650 chances in a million. The land use in the vicinity of the point of maximum impact is industrial use. In the residential area, the highest potential cancer risk is estimated at about 500 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 indicated by Figure II-3, the area with the greatest impact has an estimated potential cancer risk of over 500 chances in a million, occurring in a small area next to the north side of the railyard fence line, between freeway I-710 and I-5. The estimated cancer

risk is over 250 chances per million within approximately 400 yards from the east side of railyard property boundaries. At about a half mile from the railyard boundaries, the estimated cancer risks decrease to about 100 chances per million.

Figure II-3: Estimated Near-Source Cancer Risks (chances per million people) from the UP Commerce Railyard



As indicated by Figure II-4, the risks further decrease to 50 in a million within about 1 mile from the railyard, then to 25 in a million at approximately a 2 mile distance from the railyard boundaries. At about 4 miles from the railyard boundaries, the estimated cancer risks are at 10 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 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 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 workers and school-age children, respectively. As Table II-5 shows, 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.

The more populated areas near the UP Commerce Railyard are located north and southeast of the railyard. Based on the 2000 U.S. Census Bureau's data, the zone of impact of the estimated risks above 10 chances in a million levels encompasses approximately 17,430 acres where about 270,000 residents live. Table II-6 presents the exposed population and area coverage size for various impacted zones of cancer risks.

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

Estimated Cancer Risk (chances per million)	Impacted Area (Acres)	Estimated Population Exposed
10 - 25	11,830	187,000
26 - 50	3,270	56,000
51 - 100	1,450	15,000
101 - 250	710	9,700
251-500	160	2,200
>500	10	100

Figure II-4: Estimated Regional Cancer Risks (chances per million people) from the UP Commerce Railyard

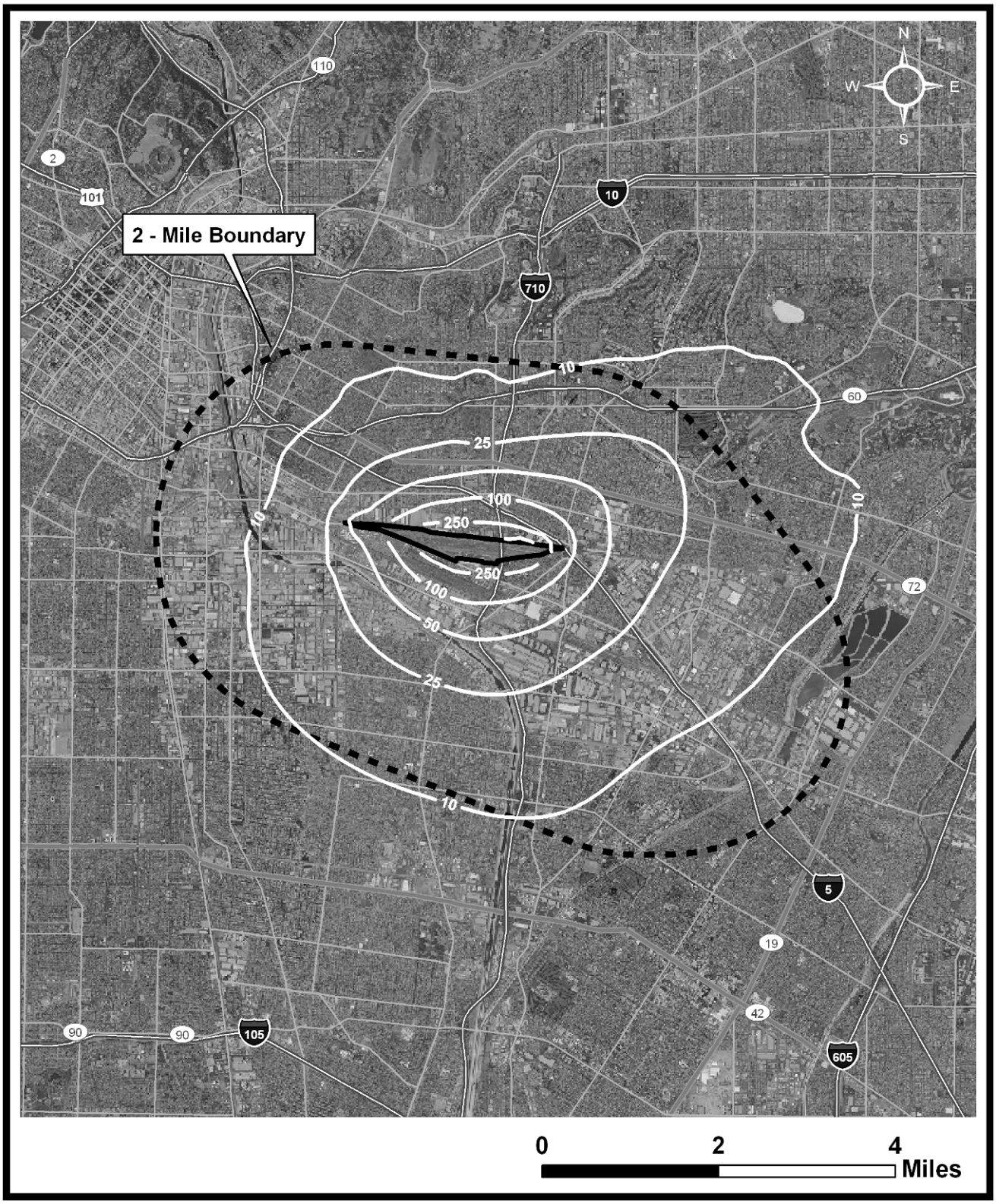
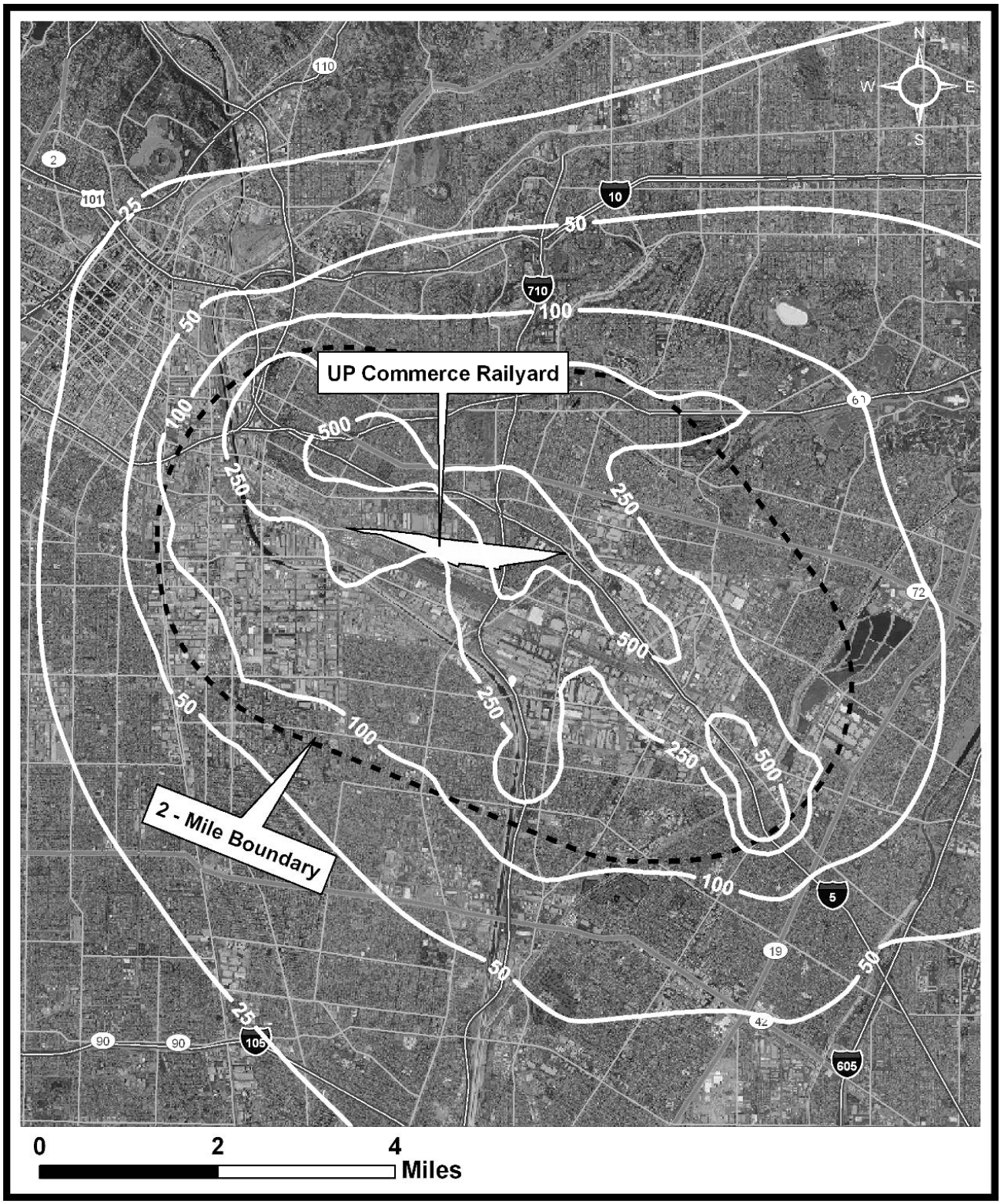
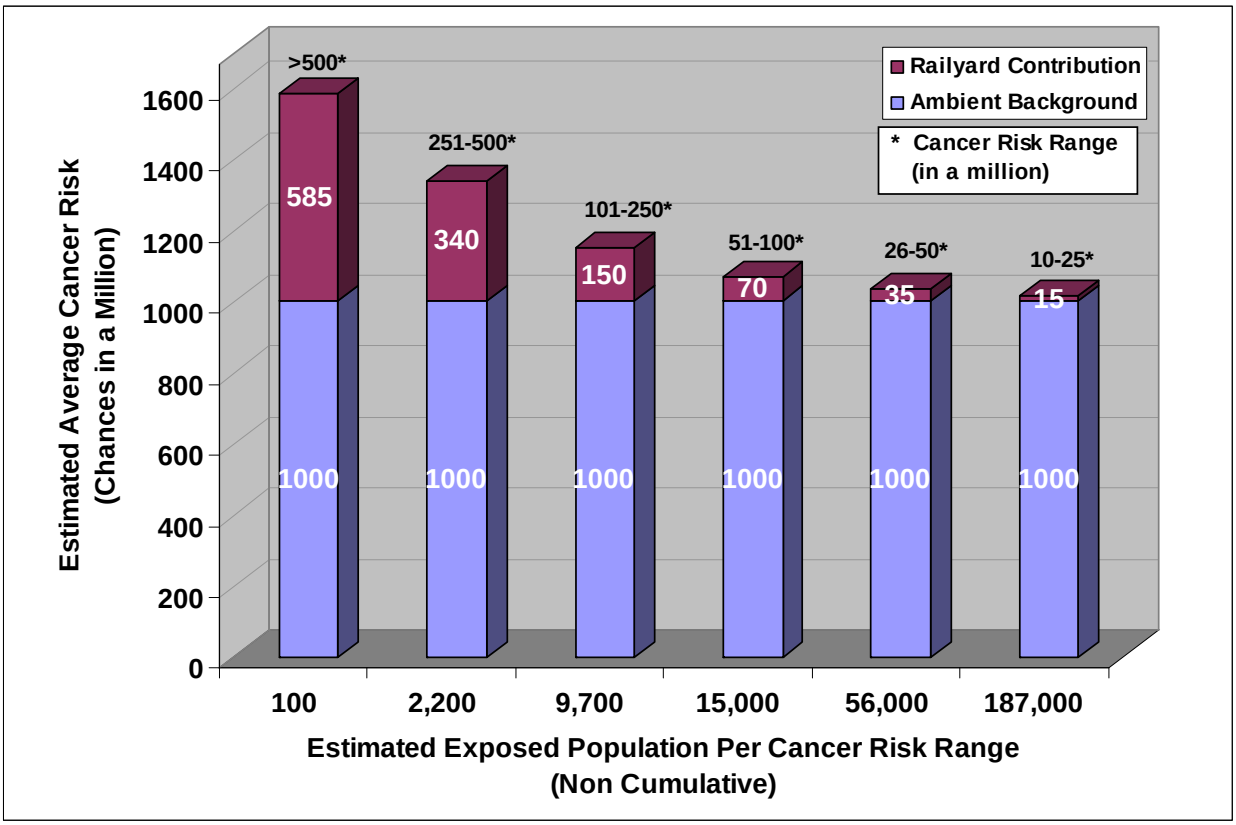


Figure II-5: Estimated Cancer Risk Levels from Off-site Diesel PM Emissions



It is important to understand that these risk levels represent the predicted risks (due to the UP Commerce 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 about 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 500 chances in a million, the estimated average potential cancer risk above the regional background is 585 chances per million. Therefore, residents living in that area would have a potential cancer risk at about 1,600 in a million.

