California Environmental Protection Agency

Air Resources Board

Health Risk Assessment for the Union Pacific Railroad Colton Railyard

Stationary Source Division
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California Air Resources Board

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I. INTRODUCTION

The California Air Resources Board (ARB or Board) conducted a health risk assessment study to evaluate the health impacts associated with toxic air contaminants emitted in and around the Union Pacific Railroad's (UP) Colton railyard located in Bloomington, California. The UP Colton Railyard is located at 19100 Slover Avenue in Bloomington, 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 within a one-mile distance from the railyard. This information was used to evaluate the potential health risks associated with diesel particulate matter emissions to those living nearby the railyard.

A. Why ARB is concerned about diesel PM emissions?

In 1998, following a 10-year scientific assessment process, ARB identified particulate matter from diesel exhaust (diesel PM) as a toxic air contaminant based on its potential to cause cancer and other adverse health problems, including respiratory illnesses, and increased risk of heart disease. Subsequent 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 particles are readily respirable and can penetrate deep into the lung and enter the bloodstream, carrying with them an array of toxins. Population-based studies in hundreds of cities in the U.S. and around the world demonstrate a strong link between elevated PM levels and premature deaths (Pope et al., 1995, 2002 and 2004; Krewski et al., 2000), increased hospitalizations for respiratory and cardiovascular causes, 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 contaminants in and around a railyard facility. Statewide, diesel PM accounts for about 70% of the estimated potential ambient air toxic cancer risks based on an analysis conducted by ARB staff in 2000 (ARB, 2000). That analysis also indicated that residents in the South Coast Air Basin (SCAB) had higher estimates of risk than elsewhere in the State. These findings are consistent with the preliminary findings reported in a recently released draft report entitled the "*Multiple Air Toxics Exposure Study in the South Coast Air Basin (SCAQMD, 2008)".* This study reported that diesel PM emissions have decreased, but these emissions are still the major contributor to air toxics risk in the SCAB, accounting for over 80% of the total risk from air toxics in the region. The higher percentage contribution over the previously reported 70% reflects the fact that there has been a proportionally greater reduction in other air toxics, such as benzene and 1, 3-butadiene.

[*] 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.

Based on scientific research findings and the dominance of diesel PM emissions, the health impacts in this railyard health risk assessment study primarily focus on the risks from the diesel PM emissions.

B. Why evaluate diesel PM emissions at the UP Colton 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 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 Colton Railyard is one of the designated railyards subject to the Agreement and the HRA requirements.

C. What are Health Risk Assessments (HRAs)?

An exposure assessment is an analysis of the amount (i.e., concentration in the air) of a pollutant that a person is exposed to in a specific time period. This information is used in a risk assessment to evaluate the potential for an air pollutant to contribute to cancer or other health effects. A health risk assessment uses mathematical models to evaluate the health impacts from exposure to certain chemicals 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.

A 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 emissions from all sources in the South Coast Air Basin are about 7,750 tons per year in 2005 (ARB, 2006a). Diesel PM emissions from the UP Colton Railyard are estimated at about 16.54 tons for the year 2005, which is about 0.21% 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 Ports of Los Angeles and 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 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 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 the 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 not be expected to exceed 100 chances in a million. If a population (e.g., one million people) were exposed to the same potential cancer risk (e.g., 100 chances per million), then statistics would predict that no more than 100 of those million people exposed would be likely to develop cancer from a lifetime of exposure (i.e., 70 years) 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 often designed to be conservative on the side of health protection in order to avoid underestimation of risk to the public. As indicated by the OEHHA Guidelines, the Tier-1 evaluation is useful in comparing risks among a number of facilities and similar sources. Thus, the risk estimates should not be interpreted as a literal prediction of disease incidence in the affected communities but more as a tool for comparison of the relative risk between one facility and another. Therefore, 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.

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

D. Who prepared the UP Colton 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 *ARB Rail Yard Emissions Inventory Methodology* (ARB, 2006c), and *ARB 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 Colton Railyard) developed the emission inventories based on the year 2005 activities and performed the air dispersion modeling for all 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, modeling the impacts of those sources, and preparing the railyard health risk assessments. ARB staff was also responsible for releasing the draft HRAs to the public for comment and presenting them at community meetings. After reviewing public comments on the draft HRAs, ARB staff made revisions as necessary and appropriate, and is now releasing the HRAs in final form. Ultimately, the information derived from the railyard HRAs is to be used to help identify the most effective mitigation measures that could be implemented to further reduce railyard emissions and public health risks.

E. How is this report structured?

The next chapter provides a summary of the UP Colton Railyard operations, emissions, air dispersion modeling, and health risk assessment results. Following the summary, the third chapter presents the details of the UP Colton 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 Colton 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 Union Pacific Railroad's (UP) Colton Railyard operations, emissions, air dispersion modeling, and health risk assessment results.

A. General Description of the UP Colton Railyard

The Union Pacific (UP) Colton Railyard is located at 19100 Slover Avenue in Bloomington, California (see Figure II-1). The UP Colton Railyard covers a narrow area approximately 5.5 miles in length and 1/3 mile in width, at the widest part. The railyard is located adjacent to and directly south of the I-10 freeway. Land use north of the railyard and I-10 includes commercial, industrial, and residential areas. There are several truck distribution centers just north of the I-10. The nearest residential area is located at the west end of the UP Colton railyard, just north of the I-10, approximately 500 feet from the railyard boundary. Land use to the south of the railyard includes residential and industrial areas. There are a number of truck distribution centers and a bulk fuel storage plant in this area. The nearest residential area is located at the west end of the railyard about 350 feet from the Yard's southern boundary. Bloomington Junior High School is located south of the railyard, just east of Cedar Avenue. Land uses to the east and west include commercial and residential areas.

Facilities and equipment at the UP Colton Railyard include a locomotive shop, a locomotive service track, a locomotive wash area, a wheel shop, a sand tower, a railcar repair shop, diesel fuel storage tanks, various oil storage tanks, and a wastewater treatment plant.

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

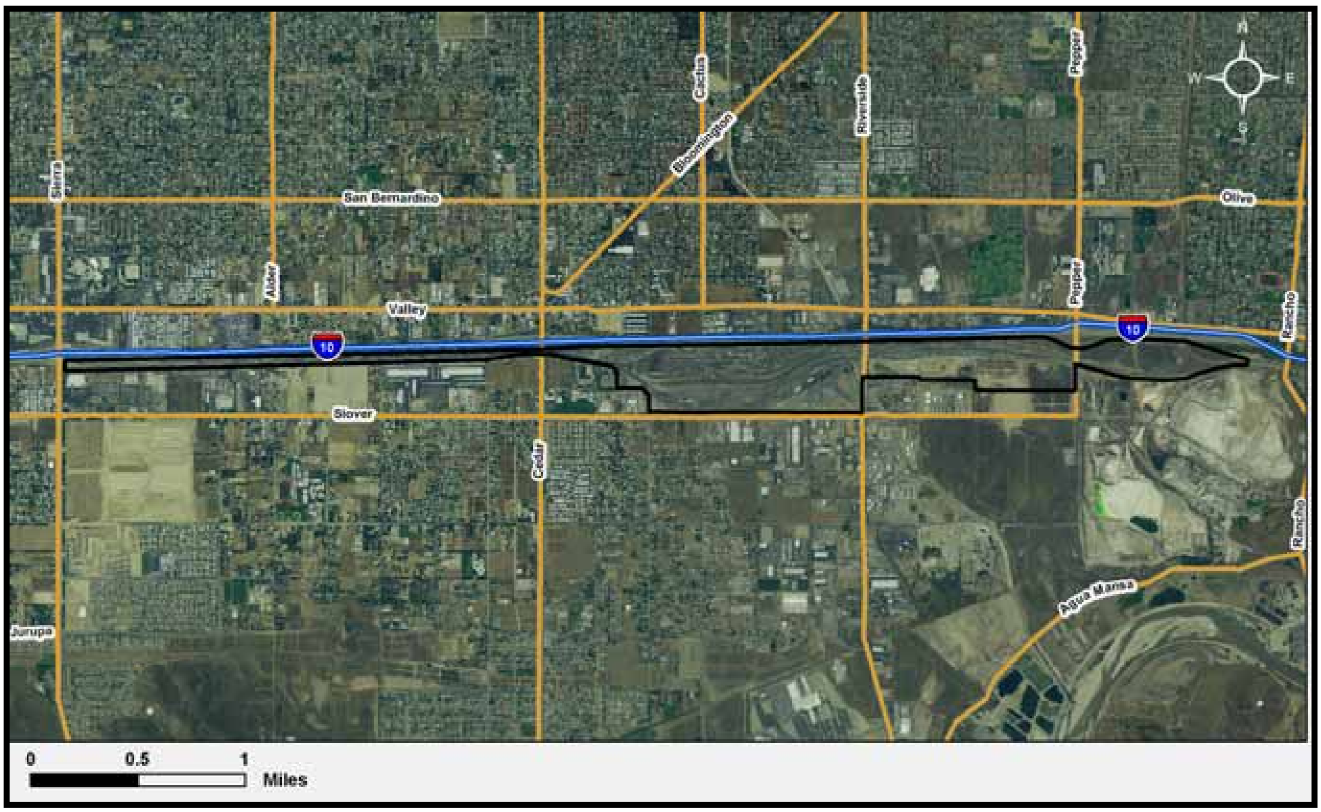
The UP Colton Railyard is a classification yard. The primary function of a classification railyard is to "break" arriving trains into sections based on their final destinations, and to build new trains that then depart for the desired destinations. This is accomplished by pushing the connected cars of an arriving train from the Receiving Yard over a "hump" (a raised section of track). Cars are decoupled at the top of the hump and gravity allows the cars roll into the "bowl." The bowl is a large area with a number of parallel tracks. A computer controls switching each car into the appropriate track within the bowl. Railyard switcher locomotives build new trains by pulling sections of cars out of the bowl, connecting them to others with the same destination(s), and moving them to the departure yard, thereby creating a new outbound train.