Figure II-6: Comparison of Estimated Potential Cancer Risks from the UP Commerce Railyard and the Regional Background Risk Levels



E. What are the estimated non-cancer risks near the UP Commerce Railyard?

The potential non-cancer chronic health hazard index from diesel PM emissions from the UP Commerce 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 Railyards studies are completed, the downwind diesel PM emissions from the three other BNSF Commerce railyards may affect and overlap certain areas near the UP 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 UP Commerce 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 off-site emissions for 2005. The diesel PM emissions from the UP Commerce 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 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 UP Commerce Railyard. This result is expected because the diesel PM emissions from the significant off-site sources are equivalent to 10 times the UP Commerce 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 levels associated with off-site diesel PM emissions encompasses approximately 28,300 acres where about 430,000 residents live. For comparison with the UP Commerce Railyard health risks, the same level of potential cancer risks (100 chances in a million) covers about 880 acres with a population of approximately 12,000. 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 Estimated for 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

*: Approximate estimates due to partial of these isopleths extend beyond 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 UP Commerce, this regulation could reduce up to 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 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. UP COMMERCE RAILYARD DIESEL PM EMISSIONS

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

For the year 2005, the combined diesel PM emissions from the UP Commerce Railyard (on-site emissions) 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 124 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 91% of the total combined on-site and off-site diesel PM emissions. Off-site stationary sources contribute less than 400 pounds per year of diesel PM emissions. The UP Commerce Railyard diesel PM emissions are estimated at about 11 tons per year, which accounts for about 9% of the total combined on-site and off-site diesel PM emissions.

A. UP Commerce Railyard Diesel PM Emissions Summary

The UP Commerce Railyard activity data and emission inventories were provided by the Union Pacific Railroad and its consultants Sierra Research and Air Quality Management Consulting. 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). Detailed calculation methodologies and resulting emission factors are included in the *Toxic Air Contaminant Emissions Inventory and Dispersion Modeling Report for the Commerce Rail Yard, Los Angeles, California* (Sierra Research, 2007) submitted by Sierra Research (hereafter Sierra Research Report).

The UP Commerce Railyard is a cargo handling facility with a focus on domestic containers, and processed an estimated 350,000 containers in 2005. Cargo containers and other freight are received, sorted, and distributed from the facility. Intermodal containers may arrive at the facility by truck to be loaded onto trains for transport to distant destinations, or arrive by train and unloaded onto chassis for transport by truck to local destinations. Cargo containers and chassis are also temporarily stored at the railyard. The railyard also includes facilities for crane and yard hostler maintenance, locomotive service and repair, and an on-site wastewater treatment plant.

Activities at UP Commerce Railyard include receiving inbound trains, switching rail cars, loading and unloading intermodal trains, building and departing outbound trains, storage of intermodal containers and truck chassis, and repairing freight cars and intermodal containers/chassis. The railyard includes a bypassing main line with freight and passenger train traffic that is not part of the railyard operations.

Facilities within the railyard include: 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. On-site sources were separated into five operation areas based on specific activities to better characterize diesel PM emissions. These areas are summarized in Table III-1 and shown in Figure III-1. The detailed schematic and descriptions of the areas and activities are presented in the Sierra Research Report (Sierra Research, 2007).

Table III-1: UP Commerce Railyard Activities

Area	Description
Main Yard	***Most activities occurring here (loading, unloading, cargo handling, etc.)***
Maintenance Area	***Maintenance and service area for locomotives, tractors, cranes, etc.***
Chassis Stack Area 1 and 2	***Areas to stack the chassis***
Intermodal Gate	***Trucks entering and leaving the Yard***

Using the data provided by UP and the methodology described in the Sierra Research Report, the diesel PM emissions from railyard sources are estimated to be approximately 11.23 tons per year. The diesel PM emissions from each activity are provided in Table III-2.

Table III-2: Summary of the UP Commerce Railyard Diesel PM Emissions

Sources	Diesel PM Emissions (tons per year)	
	Total Diesel PM Emissions	**Percent of Total**
LOCOMOTIVES	**4.87**	**44%**
Switchers	*1.90*	*39%*
Service/Testing	*1.70*	*35%*
Line Hauls	*1.27*	*26%*
CARGO HANDLING EQUIPMENT	**3.94**	**35%**
ON-ROAD TRUCKS*	**2.01**	**18%**
TRUs and Reefer Cars	**0.27**	**2%**
Heavy Equipments	**0.14**	**1%**
TOTAL	**11.23**	**100%**

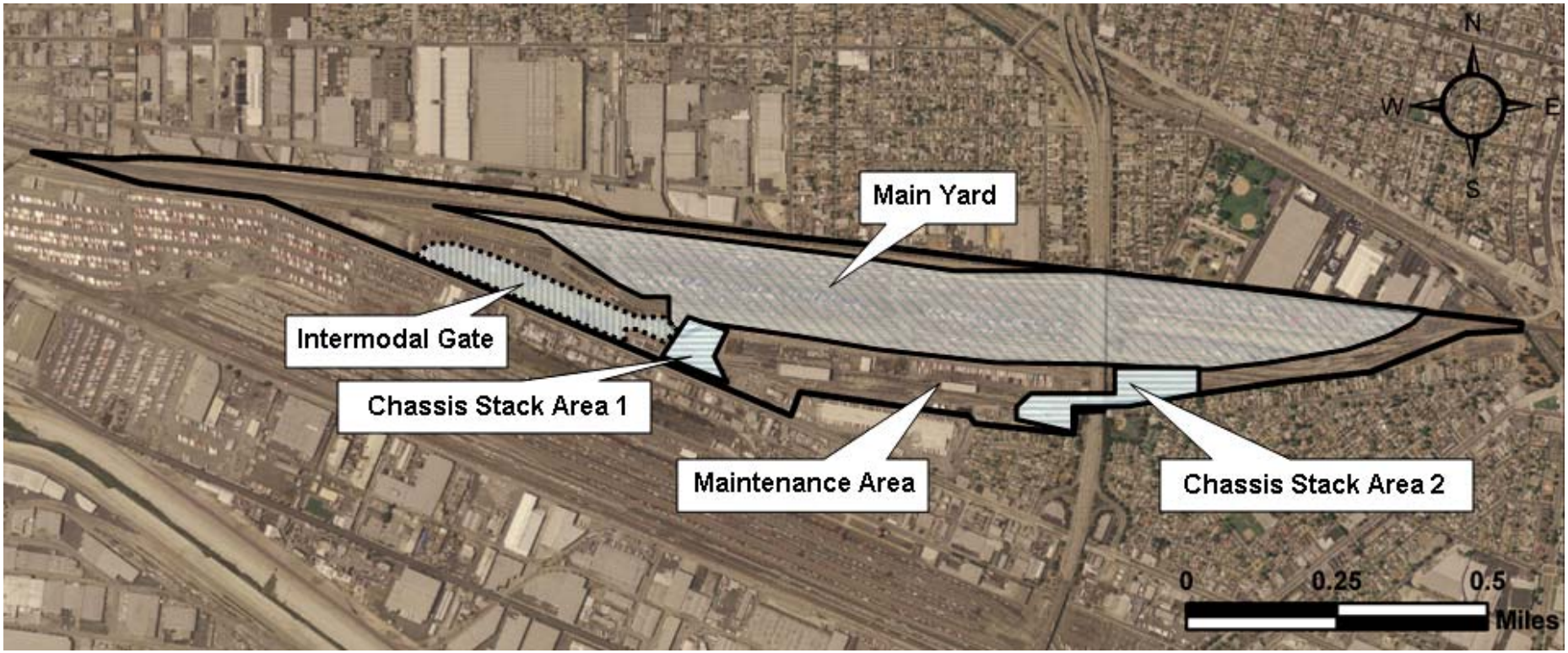
*: For further detail on railyard versus off-site on-road truck emissions, see Section C.

Diesel PM is not the only toxic air contaminant (TAC) emitted in the UP Commerce Railyard. A relatively small amount of gasoline toxic air contaminants is generated from gasoline storage tanks and gasoline-powered vehicles and engines, including benzene, isopentane, toluene, etc. Some other toxic air contaminants, such as xylene, are

emitted from the wastewater treatment plant. The detailed emission inventories for these TACs are presented in the *Toxic Air Contaminant Emissions Inventory and Dispersion Modeling Report for the Commerce Rail Yard, Los Angeles, California* (Sierra Research, 2007). The total amount of these toxic air contaminants emissions is about 0.07 tons or 140 pounds per year, compared to the 11 tons per year of the diesel PM emissions in the railyard.

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 on Table II-3), these non-diesel PM toxic air contaminants have less than a thousandth of the potency weighted emissions as compared to diesel PM (0.0007 vs. 11.23 tons per year). Hence, only diesel PM emissions are presented in the on-site emission analysis.

Figure III-1: The UP Commerce Railyard Emission Source Locations



1. Locomotives

Locomotives are the largest diesel PM emission sources at the UP Commerce Railyard. Locomotives contribute about 4.9 tons per year or about 44% of the total railyard diesel PM emissions.

The locomotive operations at the UP Commerce Railyard are divided into three major categories: switching (i.e., moving rail cars within the yard), basic locomotive services (i.e., maintenance, testing, etc.), and arriving-departing line haul locomotives. The locomotive operations are further divided into activity subcategories to describe the emission modes and spatial allocation, such as locomotive movements, idling, etc.

Line haul locomotives include hauling through trains on the main line, pulling arriving trains into the yard, and departing trains out of the yard. For the year of 2005, there were XXXX line haul locomotives operated at the UP Commerce Railyard. Switching operations include the use of three medium horsepower locomotives (one on the west end of the railyard, and another pair on the east end of the railyard) to move sections of trains at the ends of the yard. Locomotive servicing and maintenance involves both line haul and switcher locomotives, and includes idling associated with refueling, sanding, oiling, and waiting to move to outbound trains. In addition, maintenance activities include additional periods of idling and higher throttle settings during load tests either prior to, or following specific maintenance tasks. For the year of 2005, there were XXXX service and maintenance events that occurred at the UP Commerce Railyard.

Temporal emission profiles were estimated for each activity based on hourly locomotive counts. The profiles developed account for hourly, daily and seasonal temporal variations and are reflected in the air dispersion modeling to capture operational variations.

The locomotive diesel PM emission factors used in this study are based on those of UP Roseville Railyard Study (ARB, 2004), and have been adjusted according to 2005 fuel sulfur levels provided by UP. The adjustment factors are linear in sulfur content, allowing emission rates for a specific mixture of California and non-road fuels to be calculated as a weighted average of the emission rates for each of the fuels. Adjustment factors were developed and used to prepare tables of emission factors for two different fuel sulfur levels:

- California Fuel. In 2005, Chevron was Union Pacific Railroad's principal supplier of diesel fuel in California. Chevron's California refineries produced only one grade of low sulfur diesel for both CARB diesel and U.S. EPA on-road diesel fuels in 2005. Quarterly average sulfur content for these refineries ranged from 59 ppm to 400 ppm, with an average of 221 ppm. The 221 ppm sulfur content is assumed to be representative of California fuel used by UP (Sierra Research Report).
- Non-Road Fuel. In the U.S. EPA's 2004 regulatory impact analysis in support of regulation on non-road diesel engines, the estimated 49-state average fuel sulfur content is 2,639 ppm (U.S. EPA, 2004c). The 2,639 ppm sulfur content is

assumed to be representative of non-road diesel fuel used by UP for fueling of locomotives outside of California (Sierra Research Report).

The benefit of the diesel fuel regulations is presented in detail in Section B.

The results are shown in two tables in Appendix D. Table III-3 presents the summary of diesel PM emissions from locomotive operation activities.

Table III-3: Locomotive Diesel PM Emissions

Activity	Diesel PM Emissions	
	Tons per year	Percent of Total
Switching	**1.90**	**39%**
Service/Maintenance	**1.70**	**35%**
Arriving/Departing Line Haul	**1.27**	**26%**
TOTAL	**4.87**	**100%**

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 UP Commerce Railyard will benefit from these mitigation measures as diesel PM emissions from locomotives are gradually reduced as the locomotive fleets turnover.

2. Cargo Handling Equipment

Cargo handling equipment (CHE) is the second largest diesel PM emission source at the UP Commerce Railyard. The diesel PM emissions from cargo handling equipment was estimated at 3.94 tons in year 2005, equivalent to about 35% of the total diesel PM emissions from the UP Commerce Railyard.

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

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

- Forklifts are industry trucks used to hoist and transport materials by means of one or more steel forks inserted under the load.
- Top picks are also known as top handlers. Top picks are another common type of cargo handling equipment. It is a large truck-like vehicle with an overhead beam which locks onto the top of containers in a single stack.

The CHE diesel PM emissions in the UP Commerce Railyard were estimated using the latest version of ARB OFFROAD model. As indicated in Table III-4, about 75% of the CHE diesel PM emissions were due to the yard hostlers, at about 2.96 tons per year. The RTGs emit about 23% of the total CHE diesel PM emissions (0.9 tons per year). The remaining 2% of the CHE diesel PM emissions was divided among the chassis stackers, forklifts, and top picks. Additional details of calculations and estimations are presented in Sierra Research Report.