There is also a locomotive service facility at the railyard that performs both basic services and scheduled and unscheduled maintenance and load testing. In 2005, all service and maintenance was performed at the service track, while a new locomotive shop facility was constructed at the east end of the railyard.

Activities at the UP Colton Railyard include receiving inbound trains, building outbound trains, refueling locomotives, servicing locomotives, maintaining locomotives, washing locomotives, and performing sand tower operations. There are a number of tanks at the facility that are used to store liquid petroleum products such as diesel fuel, gasoline, lubricating oils, and recovered oil.

Within the railyard, the primary locomotive activities are associated with arriving and departing trains and servicing the locomotives that power these trains. Arriving and departing trains' 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, built in 2006, also performs periodic and unscheduled maintenance on locomotives.

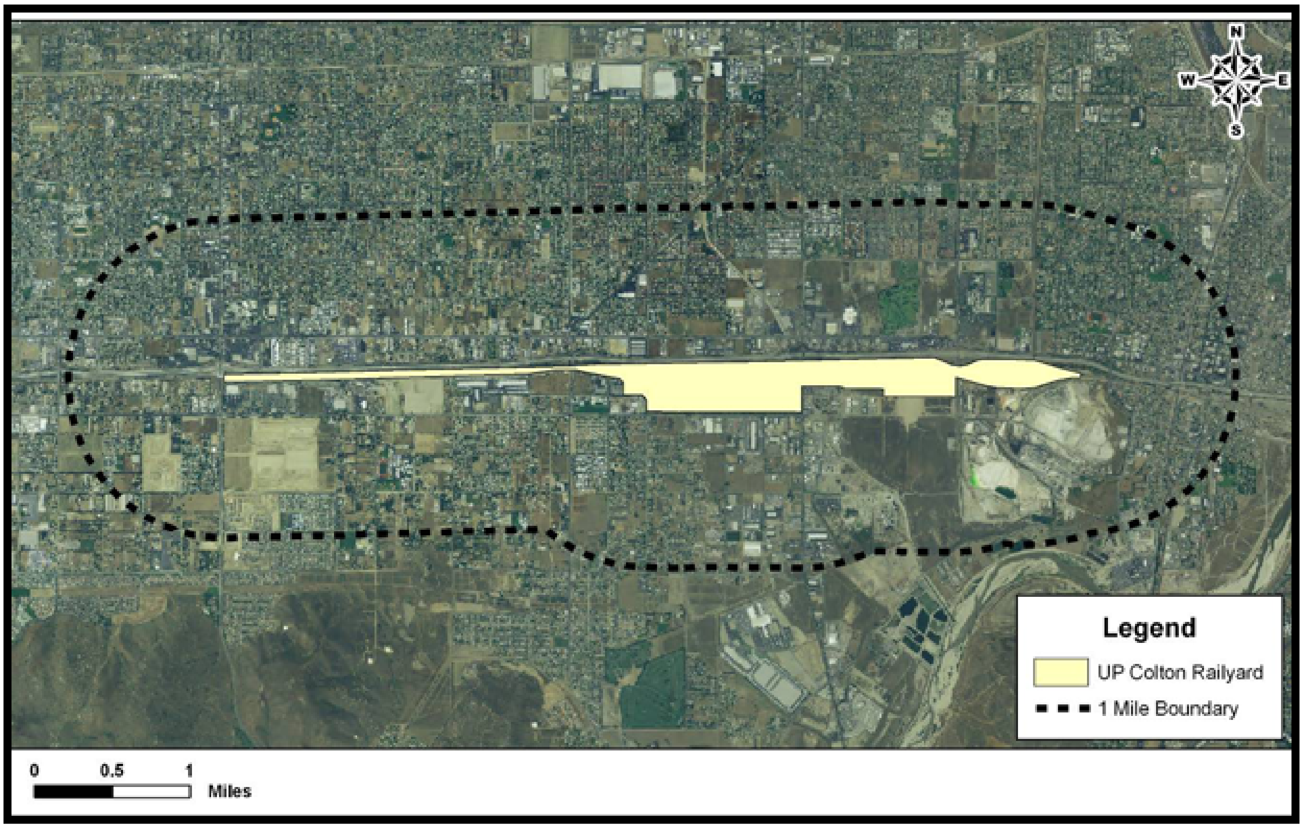
Figure II-1: UP Colton Railyard and Surrounding Areas



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

In 2005, the combined diesel PM emissions from the UP Colton Railyard (on-site emissions) and other significant emission sources within a one-mile distance from the boundary of the UP Colton railyard (off-site emissions) are estimated at about 60 tons per year (see Figure II-2). Estimated off-site diesel PM emissions from mobile sources (not generally related to activities at the railyard) are about 42 tons per year, or about 70% of the total combined on-site and off-site diesel PM emissions. Off-site stationary sources contribute about 1.5 tons per year of the diesel PM emissions or about 2.5 % of the total combined emissions. The UP Colton Railyard diesel PM emissions are estimated at about 16.5 tons per year, which accounts for about 27.5% of the total combined on-site and off-site diesel PM emissions.

Figure II-2: Off-Site One Mile boundary of the UP Colton Railyard



To provide a perspective on the railyard diesel PM emissions, Table II-1 lists the estimated diesel PM emissions (for the year of 2005) for the eighteen railyards. The diesel PM emissions from the UP Colton Railyard rank sixth among the eighteen railyards.

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

Railyard	Locomotive	Cargo Handling Equipment	On-Road Trucks	Others (Off-Road Equipment, TRUs, Stationary Sources, etc.)	Total[§]
BNSF Barstow	**27.1**	**0.03**	**0.04**	**0.75**	**27.9**
BNSF San Bernardino	**10.6**	**3.7**	**4.4**	**3.4**	**22.0**
BNSF San Diego	**1.6**	**N/A**	**0.007**	**0.04**	**1.7**
UP ICTF/Dolores	**9.8**	**4.4**	**7.5**	**2.0**	**23.7**
UP Colton	**16.3**	**N/A**	**0.2**	**0.05**	**16.5**
UP Oakland	**3.9**	**2.0**	**1.9**	**3.4**	**11.2**
UP City of Industry	**5.9**	**2.8**	**2.0**	**0.3**	**10.9**
UP Roseville*	**25.1***	**N/A**	**N/A**	**N/A**	**25.1**
BNSF Hobart	**5.9**	**4.2**	**10.1**	**3.7**	**23.9**
UP Commerce	**4.9**	**4.8**	**2.0**	**0.4**	**12.1**
UP LATC	**3.2**	**2.7**	**1.0**	**0.5**	**7.3**
UP Stockton	**6.5**	**N/A**	**0.2**	**0.2**	**6.9**
UP Mira Loma	**4.4**	**N/A**	**0.2**	**0.2**	**4.9**
BNSF Richmond	**3.3**	**0.3**	**0.5**	**0.6**	**4.7**
BNSF Stockton	**3.6**	**N/A**	**N/A**	**0.02**	**3.6**
BNSF Commerce Eastern	**0.6**	**0.4**	**1.1**	**1.0**	**3.1**
BNSF Sheila	**2.2**	**N/A**	**N/A**	**0.4**	**2.7**
BNSF Watson	**1.9**	**N/A**	**<0.01**	**0.04**	**1.9**
STATEWIDE RY TOTAL	**136.8**	**25.33**	**31.15**	**17.0**	**210.1[§]**
Statewide RY Percent	***65%***	***12%***	***15%***	***8%***	***100%***

*The UP Roseville Health Risk Assessment (ARB, 2004a) was based on 1999-2000 emission estimate, only locomotive diesel PM emissions were reported in that study. The actual emissions were estimated at a range of 22.1 to 25.1 tons per year.
[§]Numbers may not add precisely due to rounding.

1. ***Railyard***

The UP Colton Railyard emission sources include, but are not limited to, locomotives, heavy-heavy duty (HHD) diesel-fueled delivery trucks, heavy equipment, fuel storage tanks, and an emergency generator. The facility operates 24 hours per day, 365 days per year. The emissions were calculated on a source-specific and facility-wide basis for the 2005 baseline year. The future growth in emissions at the UP Colton facility is not incorporated in the HRA emission inventory, but will be included as part of the mitigation emission reduction efforts. The methodology used to calculate the diesel PM and other toxic air contaminant (TAC) emissions is based on the *ARB Rail Yard Emissions Inventory Methodology* (ARB, 2006c). The locomotive emission factors used in the study are presented in Appendix D.

As indicated by Table II-2, locomotive operations within the railyard are responsible for an estimated 16.30 tons per year of diesel PM emissions (about 99% 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 10.2 tons per year. Locomotive service and testing activities account for 2.6 tons per year, and line haul freight and pass-through trains contribute 3.5 tons per year of the diesel PM emissions. Diesel-fueled trucks and other vehicles contribute about 0.19 tons per year, or about 1% of the total on-site diesel PM emissions.

Diesel PM is not the only toxic air contaminant (TAC) emitted in the UP Colton Railyard. Relatively small amounts of gasoline toxic air contaminants are generated from the gasoline storage tanks (including isopentane, toluene, benzene, etc.). Some other toxic air contaminants, such as xylene, toluene and ethyl benzene are emitted from the wastewater treatment plant. The detailed emission inventories for these TACs are presented in the *Toxic Air Contaminant Emissions Inventory and Air Dispersion Modeling Report for the UP Colton Rail Yard, Bloomington, California* (Sierra Research, 2007). The total amount of these toxic air contaminants emissions is about 0.21 tons or 420 pounds per year, as compared to the 16.5 tons per year of the diesel PM emissions from 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 in Table II-3), these non-diesel PM toxic air contaminants emissions are about a factor of 80 less than a potency weighted emissions as compared to diesel PM (0.2 tons per year vs. 16.54 tons per year). Hence, only diesel PM emissions are presented in the on-site emission analysis.

Table II-2: UP Colton Railyard and Surrounding Areas (off-site) Diesel PM Emissions in 2005

DIESEL PM EMISSION SOURCES	UP Colton Railyard		Off-site Emissions**	
	Tons/Year	Percentage	Tons/Year	Percentage
LOCOMOTIVES	**16.30**	**99%**	-	-
- Switch Locomotives (conducting yard operations)	10.2	62%	-	-
- Freight & Through Trains	3.5	21%	-	-
- Service/Testing/Refueling	2.6	16%	-	-
YARD TRUCKS	**0.19**	**1%**	-	-
OTHERS (Heavy Equipment and Emergency Generators)	**0.05**	**0.3%**	-	-
OFF-SITE MOBILE SOURCES (e.g., heavy duty trucks, etc.)	-	-	**42**	**97 %**
OFF-SITE STATIONARY SOURCES (e.g., public facilities, public utilities, etc.)	-	-	**1.5**	**3%**
TOTAL	**16.54***	**100%**	**43.5**	**100%**

* Numbers may not add precisely due to rounding.
** Emissions within the one-mile boundary. (Railyard emissions not include)

2. Surrounding Sources

ARB staff evaluated significant mobile and stationary sources of diesel PM emissions surrounding UP Colton Railyard. The Health Risk Assessment study for the UP Roseville Railyard (ARB, 2004a) indicated that cancer risk associated with on-site diesel PM emissions is substantially reduced beyond a one-mile distance from the railyard. Therefore, for the UP Colton Railyard, 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.

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 one-mile distance from the UP Colton railyard boundary 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.

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.

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 a one-mile distance from the boundary of the UP Colton railyard 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 one-mile distance from the boundary of the UP Colton Railyard, off-site diesel PM emissions are predominantly generated by mobile sources, which emit around 42 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 freeway I-10, and major local streets. There are some stationary sources that generate about 1.5 tons per year of diesel PM emissions. Three major stationary sources, California Portland Cement Company, Arrowhead Regional Medical Center, and General American Transportation Corporation (GATX) contribute about 1.46 tons per year of the off-site stationary sources diesel PM emissions. Diesel PM emissions from sources in the UP Colton Railyard and the sources within a one-mile distance from the boundary of the UP Colton railyard are summarized in Table II-2.

ARB staff also evaluated other toxic air contaminant (TACs) emissions around the UP Colton Railyard. 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 five 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 9.0 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 II-3. As can be seen in Table II-3, the potency weighted toxic emissions for these TACs are about 0.247 tons per year, which is substantially less than the diesel PM emissions.

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

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 carcinogenic toxic air contaminants from South Coast Air Basin gasoline sources in 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: Cancer Potency Weighted Toxic Air Contaminant Emissions from Significant Off-Site Stationary Sources Surrounding UP Colton Railyard

Compound	Cancer Potency Factor	Weighting Factor	Estimated Emission (tons/year)	Potency Weighted Toxic Emission (tons/year)
Diesel PM	1.1	1	43.5	**43.5**
1,3-Butadiene	0.6	0.55	0.021	**0.012**
Benzene	0.1	0.09	0.736	**0.066**
Carbon Tetrachloride‡	0.15	0.14	0.000056	**0.000**
Formaldehyde	0.021	0.02	8.48	**0. 169**
Total (non-diesel PM)	**-**	**-**	**9.24***	**0.247**

*: Numbers may not add precisely due to rounding.

‡ Very 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.

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

Compound	TACs Emissions (tons/year)			
	From All Sources	Potency Weighted**	From Gasoline Vehicles	Potency Weighted**
Diesel PM	7,746	**7,746**	-	-
1,3-Butadiene	695	**382**	420	**231**
Benzene	3,606	**325**	2,026	**182**
Formaldehyde	4,623	**92**	1,069	**21**
Acetaldehyde	1,743	**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 Colton Railyard?

As discussed previously, the ARB developed *Health Risk Assessment Guidance for Railyard and Intermodal Facilities* (ARB, 2006d) to help ensure that the methodologies used in each railyard HRA meet the requirements in the ARB / Railroad Statewide Agreement. The railyard HRA follows *The Air Toxics Hot Spots Program Risk Assessment Guidelines* (OEHHA, 2003) published by the 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 **I**mprovement 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.

The UP Colton Railyard does not monitor meteorological variables on site. Wind speed, wind direction, temperature, and cloud cover data from the Ontario International Airport were used for this project. Although the Ontario International Airport is approximately 10 miles west of the UP Colton Railyard, the dominant effect of the elevated terrain an land sea effects near the coast was judged to be sufficiently important for airflow patterns that Ontario surface winds would be most representative of conditions at the railyard. The selection of Ontario International Airport for surface winds data was largely dependent on the limited availability of data from other stations for the same years for which upper air data were available. There are several SCAQMD surface stations in the general vicinity of the railyard for which historical (1981) data are available, but only in a form usable in AERMOD's predecessor, ISCST3. Based on the AERMOD meteorological data selection criteria, different meteorological stations around the UP Colton Railyard were evaluated and the data from the Ontario International Airport was selected for the final modeling.

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

The potential cancer risk levels associated with the estimated diesel PM emissions at the UP Colton 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, and 250 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-3 focuses on the more regional impacts. In each figure, the risk isopleths are overlaid onto a satellite image of the Bloomington area surrounding the UP Colton 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 exposure at the point of maximum impact be reported. The point of maximum impact (PMI), which is defined as a location or the receptor point with the highest cancer risk level outside of the facility boundary, with or without residential exposure, is predicted to be located at the northeast side of the railyard fence line (see Figure II-3). This is directly downwind of high emission density areas for the prevailing southwesterly wind, where locomotive activities (line haul, switchers, and locomotive service shop) generates about 50% of the facility-wide diesel PM emissions (see the emission allocation in Appendix E). The cancer risk at the PMI is estimated to be about 575 chances in a million. The land use in the vicinity of the PMI is primarily zoned as industrial use. However, there may be residents living in this zoned area. In the residential zoned area, the potential cancer risk of maximally exposed individual resident (MEIR) or maximum individual cancer risk (MICR) is estimated at about 150 chances in a million. As indicated by the Roseville Railyard Study (ARB, 2004a), the location of the PMI may vary depending upon the settings of the model inputs and parameters, such as meteorological data set or emission allocations in the railyard. Therefore, given the estimated emissions, modeling settings, and the assumptions applied to the risk assessment, there are great uncertainties associated with the estimation of point of maximum impact (PMI) and maximum individual cancer risk (MICR). These indications should not be interpreted as a literal prediction disease incidence but more as a tool for comparison. In addition, the estimated point of maximum impact location and maximum individual cancer risk value may not be replicated by air monitoring.