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 UP Commerce Railyard will benefit from these mitigation measures.

Table III-4: Cargo Handling Equipment Diesel PM Emissions

Activity	Diesel PM Emissions	
	Tons per year	Percent of Total
Yard Hostlers	**2.96**	**75%**
RTG Cranes	**0.90**	**23%**
Chassis Stackers	**0.06**	**1.5%**
Forklifts	**0.01**	**<1%**
Top Picks	**0.01**	**<1%**
TOTAL	**3.94**	**100%**

3. On-Road Diesel-Fueled Trucks

On-road trucks contribute about 18% of the total railyard diesel PM emissions at about 2.01 tons per year. As shown in Table III-5, 99% of the on-road truck diesel PM emissions come from heavy heavy-duty* (HHD) trucks, which were estimated as 1.99

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

tons per year. All of the other diesel-fueled trucks generate about 0.02 tons per year of the diesel PM emissions. Over two-thirds of the HHD truck diesel PM emissions were emitted while they are traveling versus idling.

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 in 2007, the UP Commerce Railyard will benefit from these mitigation measures as diesel PM emissions from heavy-duty diesel fueled trucks are gradually reduced as the truck fleets turnover.

Table III-5: UP Commerce Railyard On-Road Truck Diesel PM Emissions

Source	Diesel PM Emissions (tons per year)		
	Traveling	Idling	Total
HDD Diesel-Fueled Truck	1.41**	0.59**	1.99**
Other Diesel-Fueled Trucks	0.02	0.00	0.02
TOTAL	1.43	0.59	2.01
Percent of Total On-Road Truck Emissions	71%	29%	100%

**: Numbers may not add precisely due to rounding.

4. TRUs and Reefer Cars

Transport refrigeration units (TRUs) and refrigerated rail cars (reefer cars) are used to transport perishable and frozen goods. TRUs and reefer cars are transferred in and out of the railyard and are temporarily stored at the railyard. Diesel PM emissions from TRUs and reefer cars were estimated as 0.27 tons per year, or about 2% of railyard diesel PM emissions. The detailed methodology is discussed in the Sierra Research Report.

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 UP Commerce Railyard will benefit from these mitigation measures as diesel PM emissions from TRUs are steadily reduced as their fleets turnover.

5. Heavy Equipment

In addition to the cargo handling equipment discussed above, diesel-fueled heavy equipment is used at the UP Commerce Railyard. The heavy equipment is used for non-cargo-related activities at the railyard, such as locomotive maintenance, handling of parts and company material, derailments, etc. The diesel PM emissions from heavy equipment was estimated as 0.14 tons in year 2005, equivalent to about 1% of total railyard diesel PM emissions. A detailed methodology is discussed in the Sierra Research Report.

B. CURRENT APPLICABLE DIESEL FUEL REGULATIONS AND THEIR BENEFITS TO THE RAILYARDS

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

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

- A limit of 500 parts per million by weight (ppmw) on sulfur content to reduce emissions of both sulfur dioxide and directly emitted PM.
- A limit on aromatic hydrocarbon content of 10 volume percent for large refiners and 20 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 ppmw beginning in June 2006. Thus, ARB's specifications for sulfur and aromatic hydrocarbons are shown in Table III-6.

Table III-6: California Diesel Fuel Standards

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

The regulation limiting aromatic hydrocarbons also includes a provision that enables producers and importers to comply with the regulation by qualifying a set of alternative specifications of their own choosing. The alternative formulation must be shown, through emissions testing, to provide emission benefits equivalent to that obtained with a 10 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.

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

The United States Environmental Protection Agency (U.S. EPA) has also established separate diesel fuel specifications for on-road diesel fuel and off-road (nonroad) diesel fuel. The inital U.S. EPA diesel fuel standards were applicable in October 1993. The U.S. EPA regulations prohibited the sale or supply of diesel fuel for use in on-road motor vehicles, unless the diesel fuel had a sulfur content no greater than 500 ppmw. In addition, the regulation required on-road motor-vehicle diesel fuel to have a cetane index of at least 40 or have an aromatic hydrocarbon content of no greater than 35 percent by volume (vol. %). 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 on-road vehicles. The current U.S. EPA on-road diesel fuel standard is shown in Table III-7.

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 in Table III-7.

Table III-7: 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-8 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 nonvehicular diesel fuel. Nonroad diesel fuel sulfur levels have been recorded as about 3,000 ppmw in-use and aromatics level of about 35 percent by volume in-use.

Table III-8: 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 linehaul 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 on-road heavy duty diesel trucks, as they are the primary source of diesel PM from the on-road vehicle fleet. ARB staff estimated mobile emissions based on roadway specific vehicle activity data and allocated them to individual roadway links. All roadway links within a 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 their truck traffic related to these facilities is reflected in the roadway link traffic activities. Because the off-site mobile sources have only focused on the on-road diesel emissions, the exclusion of extended idling and off-road equipment may result in an underestimation of off-site mobile sources emissions.

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

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.

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-9. 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-9: Off-site Mobile Source Diesel PM Emissions by Vehicle Type

Vehicle Types of Off-Site Mobile Diesel PM Sources	Gross Vehicle Weight (pounds)	Diesel PM Emissions	
		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-10, 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-10: 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 about 300 pounds per year of the diesel PM emissions.

ARB staff also evaluated other toxic air contaminant (TACs) emissions around the UP Commerce 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% 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 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 weighting 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 cancer potency weighted toxic emission as shown in Table III-11. As can be seen in Table III-11, 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 95% upper confidence limit of excess cancer cases occurring in an exposed population assuming continuous lifetime exposure to a substance at a dose of one milligram per kilogram of body weight, and are expressed in units of $(mg/kg\text{-}day)^{-1}$.

The detailed methodology of off-site stationary source emissions is presented in Appendix B.

Table III-11: Potency Weighted Toxic Emissions from Significant Off-Site Stationary Sources Surrounding UP Commerce 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*	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.

In addition, ARB staff evaluated the potential cancer risk levels caused by the use of gasoline in the South Coast Air Basin. Table III-12 shows the emissions of four major

* The emitted carbon tetrachloride could last for a long time.

carcinogen compounds of gasoline exhausts in South Coast Air Basin in the year of 2005 (ARB, 2006a). As indicated in Table III-12, 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 III-12: 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.

IV. AIR DISPERSION MODELING FOR THE UP COMMERCE 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 UP Commerce 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 UP Commerce 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 represents 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 relatively simple to implement.

B. Source Characterization and Parameters

The emission sources from the locomotives and other mobile sources at the UP Commerce 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 Sierra Research 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 Union Pacific Railroad.

C. Meteorological Data

In order to run AERMOD, the following hourly surface meteorological data are required: wind speed, wind direction, ambient temperature, 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 UP Commerce Railyard was the same as that selected by BNSF and its consultant ENVIRON International for their nearby railyards (ENVIRON, 2006). The area surrounding the UP Commerce 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 10-km radius of the UP Commerce Railyard include: Lynwood, Los Angeles-North Main Street, and Pico Rivera, operated by South Coast Air Quality Management District (SCAQMD); and Los Angeles Downtown University of Southern California (USC) Campus station, operated by National Weather Service (NWS).

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 variations due to the nearby hills. Based on ARB criteria for representativeness (ARB, 2006d), the Lynwood station was chosen as the most representative meteorological station for the UP Commerce 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), 5 years of 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). The UP's consultant did a sensitivity analysis and found that year-to-year variability would not cause significant differences in the modeled health impacts. Therefore, the meteorological data from 2005 were selected for UP Commerce Railyard air dispersion modeling because it had adequate completeness and quality, and were the most recent year available.

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

Figure IV-1 presents the wind rose and Figure IV-2 provides the wind class frequency distributions for the meteorological data used in UP Commerce Railyard air dispersion modeling.

The yearly average wind speed is 1.9 meters per second. The prevailing wind over the modeling domain blows from southwest to northeast.

Figure IV-1: Wind Rose Plot for Lynwood Station in 2005

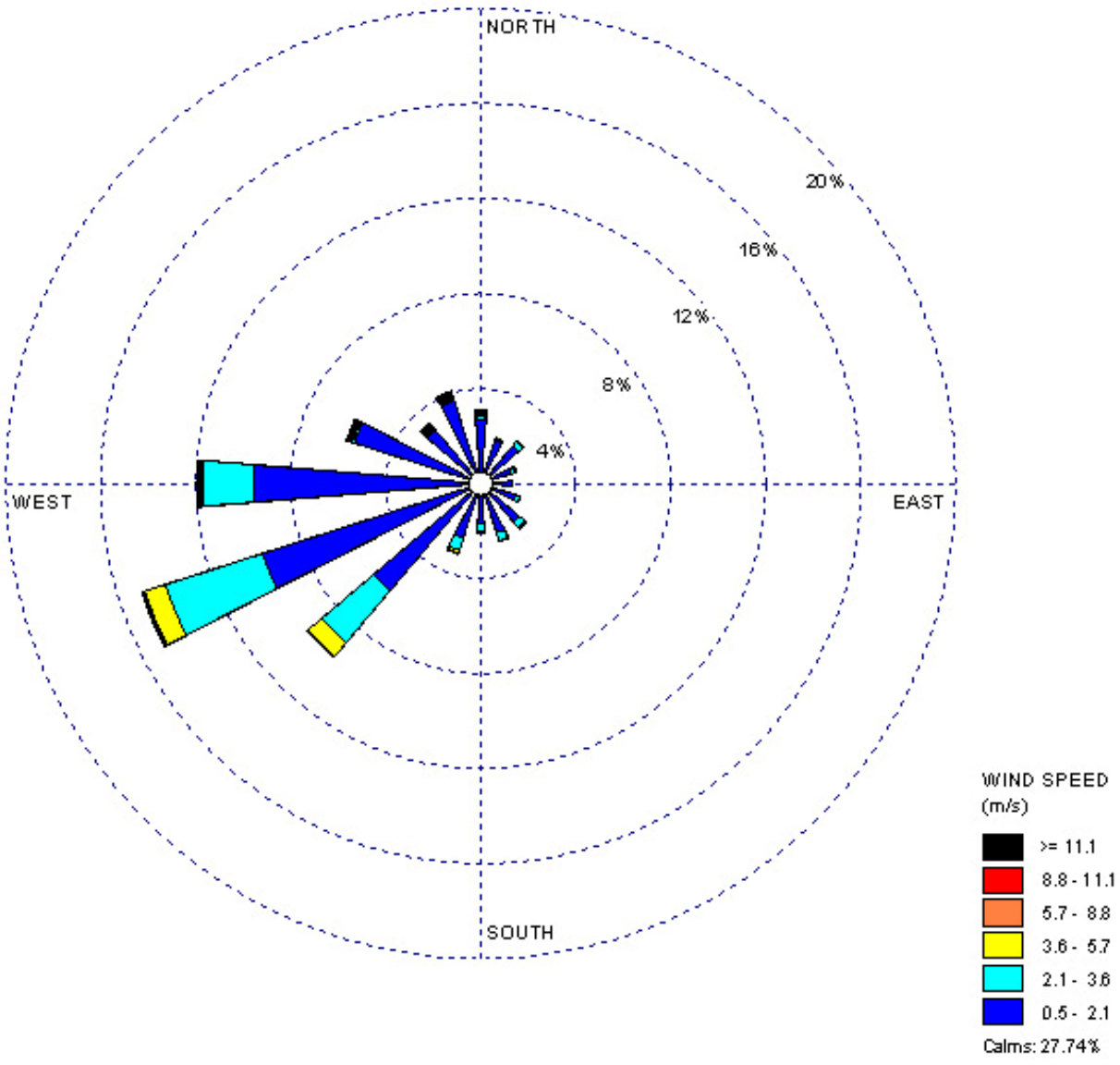
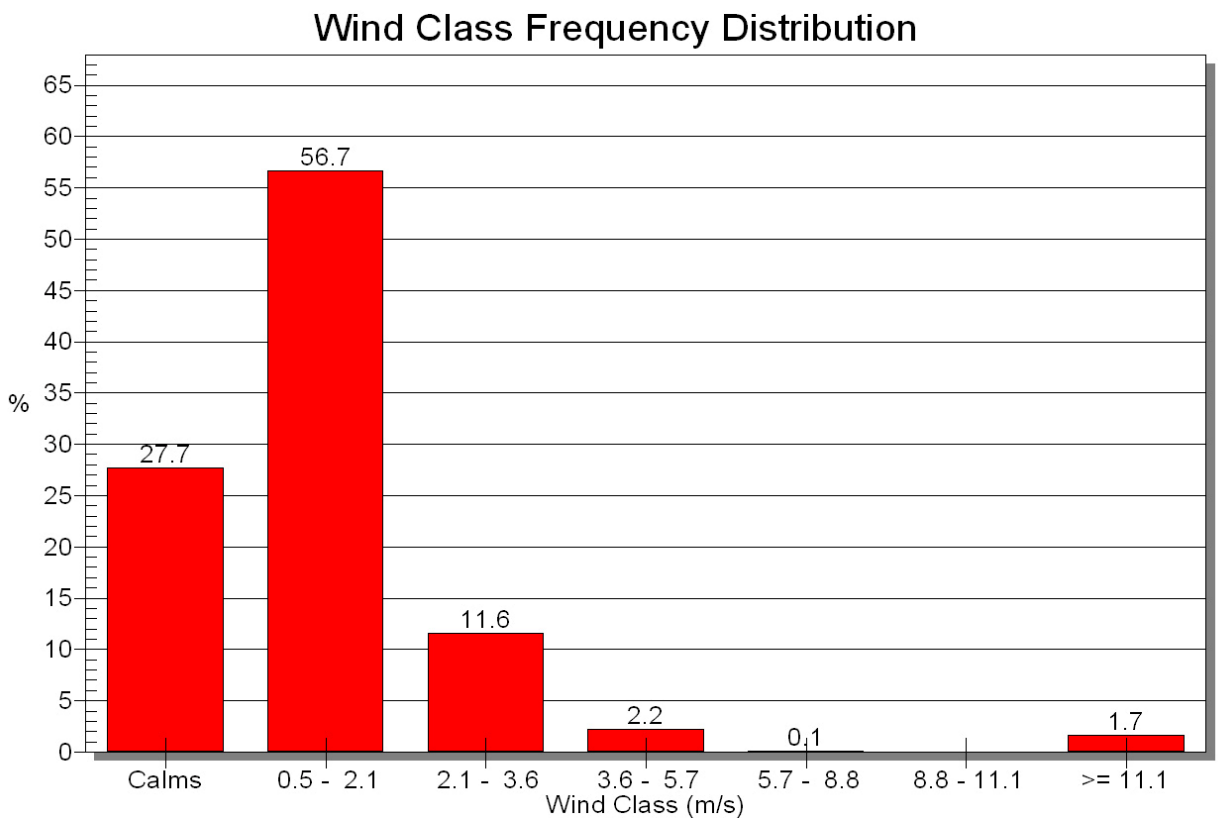