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

As indicated by Figure II-3, the UP Colton Railyard can be divided into three areas, eastern, central and western; the area with the greatest impact has an estimated potential cancer risk of over 250 chances in a million, occurring in a very small area next to the northeastern side of the railyard fence line, right next to freeway I-10. The estimated cancer risk is about 250 chances per million within approximately 200 yards from the northeastern side of the railyard property boundary. At about 400 yards from the eastern side of the railyard boundary, the estimated cancer risks decrease to about 100 chances per million. As indicated by Figure II-4, the risks further decrease to 50 in a million within about half mile from the eastern side of the railyard boundary, then to 25 in a million approximately one mile from the railyard boundary. At about 2 miles from the eastern part of the railyard boundary, the estimated cancer risks are at 10 in a million or lower. For the central part of the railyard, the cancer risk is 100 in a million at about quarter a mile from the railyard boundary and at about half a mile the cancer risk is approximately 50 in a million. At about 1 mile the cancer risk is 25 in a million and at about 1.5 miles the cancer risk is 10 in a million or lower.

On the western side of the railyard, the area with the greatest impact has an estimated potential cancer risk of over 100 chances in a million. This area is located approximately 200 yards from the western part of the railyard boundary. At about a quarter a mile the estimated cancer risk decreases to 50 in a million and then at about half a mile the estimated cancer risk is 25 in a million or lower. At about 1 mile, the estimated the cancer risk decreases to 10 in a million.

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

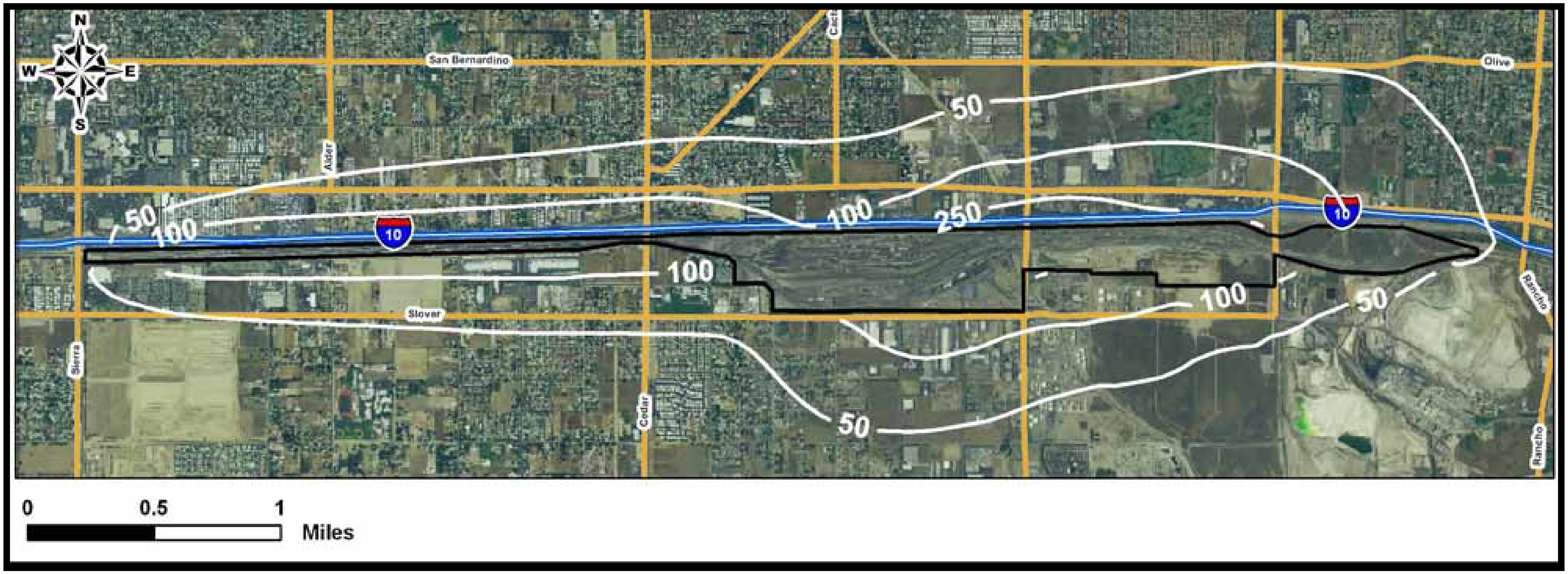
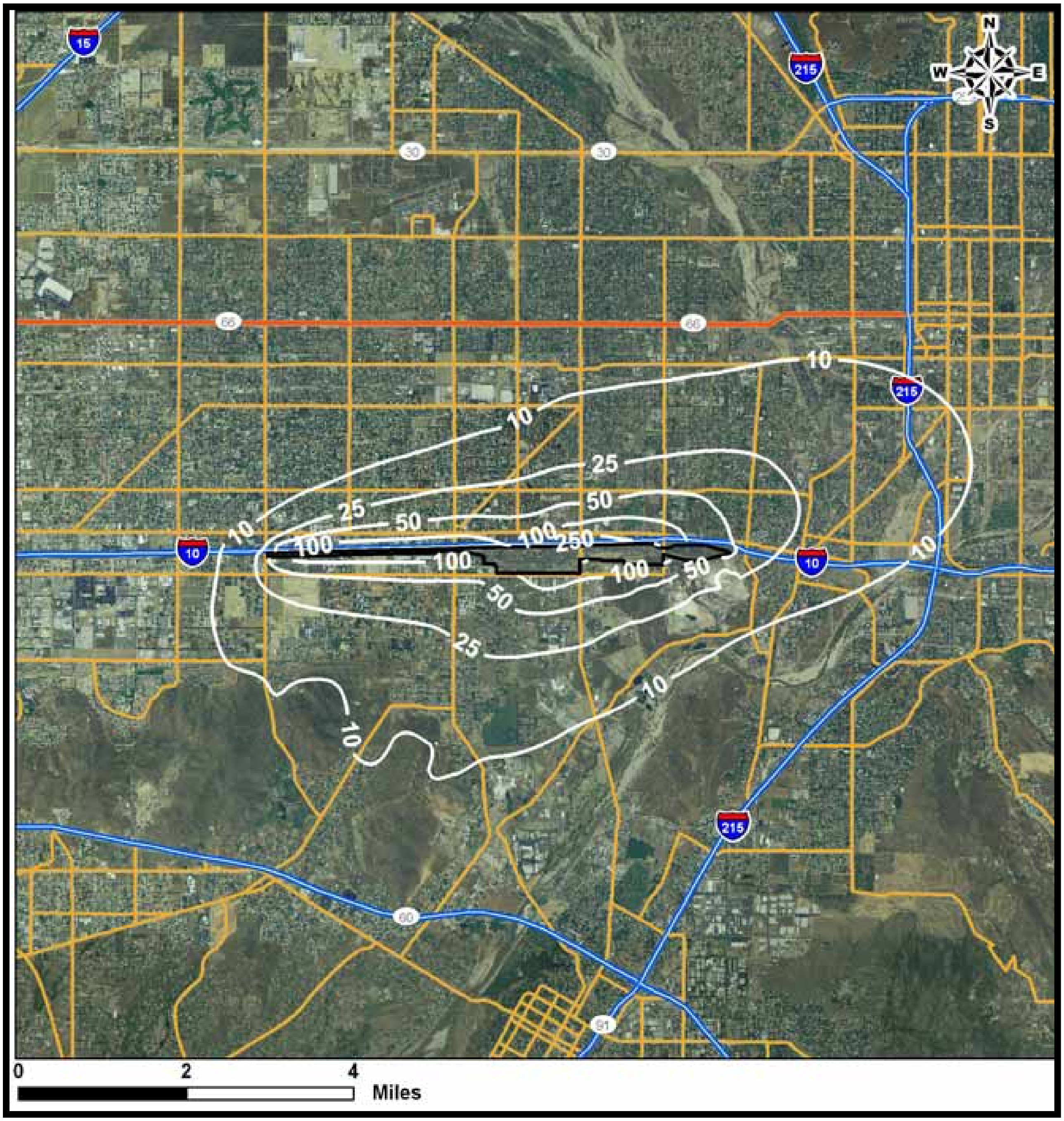


Figure II-4: Estimated Regional Cancer Risks (chances per million people) from the UP Colton Railyard



The OEHHA Guidelines recommend 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-5 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 Levels (Chances in a Million)				
70	10	25	50	100	250
30	4	11	21	43	107
9*	2.5	6.3	12.5	25	62.5
40‡	2	5	10	20	50

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

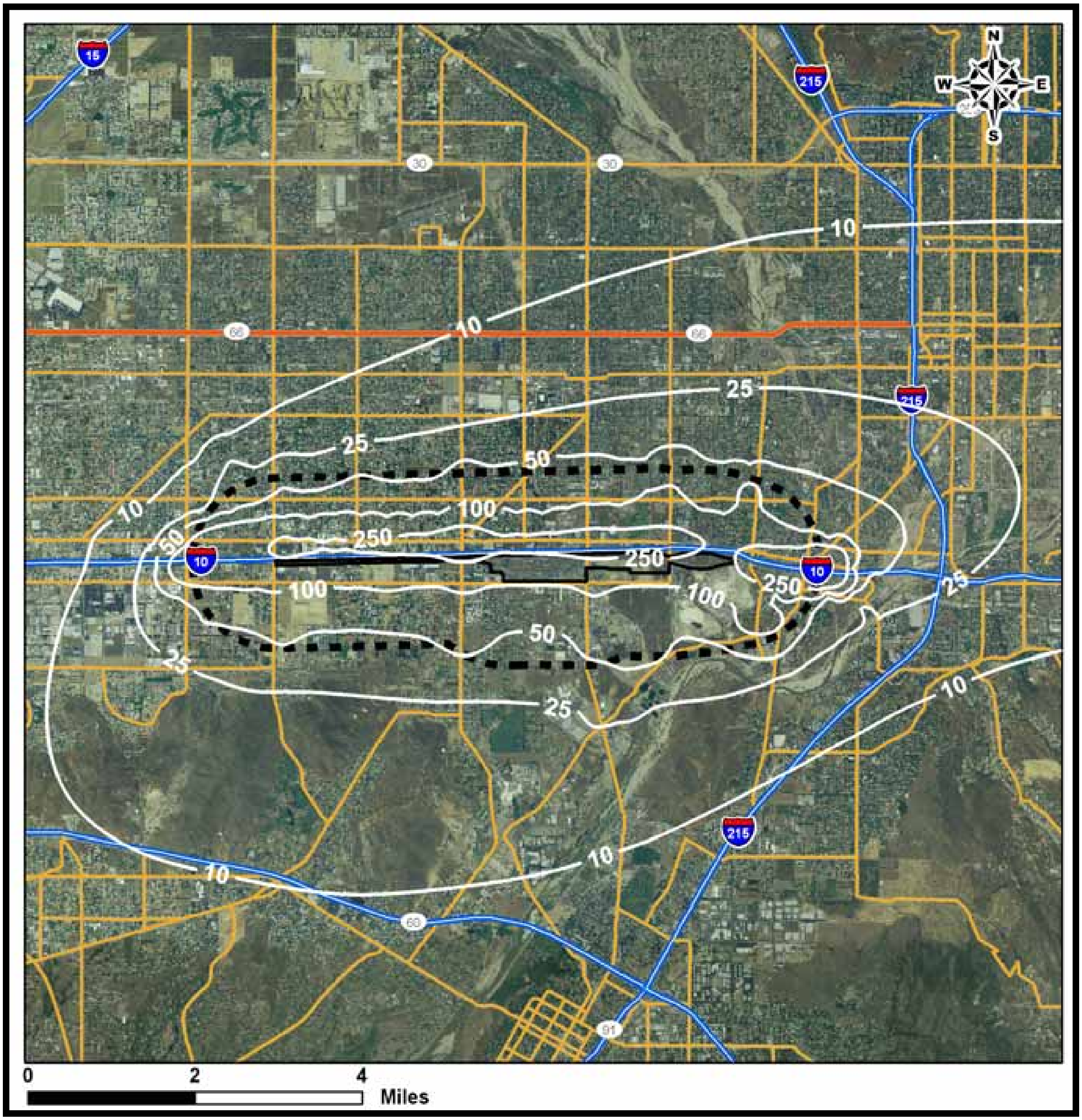
The more populated areas near the UP Colton Railyard are located to the west, north and southwest of the railyard. Based on the 2000 U.S. Census Bureau's data, the zone of impact of the estimated risks above 10 chances in a million levels encompasses approximately 17,000 acres where about 91,000 residents 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 UP Colton Railyard Diesel PM Emissions

Estimated Cancer Risk (chances per million)	Impacted Area (Acres)	Estimated Population Exposed
10 - 25	11,000	60,000
25-50	3,500	26,000
50-100	1,600	5,000
>100	635	320
>10	**17,000***	**91,000***

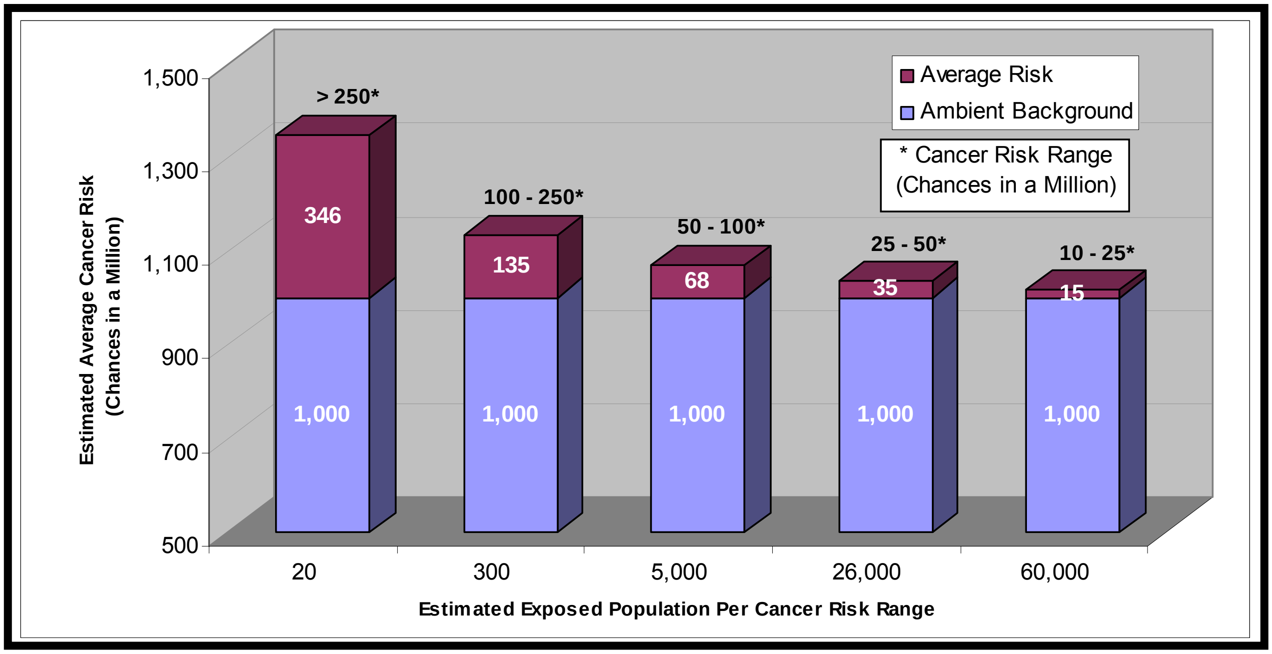
* Numbers may not add up due to rounding.

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 Colton Railyard diesel PM emissions) above the existing background risk levels. For the broader South Coast Air Basin, the estimated average 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 250 chances in a million, the estimated average potential cancer risk above the regional background is about 350 chances per million. Therefore, residents living in that area would have a potential cancer risk at about 1,350 in a million.