Figure IV-2: Wind Class Frequency Distribution Plot for Lynwood Station Data in 2005



The detailed procedures of meteorological data preparation and quality control are described in Sierra Research Report.

D. Model Receptors

Model receptors are the locations where the model provides concentrations. A Cartesian grid receptor network is used in this study where an array of points are identified by their x (east-west) and y (north-south) 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 20x20 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, 4 receptor grid networks were used. A fine grid of 50 m x 50 m (m: meter) surrounding the UP Commerce Railyard was used for modeling within 400 m of the fence line. A medium-fine grid of 100 m x 100 m was used for receptors between 400 m and 800 m of the fence line around the fine grid network, and a medium grid of 200 m x 200 m was used for receptor distances between 800 m and 1500 m. A coarse receptor grid of 500 m x 500 m was used throughout the rest of the modeling domain.

Figure IV-3 shows the fine, medium fine, and medium grid receptor networks and Figure IV-4 illustrates the coarse grid receptor networks used in air dispersion modeling for the UP Commerce Railyard.

Figure IV-3: Fine and Medium Grid Receptor Networks Used in Air Dispersion Modeling for UP Commerce Railyard

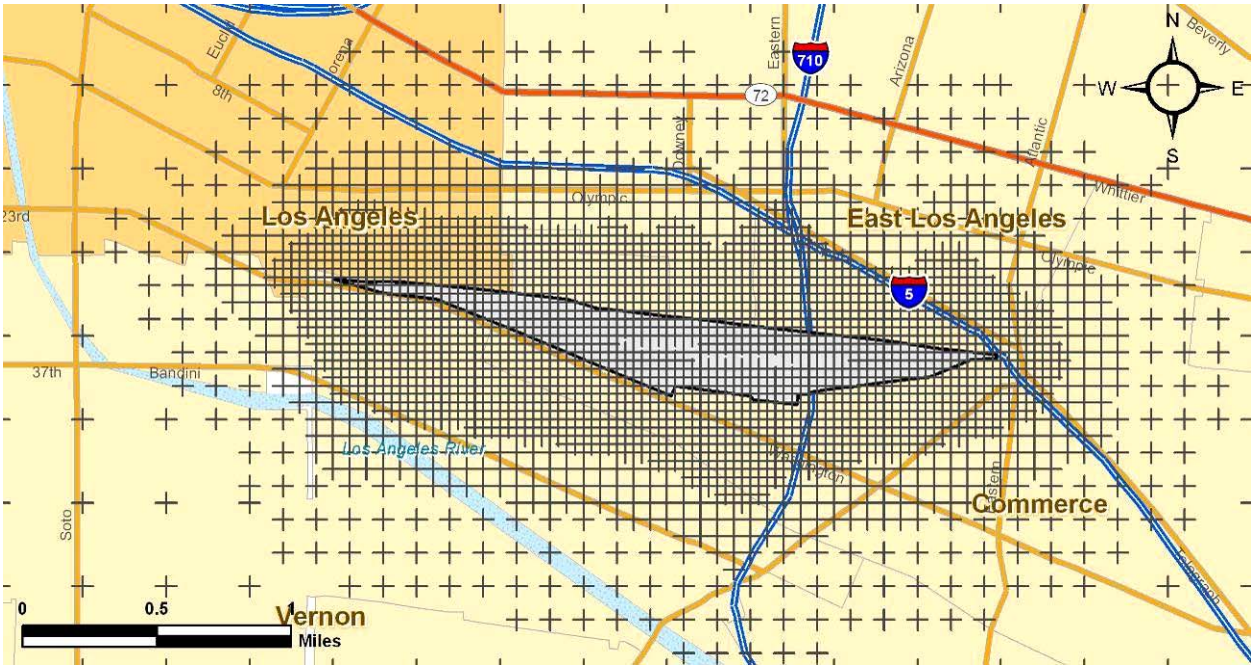
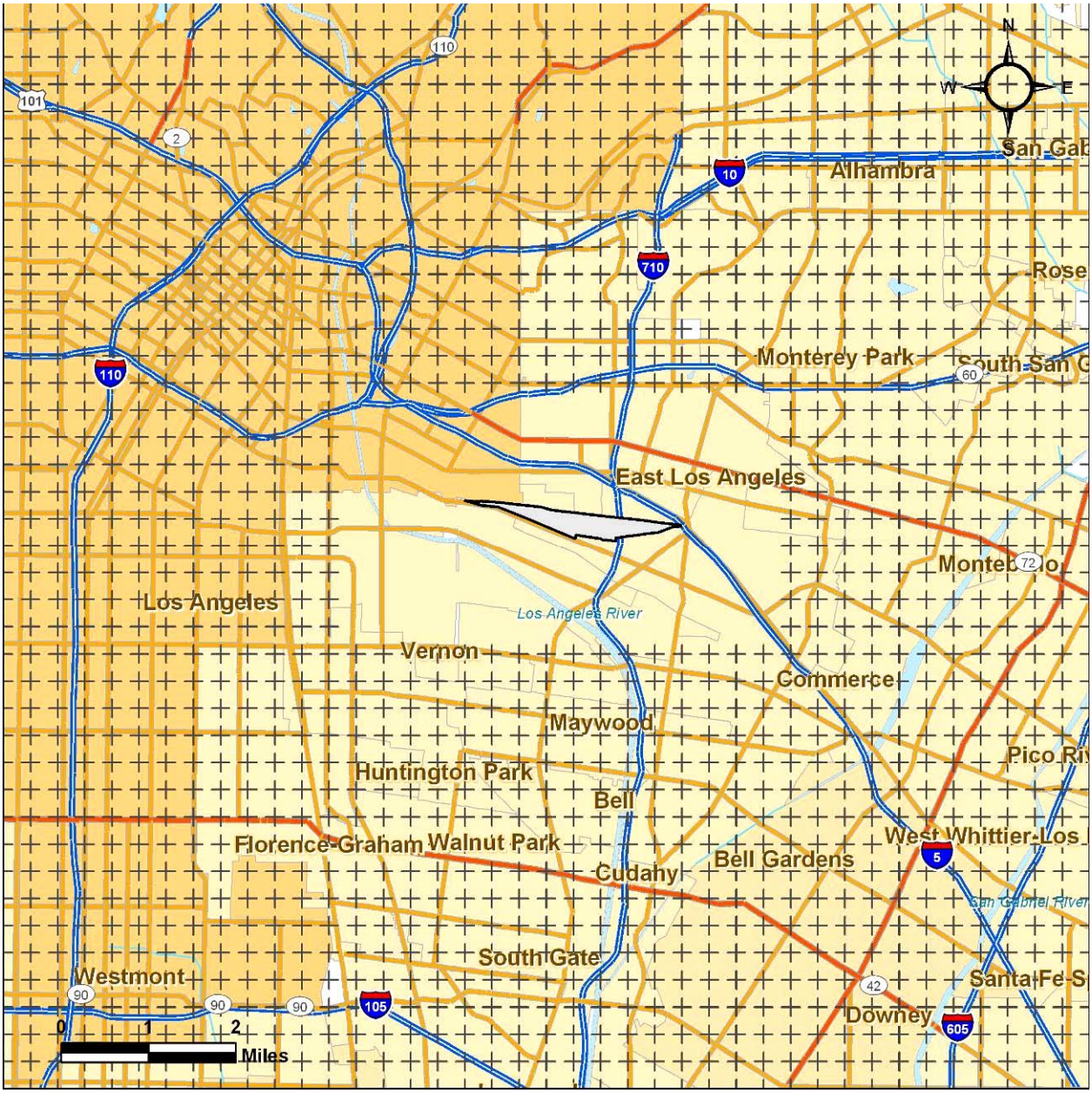


Figure IV-4: Coarse Grid Receptor Networks Used in Air Dispersion Modeling for UP Commerce Railyard



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 Sierra Research 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 Sierra Research Report.

V. HEALTH RISK ASSESSMENT OF THE UP COMMERCE 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 UP Commerce Railyard. In addition, the detailed health risk assessment (HRA) results are presented and the associated uncertainties are discussed qualitatively.

A. Health Risk Assessment Guidelines

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

- Tier 1: a standard point-estimate approach that uses a combination of the average and high-end point-estimates.
- Tier 2: utilizes site-specific information for 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 percentile 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 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 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. In general, the longer the exposure time for an individual, the greater the estimated potential risk for the individual. 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 proportionately decrease. 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 UP Commerce Railyard. A relatively small amount of gasoline toxic air contaminants is generated from gasoline storage tanks and gasoline-powered vehicles and engines, including benzene, isopentane, toluene, etc. Some other toxic air contaminants, such as xylene, are emitted from the wastewater treatment plant. The total amount of these toxic air contaminants emissions is about 0.07 tons or 140 pounds per year, compared to the 11 tons per year of the diesel PM emissions in the railyard. In addition, adjusting these emissions on a cancer potency weighted basis for their toxic potential, these non-diesel PM toxic air contaminants have less than a thousandth of the potency weighted emissions as compared to diesel PM (0.0007 vs. 11.23 tons per year). Hence, only diesel PM emissions are presented in the on-site emission analysis.

ARB staff also evaluated other toxic air contaminant (TACs) emissions around the UP Commerce 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% 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 weighting 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 can be seen, 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 UP Commerce 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*	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.

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.

* The emitted carbon tetrachloride could last for a long time.

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., $1.1(\text{mg/kg-day})^{-1}$.

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 potential 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 in 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

The potential cancer risks levels associated with the estimated diesel PM emissions at the UP Commerce Railyard are displayed by using isopleths, based on the 80th percentile breathing rate and 70 year exposure duration for residents**.** 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 V-1 and Figure V-2 present these isopleths. Figure V-1 focuses on the near source risk levels and Figure V-2 focuses the more regional impacts. In each figure, the risk isopleths are overlaid onto a satellite image of the Commerce area surrounding the UP Commerce Railyard, to better illustrate the land use (residential, commercial, industrial, or mixed use) of these impacted areas.

The OEHHA Guidelines require that, for health risk assessments, the cancer risk for the maximum exposed individual at the point of maximum impact should 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 at the north side of the railyard fence line, between freeway I-710 and I-5 (see Figure V-1). The maximum individual cancer risk is estimated to be about 650 chances in a million. The land use in the vicinity of the point of maximum impact is industrial use. In the residential area, the highest potential cancer risk is estimated at about 500 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 indicated by Figure V-1, the area with the greatest impact has an estimated potential cancer risk of over 500 chances in a million, occurring at a very small area right next to the north side of the railyard fence line, between freeway I-710 and I-5. The estimated cancer risk is over 250 chances per million within approximately 400 yards around the east side of railyard property boundaries. At about a half mile from the railyard boundaries, the estimated cancer risks decrease to about 100 chances per million. As indicated by Figure V-2, the risks further decrease to 50 in a million within about 1 mile from the railyard then to 25 in a million at approximately a 2-mile distance from

the railyard boundaries. At about 4 miles from the railyard boundaries, the estimated cancer risks are at 10 in a million or lower.

It is important to understand that these risk levels represent the predicted risks (due to the UP Commerce 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 about 1,000 in a million caused by all toxic air pollutants in 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, 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 (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.

The more populated areas near the UP Commerce Railyard are located north and southeast of the railyard. Based on the 2000 U.S. Census Bureau's data, the zone of impact of the estimated risks above 10 chances in a million levels encompasses approximately 17,430 acres where about 270,000 residents live. Table V-4 presents

the exposed population and area coverage size for various impacted zones of cancer risks.

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

Estimated Cancer Risk (chances per million)	Impacted Area (Acres)	Estimated Population Exposed
10 - 25	11,830	187,000
26 - 50	3,270	56,000
51 - 100	1,450	15,000
101 - 250	710	9,700
251-500	160	2,200
>500	10	100

Figure V-1: Estimated Near-Source Cancer Risks (chances per million people) from the UP Commerce Railyard

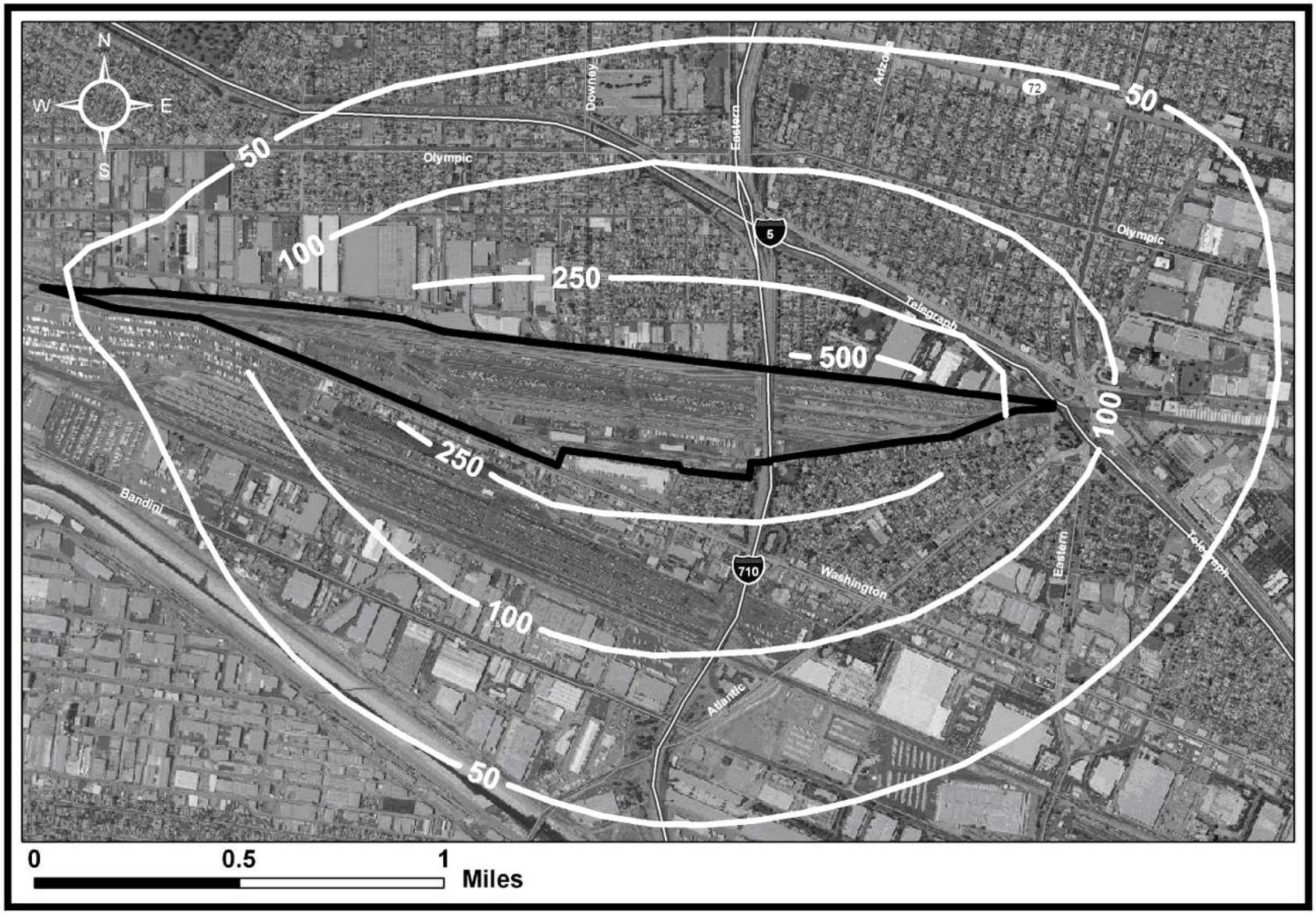
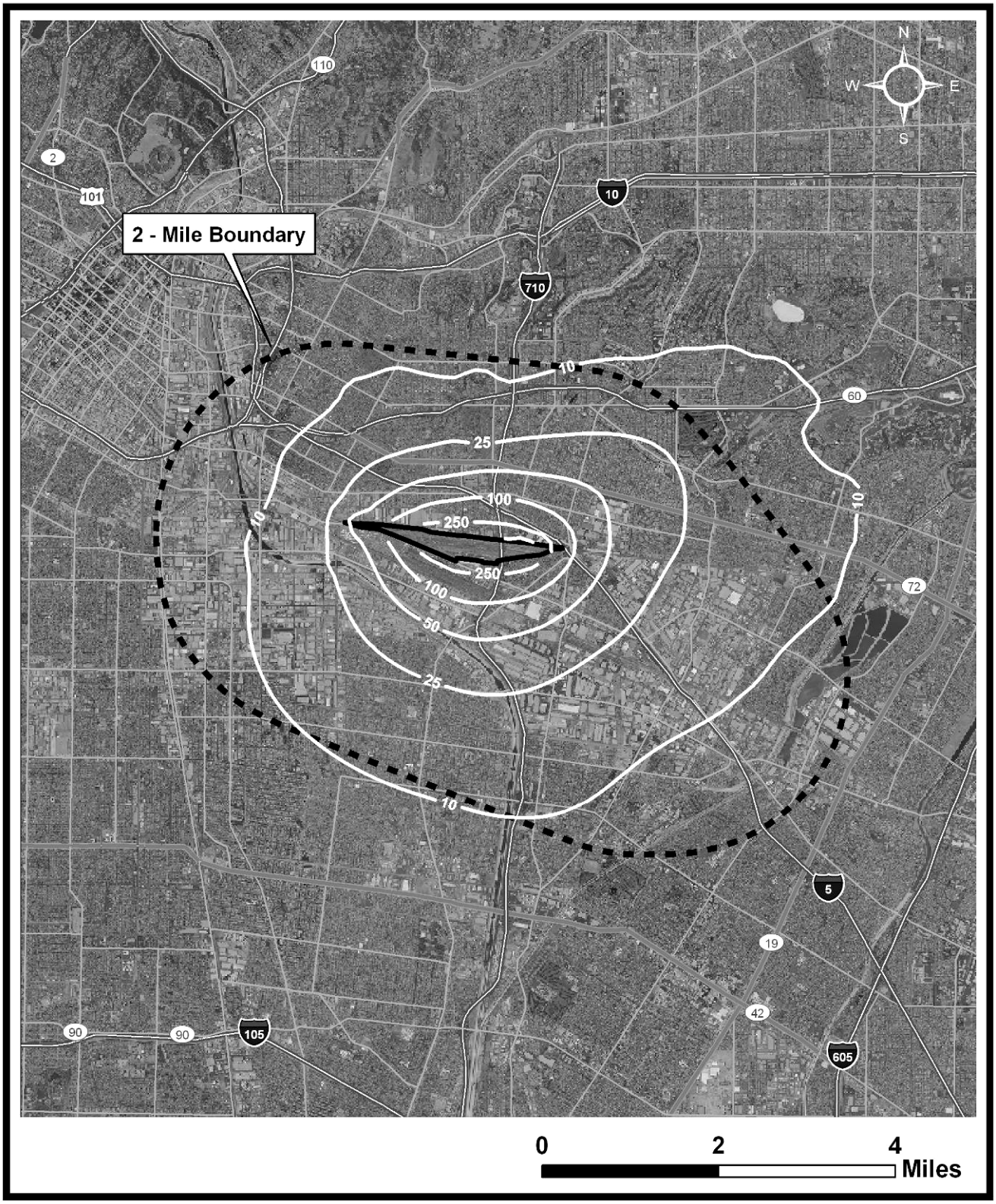


Figure V-2: Estimated Regional Cancer Risks (chances per million people) from the UP Commerce Railyard



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 (OEHHA, 2003), 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. For diesel PM, OEHHA has determined a chronic REL at 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 impact, 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 1 or greater indicates an exceedance of the chronic REL, and some adverse health impact would be expected.

As part of this study, ARB staff conducted an analysis of the potential non-cancer chronic health impacts associated with exposures to the model-predicted levels of directly emitted diesel PM from on-site sources. 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 UP Commerce 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 Railyards studies are completed, the downwind diesel PM emissions from the three other BNSF Commerce railyards may affect and overlap certain areas near the UP Commerce 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 range from 0.3 to 0.02 around the yard facility. The zone of impact where non-cancer chronic health hazard indexes are over 0.02 is an estimated area of 5,000 acres.

c) Non-Cancer Acute Risk

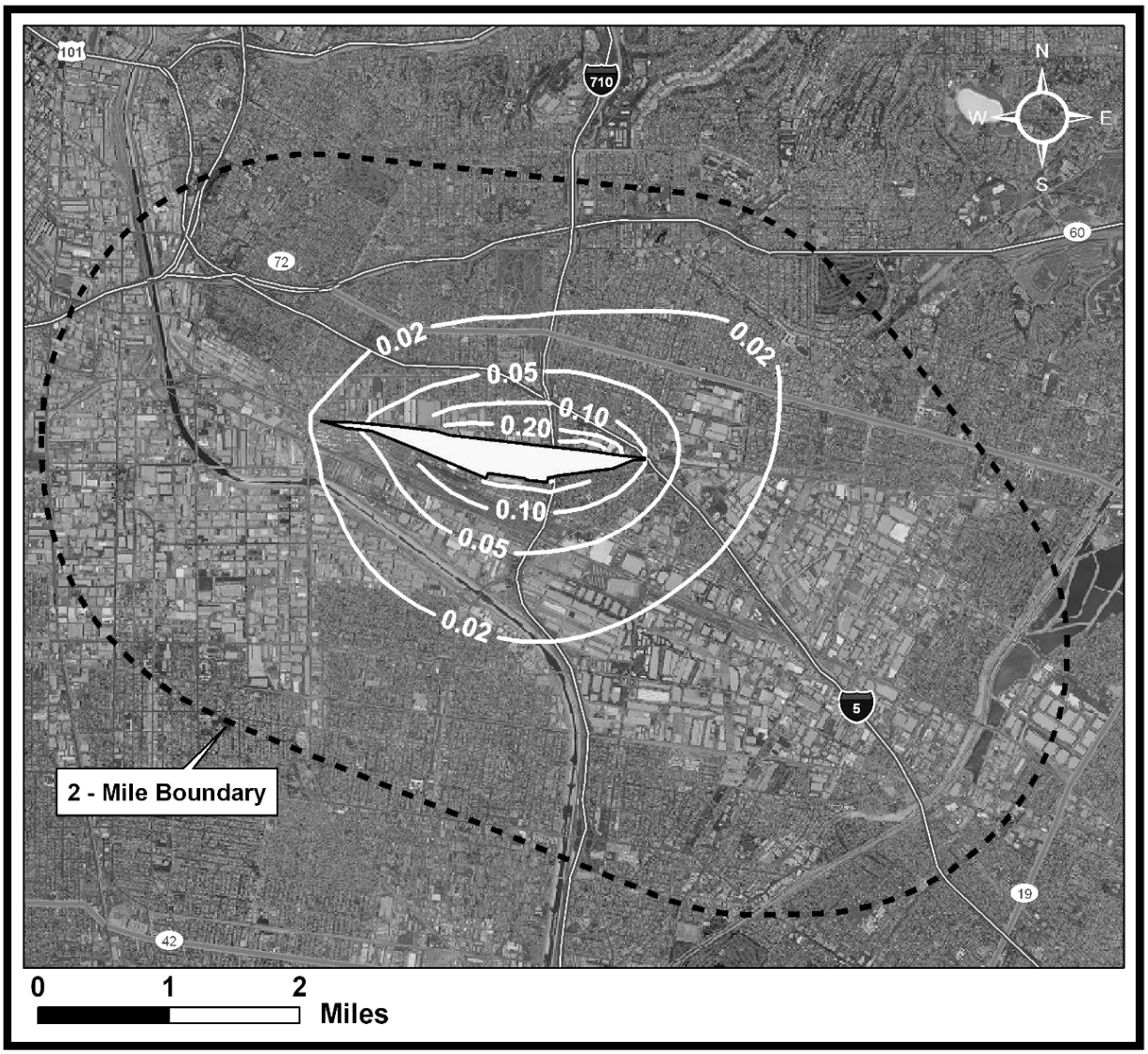
According to the OEHHA guidelines, an acute reference exposure level (REL) is an exposure that is not likely to cause adverse health effects in a human population, including sensitive subgroups, exposed to that concentration for the specified exposure duration (generally one hour) on an intermittent 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.