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

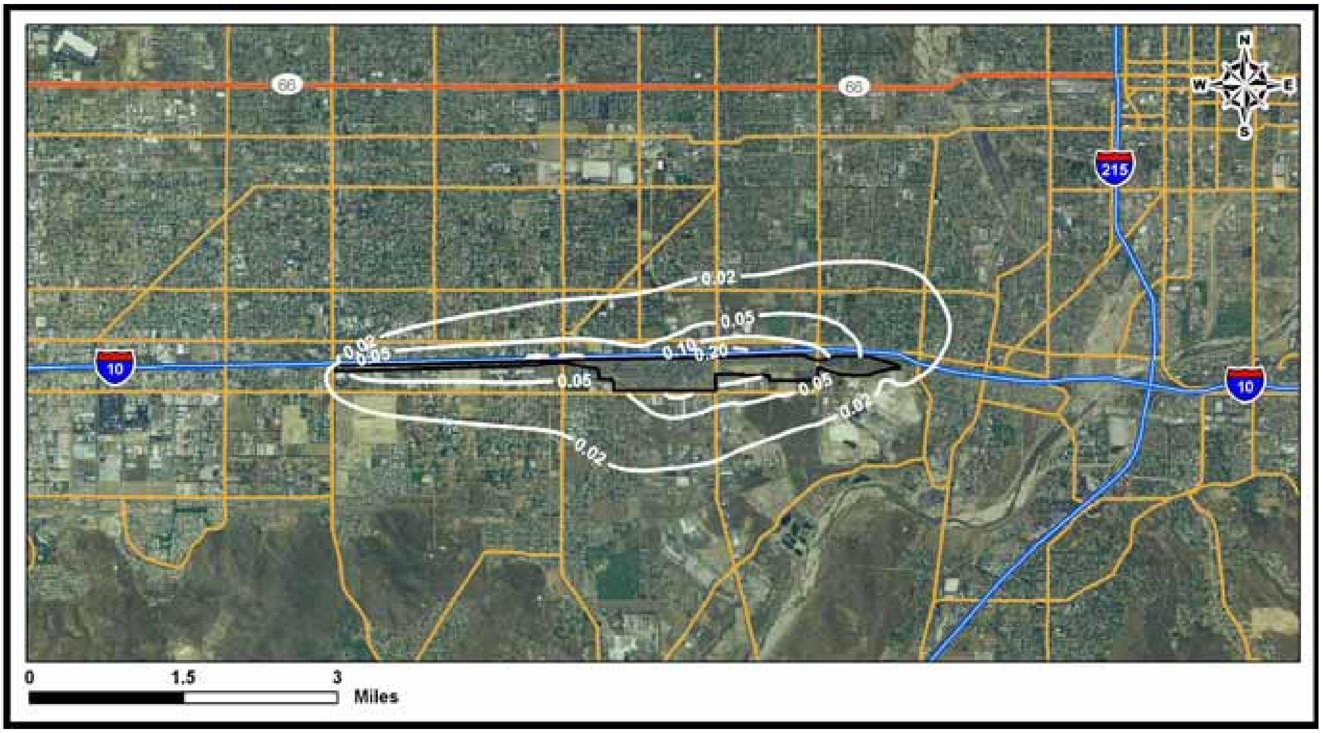


E. What are the estimated non-cancer risks near the UP Colton Railyard?

The potential non-cancer chronic risk health hazard index from diesel PM emissions from the UP Colton Railyard is estimated to range from 0.02 to 0.20 as shown in Figure II-7. According to OEHHA Guidelines (OEHHA, 2003), these levels indicate that the potential non-cancer chronic public health risks are less likely to happen.

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.

Figure II-7: Estimated Non-Cancer Chronic Risk (indicated as Hazard Indices) associated With the Diesel PM Emissions from the UP Colton



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 Colton Railyard facility using the U.S. EPA-approved AERMOD dispersion model. Specifically, off-site mobile and stationary diesel PM emission sources located within a one-mile distance from the boundary of the UP Colton was included. Diesel PM off-site emissions used in the off-site modeling runs consisted of about 42 tons per year from roadways and 1.5 tons per year from stationary facilities, representing off-site emissions for 2005. The diesel PM emissions from the UP Colton Railyard is 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 Colton Railyard. This result is expected because the diesel PM emissions from the significant off-site sources are equivalent to about three times the UP Colton 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 25 chances in a million levels associated with off-site diesel PM emissions encompasses approximately 20,000 acres where about 100,000 residents live. For comparison with the UP Colton Railyard health risks, the same level of potential cancer risks (25 chances in a million) covers about 6,000 acres with a population of approximately 30,000. 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	26,000	133,800
25 -50	9,100	46,300
50-100	5,700	38,800
100-250	3,700	12,750
>250	1,300	3,900
>10	**46,000***	**235,550***

- Approximate estimates due to partial of these isopleths extend beyond the air dispersion model domain.
- Numbers may not add up due to rounding.

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

South Coast Locomotive 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. Tier 2 locomotives became commercially available in 2005 and provide a 65 percent reduction in oxides of nitrogen (NOx) and 50 percent reduction in diesel particulate matter (PM) emissions. This Agreement will provide locomotive fleet benefits in southern California 20 years earlier than the rest of the country.

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

- Phasing-out of non-essential idling on all locomotives without idle reduction devices (60 minute limit – fully implemented);
- Installing idling reduction devices on 99% of the 450 California-based locomotives by June 30, 2008 (15 minute limit – 95 percent implemented);
- Identify and expeditiously repair locomotives with excessive smoke and ensure that at least 99 percent of the locomotives operating in California pass smoke inspections (fully implemented); and
- Requiring all locomotives that fuel in the state use at least 80 percent federal or California ultra low sulfur (15 parts per million) diesel fuel by January 1, 2007, (six years prior to federal requirement) (fully implemented);
- Preparing new health risk assessments for 16 major railyards, based on the UP Roseville Railyard health risk assessment (completed in 2004) and Office of Environmental Health Hazard Assessment (OEHHA) guidelines; (nine of 16 finalized in November 2007); and
- Identifying and implementing future feasible mitigation measures based on the results of the railyard health risk assessments.

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

ARB Cargo Handling Equipment Regulations (2007): This regulation, approved in 2005, requires the control of emissions from more than 4,000 pieces of mobile cargo handling equipment, such as yard trucks and forklifts that operate at ports and intermodal rail yards. Implementation of this regulation will reduce diesel PM by approximately 40% in 2010 and 65% in 2015, and NOx emissions by approximately

25% in 2010 and 50% in 2015.This regulation is expected to reduce diesel PM and NOx emissions by up to 80 percent by 2020. The regulation took effect on January 1, 2007.

Heavy Duty Diesel New Trucks Regulations: ARB and the U.S. EPA both have adopted emission standards for 2007 and subsequent model year heavy-duty diesel engines. These standards represent a 90 percent reduction of NOx emissions, 72 percent reduction of non-methane hydrocarbon emissions, and a 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.

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

In-Use Port and Railyard Truck Mitigation Strategies: The ARB developed a port truck fleet modernization program that will reduce diesel PM by nearly 86 percent by 2010, and NOx by nearly 56 percent by 2014, as compared to 2007 baseline. There are an estimated 20,000 drayage trucks operating at California’s ports and intermodal railyards. These trucks are a significant source of air pollution, with about 3 tons per day of diesel PM and 61 tons per day of NOx in 2007. Drayage trucks also often operate in close proximity to communities. This regulation will result in significant reductions in exposure and potential cancer risks to residents that live near ports, railyards, and the major roadways. The ARB Board approved the regulation in December 2007.

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

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

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

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

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

III. UP COLTON RAILYARD DIESEL PM EMISSIONS

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

For the year 2005, the combined diesel PM emissions from the UP Colton Railyard (on-site emissions) and significant non railyard emission sources within a one-mile distance from the boundary of the UP Colton railyard (off-site emissions) are estimated at about 60 tons per year. Estimated off-site diesel PM emissions from mobile sources (not generally related to activities at the railyard) are about 42 tons per year, or about 70% of the total combined on-site and off-site diesel PM emissions. Off-site stationary sources contribute 1.5 tons per year or 2.5% of the total combined on-site and off-site diesel PM emissions. The UP Colton Railyard diesel PM emissions are estimated at about 16.54 tons per year, which accounts for about 27.5% of the total combined on-site and off-site diesel PM emissions.

A. UP Colton Railyard Diesel PM Emissions Summary

The UP Colton 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 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 UP Colton Rail Yard, Bloomington, California* (Sierra Research, 2007) submitted by Sierra Research (Sierra Research Report).

The UP Colton Railyard is a classification yard. The primary function of a classification yard is to “break” arriving trains into sections based on their final destinations, and to build new trains that then depart for the desired destinations. This is accomplished by pushing the connected cars of an arriving train from the Receiving Yard over a “hump” (a raised section of track). Cars are decoupled at the top of the hump and gravity allows the cars roll into the “bowl.” The bowl is a large area with a number of parallel tracks. Computer controls switching each car into the appropriate track within the bowl. Yard switcher locomotives build new trains by pulling sections of cars out of the bowl, connecting them to others with the same destination(s), and moving them to the departure Yard, thereby creating a new outbound train.

Activities at the UP Colton Railyard include receiving inbound trains, building outbound trains, refueling locomotives, servicing locomotives, maintaining locomotives, washing locomotives, and performing sand tower operations. There are a number of tanks at the facility that are used to store liquid petroleum products such as diesel fuel, gasoline, lubricating oils, and recovered oil.

Within the Yard, the primary locomotive activities are associated with arriving and departing trains and servicing the locomotives that power these trains. Arriving and departing trains' locomotives are fueled in the locomotive service area after arrival, and are sent back into the Yard or to other yards after service. A locomotive maintenance shop also performs periodic and unscheduled maintenance on locomotives.

Facilities and equipment at the UP Colton Yard include a locomotive shop, a locomotive service track, a locomotive wash area, a wheel shop, a sand tower, a railcar repair shop, Diesel fuel storage tanks, various oil storage tanks, and a wastewater treatment plant. On-site sources were separated into four operational 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 Colton Railyard Activities

Area	Description
Receiving Yard	**Receiving inbound trains**
Hump, Bowl and Trim Tower	**Breaking down of the arriving trains, switching of the cars into the appropriate tracks, and building new trains**
Departure Yard	**Creating new outbound trains and their departure**
Servicing/Maintenance Area (Service Track, Wheel Shop, and Locomotive Shop)	**Maintenance and service area for locomotives (for Refueling, Servicing, washing and Sand Tower Operations).**

Note: Locomotive shop was not yet built in 2005, so all locomotive maintenance was performed at the service track

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 16.54 tons per year. The diesel PM emissions from each activity are provided in Table III-2.

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

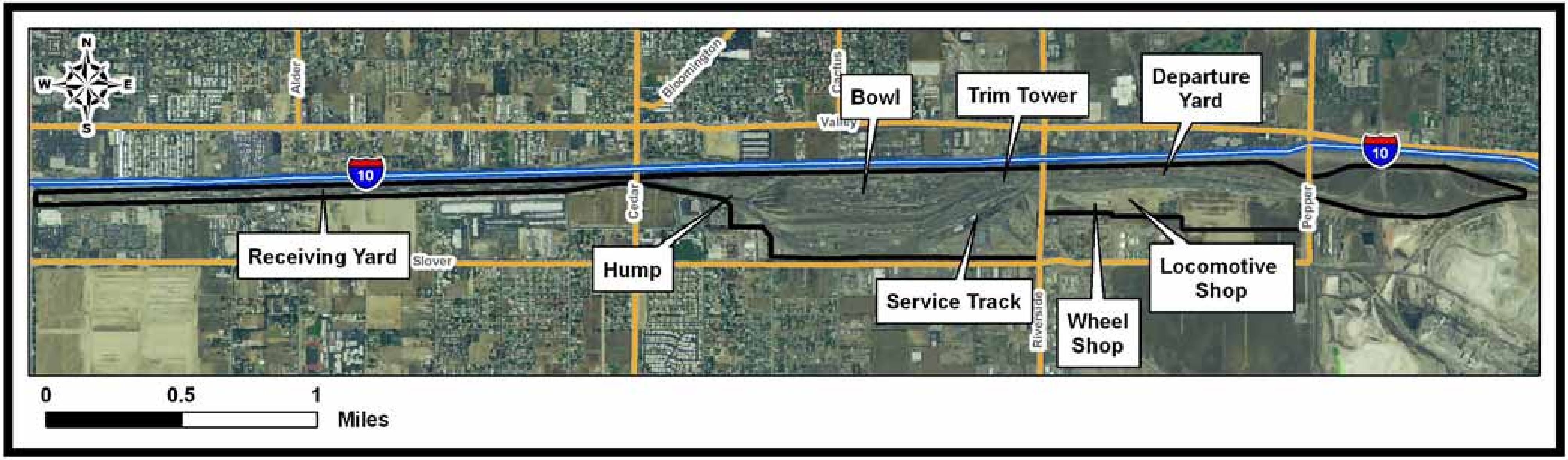
Sources	Diesel PM Emissions (tons per year)	
	Total Diesel PM Emissions	Percent of Total
LOCOMOTIVES	**16.30**	**99%**
Switchers	*10.20*	*62%*
Line Hauls (Freight and Through Trains)	*3.50*	*21%*
Service and Maintenance	*2.60*	*16%*
DIESEL FUELED YARD TRUCKS*	**0.19**	**1%**
OTHERS (Heavy Equipment and Emergency Generator)	**0.05**	**0.3%**
TOTAL	**16.54****	**100%**

*: For further detail on railyard versus off-site on-road truck emissions, see Section C.
** Numbers may not add precisely due to rounding

Diesel PM is not the only toxic air contaminant (TAC) emitted in the UP Colton Railyard. A relatively small amount of gasoline toxic air contaminants is generated from the gasoline storage tanks (including isopentane, toluene, benzene, etc.). Some other toxic air contaminants, such as xylene, toluene and ethyl benzene are emitted from the wastewater treatment plant. The detailed emission inventories for these TACs are presented in the *Toxic Air Contaminant Emissions Inventory and Air Dispersion Modeling Report for the UP Colton Rail Yard, Bloomington , California* (Sierra Research, 2007). The total amount of these toxic air contaminants emissions is about 0.21 tons or 420 pounds per year, compared to the 16.5 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 in Table II-3), these non-diesel PM toxic air contaminants emissions are about a factor of 80 less than a potency weighted emissions as compared to diesel PM (0.21 tons per year vs. 16.54 tons per year). Hence, only diesel PM emissions are presented in the on-site emission analysis.

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



1. Locomotives

Locomotives are the largest diesel PM emission source at the UP Colton Railyard. Locomotives contribute about 16.30 tons per year, or about 99% of the total railyard diesel PM emissions.

The locomotive operations at the UP Colton Railyard are divided into three major categories: switching (i.e., moving rail cars within the yard and hump and bowl and trim operations), basic locomotive services (i.e., maintenance, testing, refueling etc.), and passing 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. As shown in Table III-3 switch operations (hump and trim operations, and power moves in the yard) are the largest source of diesel PM emissions at the UP Colton railyard and account for about 10.2 tons per year or 63% of the locomotive diesel PM emissions and 62% of the total railyard diesel PM emissions. Trim operations account for about 5.28 tons per year, or 32% of the locomotive diesel PM emissions. Hump operations account for about 4.74 tons per year and power moves in the yard account for about 0.14 tons per year. Arriving, departing and through trains accounts for about 3.5 tons per year or 21%, and service and maintenance account for 2.6 tons per year, or 16% of the railyard diesel PM emissions.

Line haul locomotive activities include hauling through trains on the main line, pulling arriving trains into the Receiving Yard and departing trains out of the Departure Yard; and moving locomotives to and from the Service Track and Ready Track. Switching operations within the railyard include the use of 12 medium-horsepower switcher locomotives: two sets of three locomotives push inbound trains over the hump into the bowl, and three sets of two locomotives work the eastern end of the bowl and the departure yard to build new outbound trains. Locomotive servicing and maintenance activities are performed on both line haul and switcher locomotives, and include idling associated with refueling, sanding, oiling, and waiting to move to outbound trains. Additional periods of idling and operation at higher throttle settings occur during load test events that follow specific maintenance tasks. 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.

According to UP, the UP interstate locomotives were fueled out of state before they entered the California borders. However, data for the detailed diesel deliveries within and outside of California were not available in 2005. When trains arrive at UP railyards, UP estimated a fuel mixture of about 90% CARB-EPA on-road to 10% non-road diesel fuel, based on traveling distance before entering California borders from the last refueling facility outside California. Trains arriving and terminating at California railyards (with the exception of local trains) used fuel produced outside of California and on arriving were assumed to have approximately 10% of their capacity of that fuel left in their tanks. On arrival, locomotives were refueled with California diesel fuel, resulting in a mixture of 90% CARB and 10% non-CARB fuel: this mixture is representative of fuel on departing trains as well as trains undergoing load testing (if conducted at a specific railyard). For through trains by-passing UP railyards, an average composition of 50-50 split was applied to account for CARB-EPA and non-California diesel fuel used. Therefore, UP estimated different fuel sulfur levels based on the average fractions of California fuel being used as follows: 221 ppmw for yard operations, 463 ppmw for arriving and departing trains, 1,430 ppmw for through trains, and 2,639 ppmw for terminating trains.

The locomotive diesel PM emission factors used in this study are based on those of UP Roseville Railyard Study (ARB, 2004a), 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 ppmw to 400 ppmw, with an average of 221 ppmw. The 221 ppmw 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 ppmw (U.S. EPA, 2004c). The 2,639 ppmw 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.

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. ARB staff estimates that the replacement of the UP Colton's entire railyard (switch) locomotive with ultra low emitting locomotives could reduce those diesel PM emissions by up to 90 percent. This single measure could reduce UP Colton's total diesel PM emissions by up to 55 percent. The Locomotive NOx fleet average agreement (1998) provides a 65 percent reduction in oxides of nitrogen (NOx) and 50 percent reduction in diesel PM emissions in the South Coast Air Basin beginning in 2010. The detailed approach has been discussed in Chapter 2. Therefore, in the future, the UP Colton Railyard will benefit from these mitigation measures as diesel PM emissions from locomotives are gradually reduced as the locomotive fleets turn over.