Figure V-3: Estimated Non-Cancer Chronic Risk Health Hazard Index from the UP Commerce Railyard



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

ARB staff evaluated the impacts from off-site pollution sources near the UP Commerce 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 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 UP Commerce Railyard. This result is expected because the diesel PM emissions from the significant off-site sources are equivalent to 10 times of the UP Commerce Railyard diesel PM emissions. Figure V-5 illustrates that the non-caner chronic health risks associated with off-site diesel PM emissions are insignificant.

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 levels associated with off-site diesel PM emissions encompasses approximately 28,300 acres where about 430,000 residents live. For comparison with the UP Commerce Railyard health risks, the same level of potential cancer risks (100 chances in a million) covers about 880 acres with a population of approximately 12,000. 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 Estimated for 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

*: Approximate estimates due to partial of these isopleths extend beyond the air dispersion model domain.

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

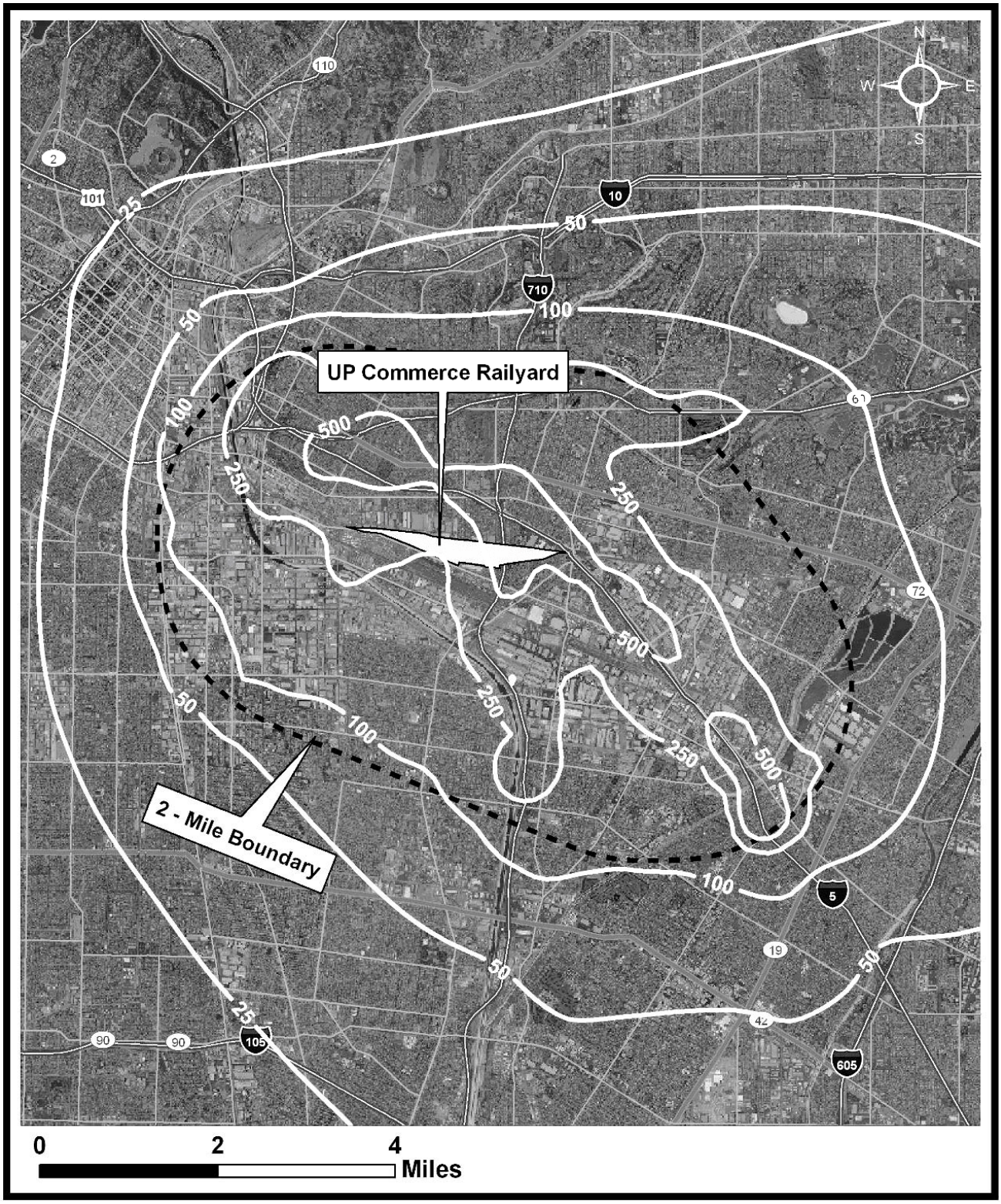
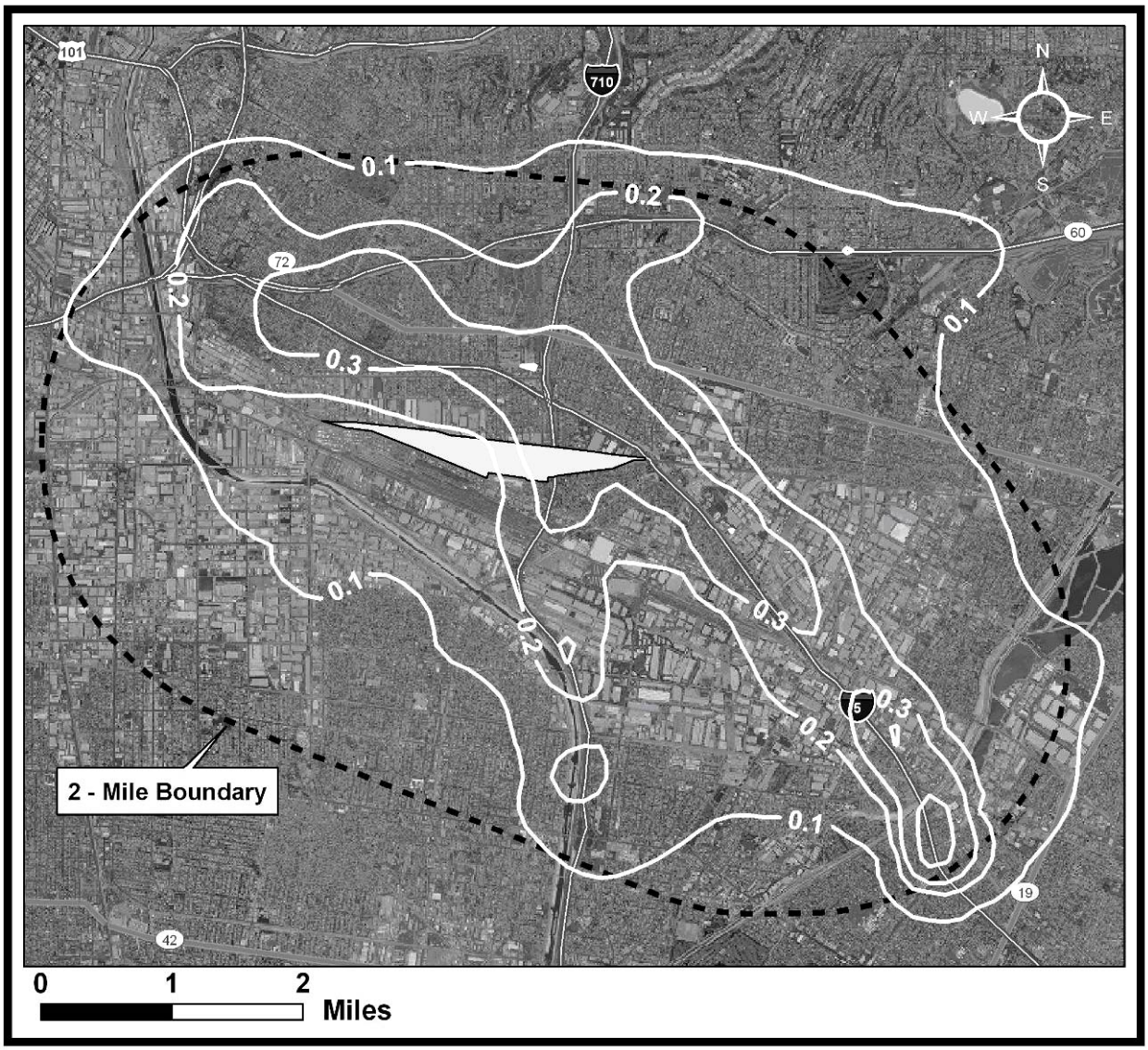


Figure V-5: Estimated Non-Cancer Chronic Health Hazard Index from Off-site Diesel PM Emissions



3. *Risks to Sensitive Receptors*

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 include schools, hospitals, day-care centers and elder care facilities. There are 27 sensitive receptors around the UP Commerce Railyard from the distance of 2 miles, including 19 schools, 4 child care centers and 4 hospitals. Table V-6 shows the number of sensitive receptors in various levels of cancer risks associated with diesel PM emission from the UP Commerce 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 (chances per million)	Number of Sensitive Receptors
10 – 25	8
25 – 50	9
50 – 100	6
> 100	4

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 UP Commerce 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 UP's electronic monitoring of locomotives entering and leaving the railyard. However, the monitoring under certain circumstances may produce duplicate readings that can result in overestimates of locomotive activity.

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). 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, where data from humans are not available, the use of data from animal studies. The diesel PM cancer potency factor is based on long-term study of railyard workers exposed to diesel exhaust at concentrations approximately ten times typical ambient exposures (OEHHA, 2003). The differences within human populations usually cannot be easily quantified and incorporated into risk assessments. 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.

VI. REFERENCES

ARB, 1998. For the "Proposed Identification of Diesel Exhaust as a Toxic Air Contaminant". April, 1998

ARB, 2000. Risk Reduction Plan to Reduce Particulate Matter Emissions from Diesel-Fueled Engines and Vehicles, Staff Report, October, 2000.

ARB, 2002. Public Hearing to Consider Amendments to the Ambient Air Quality Standards for Particulate Matter and Sulfates, Staff Report, May. 2002.

ARB, 2004a. Roseville Railyard Study, October, 2004.

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.

ARB, 2006a. The California Almanac of Emission & Air Quality, 2006 edition.

ARB, 2006b. Diesel Particulate Matter Exposure Assessment Study for the Ports of Los Angeles and Long Beach, Finial Report. April, 2006.

ARB, 2006c. ARB Draft Rail Yard Emissions Inventory Methodology. July, 2006.

ARB, 2006d. ARB Draft Health Risk Assessment Guidance for Railyard and Intermodal Facilities. July, 2006.

ARB, 2006e. Emission Reduction Plan for Ports and Goods Movement in California. March, 2006.

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.

Sierra Research, 2007. Toxic Air Contaminant Emissions Inventory and Dispersion Modeling Report for the Commerce Rail Yard, Los Angeles, California. (Final Report). Sacramento, CA. January, 2007.
http://www.arb.ca.gov/railyard/hra/hra.htm

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.

APPENDIX A

METHODOLOGY FOR ESTIMATING OFF-SITE DIESEL PM MOBILE SOURCE EMISSIONS

INTRODUCTION

This assessment includes on-road mobile emissions from all heavy duty diesel truck running exhaust as it is the primary source of diesel particulate emissions within the on-road vehicle fleet. Traditionally, on-road mobile emission inventories are generated at the county scale using California's emission factor model EMFAC and then allocated to large grid cells using the Direct Travel Impact Model (DTIM). To enhance the spatial resolution we have estimated emissions based on roadway specific vehicle activity data and allocated them to individual roadway links. All roadway links within a 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 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 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 2: Activity Matrix Example

LINKID	Hour	Speed	LHDDT1	LHDDT2	MHDDT	HHDDT

		(mph)	VMT (miles)	VMT (miles)	VMT (miles)	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 3):

Table 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:

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

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

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

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

where

- Emissions – the total emissions in grams for each link
- i = represents the individual diesel heavy duty truck types (LHDDT1, LHDDT2 – light heavy duty diesel trucks 1 and 2; MHDDT – medium heavy duty diesel truck; and HHDDT – heavy heavy duty diesel truck)
- j – represent the hours of the day (hours 1-24)
- VMT_{Link} - total VMT for that link for all heavy duty trucks (gasoline and diesel)
- Fraction = the fraction of the VMT that is attributable to each diesel heavy duty truck type The fraction is estimated based on VMT estimates in EMFAC:
  Example: $VMT_{MHDDT}/VMT_{\text{all heavy duty trucks (gasoline \& diesel)}}$
- EF = the heavy duty diesel truck emission factors. The emission factor is vehicle type and speed specific and is thus matched according to the link specific activity parameters.

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

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

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

Limitations and Caveats

We have made several important assumptions in developing this inventory. While these assumptions are appropriate at the county level they may be less appropriate for the particular areas modeled in this assessment. For example, the county specific default model year distribution within EMFAC, and vehicle type VMT fractions were assumed to be applicable for all links within the domain modeled. In the vicinity of significant heavy

heavy-duty truck trip generators it is reasonable to expect that surrounding links will also have higher heavy heavy-duty truck fractions. In these cases using EMFAC county vehicle mix fractions may underestimate the total diesel particulate emissions from on-road heavy duty trucks. In this inventory EMFAC county defaults were employed as there is insufficient data available to assess the vehicle mix fractions surrounding the railyards.

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

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

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

APPENDIX B

METHODOLOGY FOR ESTIMATING OFF-SITE DIESEL PM STATIONARY SOURCE EMISSIONS

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

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

the Emissions Modeling System for Hazardous Air Pollutants (EMS-HAP) program were assigned. The U.S. EPA stack defaults are assigned based on the Source Classification Code (SCC) or Standard Industrial Classification (SIC) code of the operation. If an applicable U.S. EPA default was not available, then a final generic default was applied. To ensure that the microscale modeling results would be health-protective, the generic release parameters assumed relatively low height and buoyancy. Two generic defaults were used. First, if the emitting process was identifiable as a vent or other fugitive-type release, the default parameters assigned were a height of five feet, diameter of two feet, temperature of 100 degrees Fahrenheit, and velocity of 25 feet per second. For all remaining unspecified and unassigned releases, the final generic default parameters assigned were a height of twenty feet, diameter of two feet, temperature of 100 degrees Fahrenheit, and velocity of 25 feet per second. All English units used in the CEIDARS database were converted to metric units for use in the microscale modeling input files.

APPENDIX C

IMPACTS FROM OFF-SITE DIESEL PM EMISSION SOURCES

Impacts from off-site pollution sources near the UP Commerce rail yard 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 UP Commerce rail yard 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.

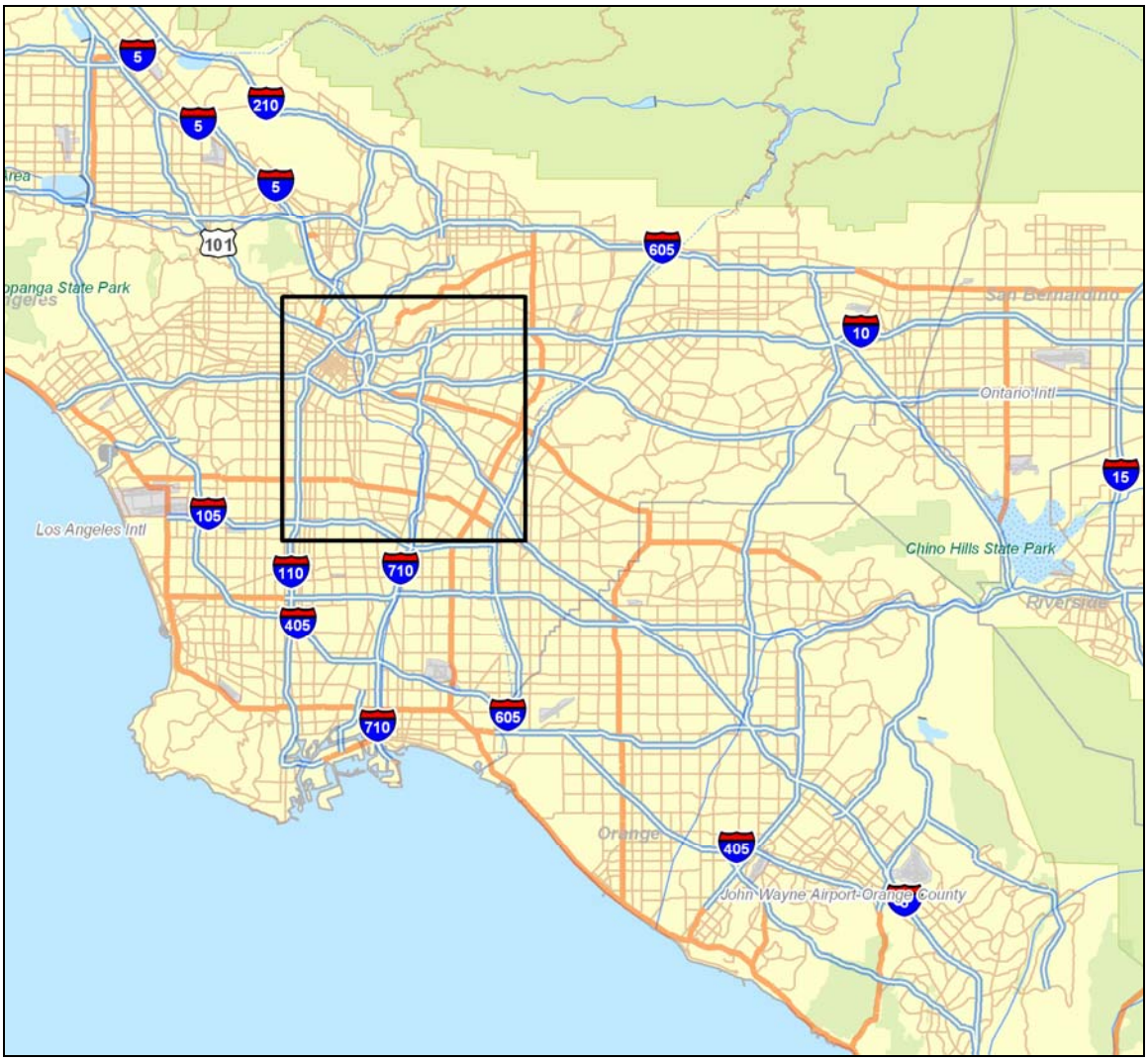


Figure 1: Region surrounding the UP Commerce rail facility with the modeling domain indicated by the black outline.

Figure 1 illustrates the region surrounding the UP Commerce 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.

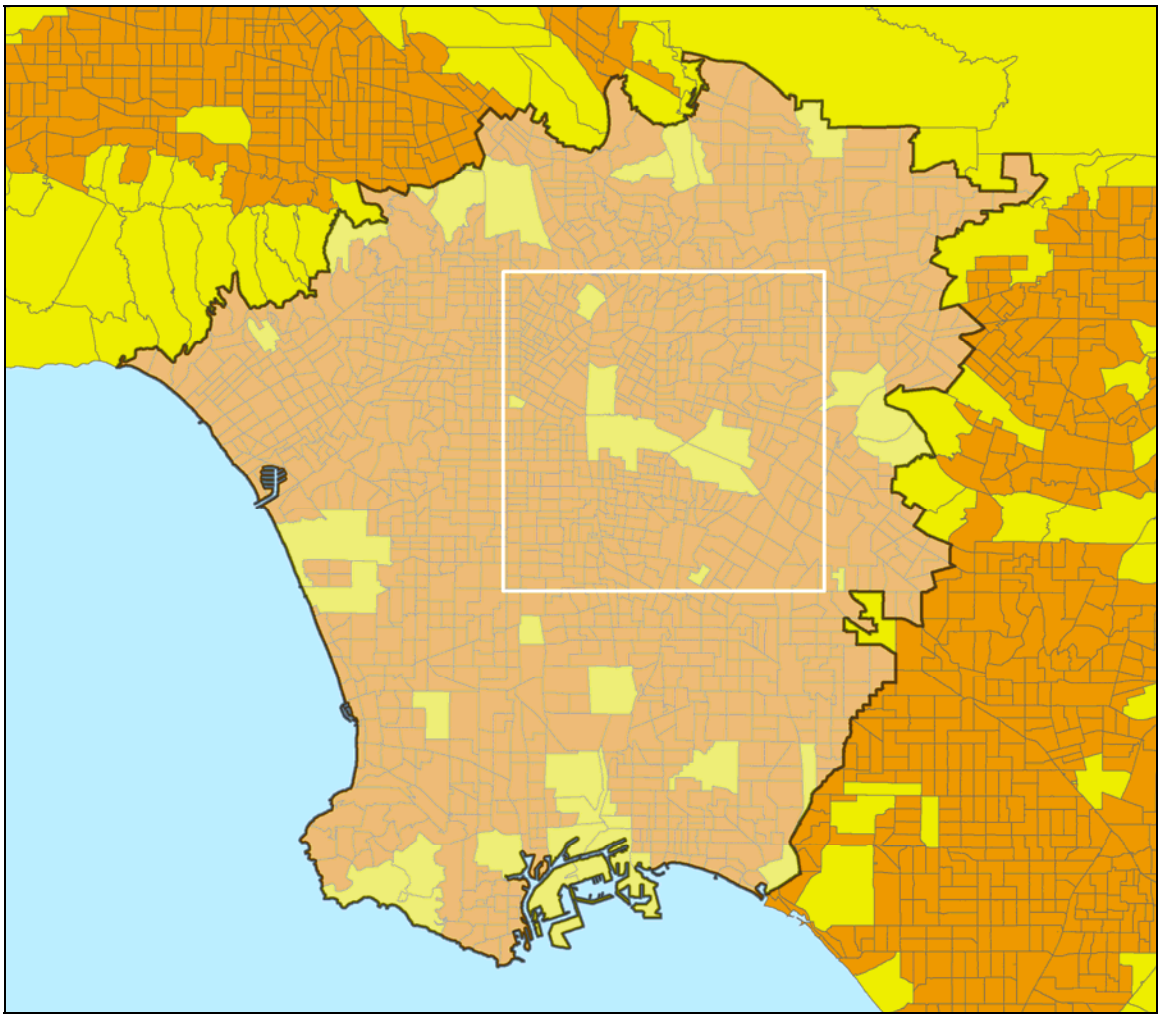


Figure 2: UP Commerce Urban Population: Orange denotes areas with at least 750 people/km^2. The highlighted region is the contiguous urban area used for modeling purposes.

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 UP Commerce 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.

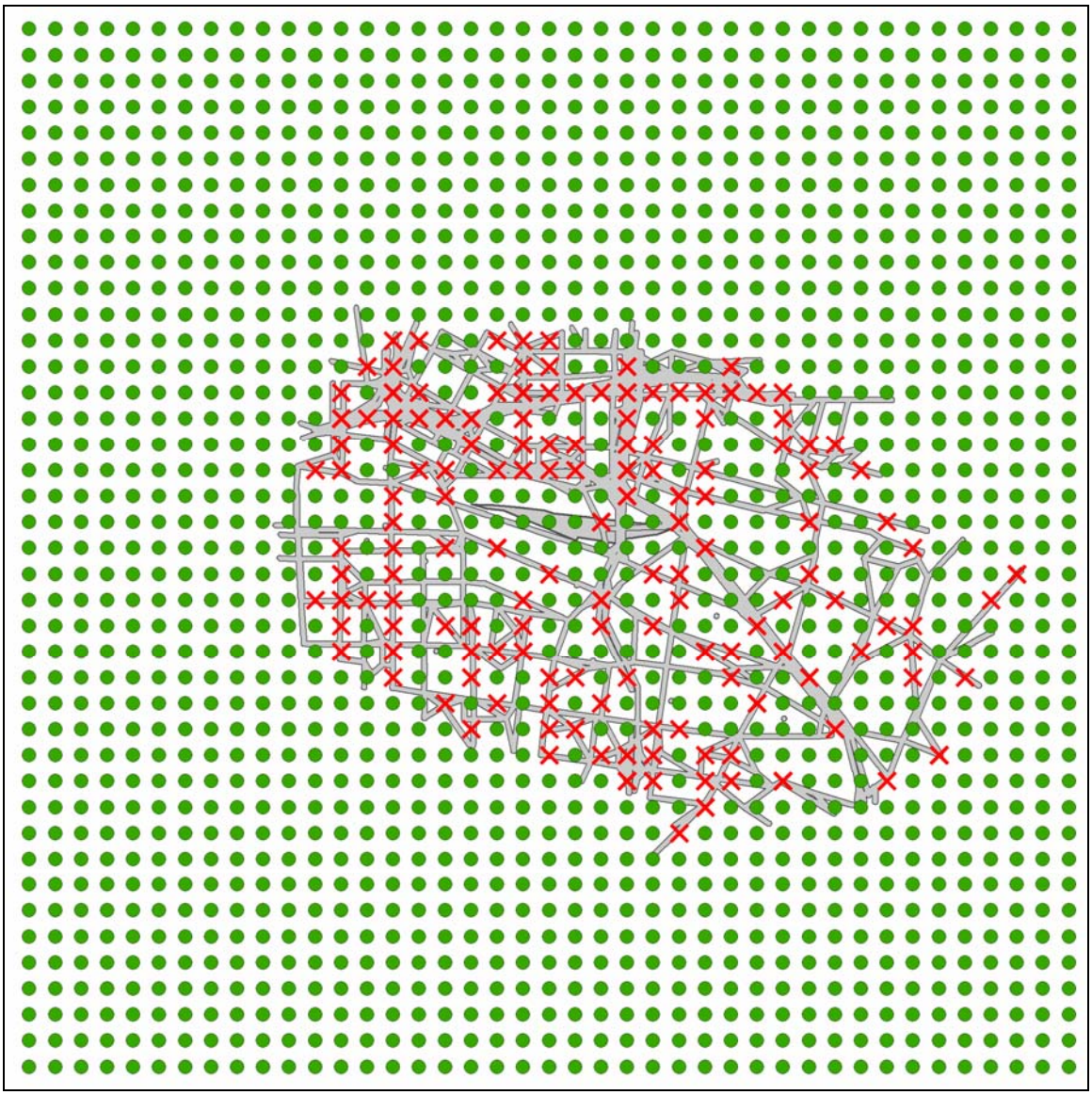


Figure 3: UP Commerce receptor network including off-site sources and rail facility

The off-site stationary and on-road emission sources used in the UP Commerce 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 Sierra Research was used for the off-site modeling runs. The data were compiled by Environ 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.

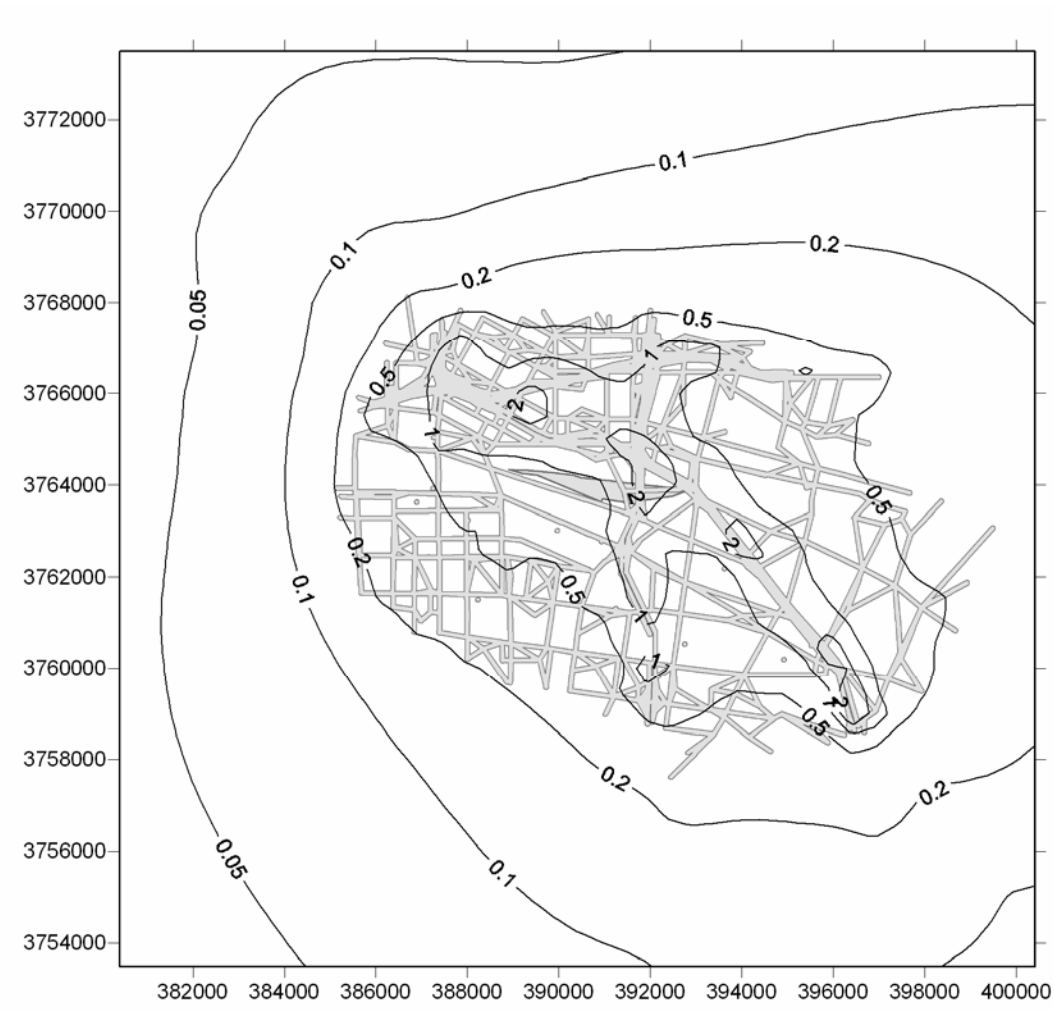


Figure 4: UP Commerce off-site sources and rail yard with modeled annual average concentrations from off-site sources in ug/m^3

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.

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

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

This page left intentionally blank

APPENDIX D

TABLES OF LOCOMOTIVE DIESEL PM EMISSION FACTORS

Locomotive Diesel PM Emission Factors (g/hr)
Adjusted for Fuel Sulfur Content of 221 ppm

Model Group	Tier	Throttle Setting										Source[1]
		Idle	DB	N1	N2	N3	N4	N5	N6	N7	N8	
Switchers	N	31.0	56.0	23.0	76.0	129.2	140.6	173.3	272.7	315.6	409.1	EPA RSD[1]
GP-3x	N	38.0	72.0	31.0	110.0	174.1	187.5	230.2	369.1	423.5	555.1	EPA RSD[1]
GP-4x	N	47.9	80.0	35.7	134.3	211.9	228.6	289.7	488.5	584.2	749.9	EPA RSD[1]
GP-50	N	26.0	64.1	51.3	142.5	282.3	275.2	339.6	587.7	663.5	847.2	EPA RSD[1]
GP-60	N	48.6	98.5	48.7	131.7	266.3	264.8	323.5	571.6	680.2	859.8	EPA RSD[1]
GP-60	0	21.1	25.4	37.6	75.5	224.1	311.5	446.4	641.6	1029.9	1205.1	SwRI[2] (KCS733)
SD-7x	N	24.0	4.8	41.0	65.7	146.8	215.0	276.8	331.8	434.7	538.0	SwRI[3]
SD-7x	0	14.8	15.1	36.8	61.1	215.7	335.9	388.6	766.8	932.1	1009.6	GM EMD[4]
SD-7x	1	29.2	31.8	37.1	66.2	205.3	261.7	376.5	631.4	716.4	774.0	SwRI[5] (NS2630)
SD-7x	2	55.4	59.5	38.3	134.2	254.4	265.7	289.0	488.2	614.7	643.0	SwRI[5] (UP8353)
SD-90	0	61.1	108.5	50.1	99.1	239.5	374.7	484.1	291.5	236.1	852.4	GM EMD[4]
Dash 7	N	65.0	180.5	108.2	121.2	306.9	292.4	297.5	255.3	249.0	307.7	EPA RSD[1]
Dash 8	0	37.0	147.5	86.0	133.1	248.7	261.6	294.1	318.5	347.1	450.7	GE[4]
Dash 9	N	32.1	53.9	54.2	108.1	187.7	258.0	332.5	373.2	359.5	517.0	SwRI 2000
Dash 9	0	33.8	50.7	56.1	117.4	195.7	235.4	552.7	489.3	449.6	415.1	Average of GE & SwRI[6]
Dash 9	1	16.9	88.4	62.1	140.2	259.5	342.2	380.4	443.5	402.7	570.0	SwRI[2] (CSXT595)
Dash 9	2	7.7	42.0	69.3	145.8	259.8	325.7	363.6	356.7	379.7	445.1	SwRI[2] (BNSF 7736)
C60-A	0	71.0	83.9	68.6	78.6	237.2	208.9	247.7	265.5	168.6	265.7	GE[4] (UP7555)

Notes:
1. EPA Regulatory Support Document, *Locomotive Emissions Regulation, Appendix B*, 12/17/1997, as tabulated by ARB and ENVIRON.
2. Base emission rates provided by ENVIRON as part of the BNSF analyses for the Railyard MOU (Personal communication from Chris Lindhjem to R. Ireson, 2006) based on data produced in the AAR/SwRI Exhaust Plume Study (Personal communication from Steve Fritz to C. Lindhjem, 2006).
3. SwRI final report *Emissions Measurements – Locomotives* by Steve Fritz, August 1995.
4. Manufacturers' emissions test data as tabulated by ARB.
5. Base SD-70 emission rates taken from data produced in the AAR/SwRI Exhaust Plume Study (Personal communication from Steve Fritz to R. Ireson, 2006).
6. Average of manufacturer's emissions test data as tabulated by ARB and data from the AAR/SwRI Exhaust Plume Study, tabulated and calculated by ENVIRON.

Locomotive Diesel PM Emission Factors (g/hr)
Adjusted for Fuel Sulfur Content of 2,639 ppm

Model Group	Tier	Throttle Setting										Source[1]
		Idle	DB	N1	N2	N3	N4	N5	N6	N7	N8	
Switchers	N	31.0	56.0	23.0	76.0	136.9	156.6	197.4	303.4	341.2	442.9	EPA RSD[1]
GP-3x	N	38.0	72.0	31.0	110.0	184.5	208.8	262.2	410.8	457.9	601.1	EPA RSD[1]
GP-4x	N	47.9	80.0	35.7	134.3	224.5	254.6	330.0	543.7	631.6	812.1	EPA RSD[1]
GP-50	N	26.0	64.1	51.3	142.5	299.0	306.5	386.9	653.9	717.3	917.4	EPA RSD[1]
GP-60	N	48.6	98.5	48.7	131.7	282.1	294.9	368.5	636.1	735.4	931.0	EPA RSD[1]
GP-60	0	21.1	25.4	37.6	75.5	237.4	346.9	508.5	714.0	1113.4	1304.9	SwRI[2] (KCS733)
SD-7x	N	24.0	4.8	41.0	65.7	155.5	239.4	315.4	369.2	469.9	582.6	SwRI[3]
SD-7x	0	14.8	15.1	36.8	61.1	228.5	374.1	442.7	853.3	1007.8	1093.2	GM EMD[4]
SD-7x	1	29.2	31.8	37.1	66.2	217.5	291.5	428.9	702.6	774.5	838.1	SwRI[5] (NS2630)
SD-7x	2	55.4	59.5	38.3	134.2	269.4	295.9	329.2	543.3	664.6	696.2	SwRI[5] (UP8353)
SD-90	0	61.1	108.5	50.1	99.1	253.7	417.3	551.5	324.4	255.3	923.1	GM EMD[4]
Dash 7	N	65.0	180.5	108.2	121.2	352.7	323.1	327.1	293.7	325.3	405.4	EPA RSD[1]
Dash 8	0	37.0	147.5	86.0	133.1	285.9	289.1	323.3	366.4	453.5	593.8	GE[4]
Dash 9	N	32.1	53.9	54.2	108.1	215.7	285.1	365.6	429.3	469.7	681.2	SwRI 2000
Dash 9	0	33.8	50.7	56.1	117.4	224.9	260.1	607.7	562.9	587.4	546.9	Average of GE & SwRI[6]
Dash 9	1	16.9	88.4	62.1	140.2	298.2	378.1	418.3	510.2	526.2	751.1	SwRI[2] (CSXT595)
Dash 9	2	7.7	42.0	69.3	145.8	298.5	359.9	399.8	410.4	496.1	586.4	SwRI[2] (BNSF 7736)
C60-A	0	71.0	83.9	68.6	78.6	272.6	230.8	272.3	305.4	220.3	350.1	GE[4] (UP7555)

Notes:
1. EPA Regulatory Support Document, *Locomotive Emissions Regulation, Appendix B*, 12/17/1997, as tabulated by ARB and ENVIRON.
2. Base emission rates provided by ENVIRON as part of the BNSF analyses for the Railyard MOU (Personal communication from Chris Lindhjem to R. Ireson, 2006) based on data produced in the AAR/SwRI Exhaust Plume Study (Personal communication from Steve Fritz to C. Lindhjem, 2006).
3. SwRI final report *Emissions Measurements – Locomotives* by Steve Fritz, August 1995.
4. Manufacturers' emissions test data as tabulated by ARB.
5. Base SD-70 emission rates taken from data produced in the AAR/SwRI Exhaust Plume Study (Personal communication from Steve Fritz to R. Ireson, 2006).
6. Average of manufacturer's emissions test data as tabulated by ARB and data from the AAR/SwRI Exhaust Plume Study, tabulated and calculated by ENVIRON.

This page left intentionally blank

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 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 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 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.

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 (mph)	HHD Diesel Emission Factor (g/mi)
18	1.315
20	**1.176**
35	0.712
60	1.009

Step5: Calculate the 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 results of the HHD Trucks diesel PM emissions while traveling between each intermodal railyads and major freewaysare are presented in Table 4.

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