Table III-3: Locomotive Diesel PM Emissions

Activity	Diesel PM Emissions in 2005	
	Tons Per Year	Percent of Total
Switching	**10.20***	**63%**
Trim Operations	5.28	32%
Hump Operations	4.74	29%
Power moves in the yard	0.14	1%
Line Haul Locomotives	**3.50**	**21%**
Freight Trains	2.45	15%
Through Trains and Power moves	0.51	3%
Local Trains	0.47	2%
Crew Changes	0.07	<1%
Service/Maintenance	**2.60**	**16%**
Service Idling	2.14	13%
Load Testing	0.44	3%
Service Movements	0.06	<1%
TOTAL	**16.30***	**100%**

- Numbers may not add up due to rounding off.

2. Yard Trucks or Diesel Fueled Trucks

UP operates a variety of on-road diesel-fueled trucks (Yard trucks) that are used for various activities in and around the Yard. These yard trucks are local vehicles used to perform support activities at the railyard. On-road diesel fueled trucks contribute about 1% of the total railyard diesel PM emissions at about 0.19 tons per year. As shown in Table III-4, 100% of the on-road truck diesel PM emissions come from diesel fueled yard trucks. Diesel PM emissions due to yard trucks at the UP Colton Railyard were estimated using emission factors from the draft EMFAC (version V2.23.7)model provided by ARB (2006c) and is based on average railyard travel distance.

An ARB regulation to modernize port and intermodal railyard drayage trucks is estimated to reduced diesel PM emissions by 86% by 2010, and NO_x by 56% by 2014, as compared to the 2007 baseline. In January 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 Colton Railyard will benefit from these mitigation measures, with diesel PM emissions from heavy-duty diesel-fueled trucks being gradually reduced as the truck fleets turn over.

Table III-4: UP Colton Railyard On-Road Truck Diesel PM Emissions

Source	Diesel PM Emissions (tons per year)		
	Traveling	Idling	Total
Diesel-Fueled Yard Trucks	0.19	0.002	0.19
TOTAL	0.19	0.01	0.19
Percent of Total On-Road Truck Emissions	100%	0%	100%

* Numbers may not add precisely due to rounding.

3. Heavy Equipment and Emergency Generator

Diesel-fueled heavy equipment is used in yard operations at the UP Colton 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 at about 0.05 tons in year 2005, equivalent to about 0.3% of total railyard diesel PM emissions. A detailed methodology is discussed in the Sierra Research Report. An emergency generator is located in the bowl area of the UP Colton Yard to provide emergency lighting when electrical service from the local power provider is disrupted. The generator is a 50 horsepower, diesel-fueled unit. Emissions from the emergency generator at the Yard are based on the rated capacity of the unit (size) and the annual hours of operation. In 2005, the generator was operated about 20 hours. The diesel PM emissions from the emergency generator was estimated as 0.001 tons per year.

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-5.

Table III-5: 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 (non-road) diesel fuel. The initial U.S. EPA diesel fuel standards were applicable in October 1993. The U.S. EPA regulations prohibited the sale or supply of diesel fuel for use in on-road motor vehicles, unless the diesel fuel had 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-6.

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 were 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-6.

Table III-6: 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-7 shows average values for in-use sulfur levels and four other properties for motor vehicle diesel fuel sold in California after the California and Federal diesel fuel regulations became effective in 1993. The corresponding national averages are shown for the same properties for on-road diesel fuel only since the U.S. EPA sulfur standard does not apply to off-road or non-vehicular diesel fuel. Non-road diesel fuel 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-7: Average 1999 Properties of Reformulated Diesel Fuel

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

1 U.S. EPA, December 2000
2 Based on margin to comply with 15 ppmw sulfur standards in June 2006
3 Poly-nuclear aromatic

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 on-road 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 fueling. UP locomotives typically refuel at Rawlins, Wyoming or Salt Lake City, Utah before traveling to Roseville in northern California or UP Colton in southern California. These major out-of-state railroad facilities have the option to use Federal non-road diesel fuels for the refueling of line haul locomotives. When these out-of-state line-haul locomotives arrive in California they typically have about 10 percent remaining volume of diesel fuel relative to their tank capacity.

UP 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. In 2005, Chevron was UP's Railroad's principal supplier of diesel fuel. Chevron's California refineries produced only one grade ("low sulfur diesel" or LSD) in 2005. Quarterly average sulfur content for these refineries ranged from 59 ppmw to 400 ppmw, with an average of 221 ppmw. This value is assumed to be representative of California fuel used by UPRR. Non-California diesel fuel for 2005 is estimated to have a sulfur content of 2,639 ppmw, based on the estimated 49-state average fuel sulfur content used by the U.S. Environmental Protection Agency in its 2004 regulatory impact analysis.

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 dropped 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 entered into an agreement in 2005 which requires that 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 on-road now average about 10 ppmw.

Sulfur oxides and particulate sulfate are emitted in direct proportion to the sulfur content of diesel fuel. Reducing the sulfur content of diesel fuel from the California's statewide average of 140 ppmw to less than 10 ppmw would reduce sulfur oxide emissions by about 90 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 on-road lower sulfur diesel fuel would provide similar levels of sulfur oxide and direct diesel particulate matter emission reductions.

The emissions reductions would be obtained with low sulfur diesel used in mobile on-road and off-road engines, portable engines, and those stationary engines required by district regulations to use CARB diesel. In addition, 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 analyzed the significant off-site emission sources based on two categories: mobile and stationary. The off-site emissions were estimated for the sources within a one-mile distance from the boundary of the UP Colton railyard.

1. Mobile Sources

For the off-site mobile sources, the analysis focused on on-road heavy duty diesel trucks, as they are the primary source of diesel PM from the on-road vehicle fleet. ARB staff estimated mobile emissions based on roadway specific vehicle activity data and allocated them to individual roadway links. All roadway links within a one-mile distance from the boundary of the UP Colton railyard 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, and major arterial, minor arterial, collector, or centroid connector.

Within a one-mile distance from the boundary of the UP Colton railyard, off-site diesel PM emissions are predominantly generated by mobile sources which emit around 42 tons per year. The majority of the off-site diesel PM emissions are from diesel-fueled heavy duty trucks traveling on freeway I-10 and major local streets.

Table III-8: Off-site Mobile Source Diesel PM Emissions by Freeways

Sources	Diesel PM Emissions	
	Tons per year	Percent of Total Off-site Mobile Sources
I-10 Freeway	32.7	78%
Local Streets	9.3	22%
TOTAL	42.0	100%

As shown in Table III-8, the freeways I-10 contribute approximately 32.7 tons per year of diesel PM emissions, which account for over 78% of total mobile sources diesel PM emissions. The remaining 9.3 tons of off-site diesel PM emissions, or 22%, of the total diesel PM emissions are from diesel-fueled trucks traveling on local streets. The methodology for mobile diesel PM emission estimation is presented in Appendix A.

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 from mobile sources are estimated at about 42 tons per year with 30.3 tons per year or 72% from heavy-heavy duty trucks. Medium – heavy duty trucks account for about 6.1 tons per year or 15% and light-heavy duty trucks 5.5 tons per year or 13% respectively. Off-site mobile source diesel PM emissions by vehicle type are shown in Table III-9.

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	**5.5**	**13%**
Medium-Heavy Duty Diesel Trucks	14,001-33,000	**6.1**	**15%**
Heavy-Heavy Duty Diesel Trucks	> 33,000	**30.3**	**72%**
Total	**-**	**42.0***	**100%**

*Numbers may not add up due to rounding

2. Stationary Sources

Emissions from off-site stationary source facilities are identified using the California Emission Inventory Development and Reporting System (CEIDARS) database, which contains information reported by the local air districts for stationary sources within their jurisdiction. The CEIDARS facilities whose locations fell within the one-mile distance from the boundary of the UP Colton railyard 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 one-mile distance from the boundary of the UP Colton railyard, the diesel PM emissions from stationary sources are estimated at about 1.5 tons per year, or about 3% of the total off-site diesel PM emissions. Three major stationary sources, California Portland Cement Company, Arrowhead Regional Medical Center, and General American Transportation Corporation (GATX) contribute about 1.5 tons per year of the off-site diesel PM emissions. There is a large number bulk fuel storage facilities operated by Kinder Morgan, Shell, BP and others within one-mile of the railyard boundary. However, these facilities only emit TACs. These TACs were accounted for in the potency weighted emission tables.

ARB staff also evaluated other toxic air contaminant (TACs) emissions around the UP Colton Railyard. The total emissions of toxic air contaminants, other than diesel PM emitted from the stationary sources, were estimated at about 25 tons per year. Over 70 toxic air contaminant species are identified among these emissions, in which ammonia, toluene and Xylene are the three major contributors with emissions estimated at 5, 2, and 3 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 9.0 tons per year.

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 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-10. As can be seen in Table III-10, the potency weighted toxic emissions for these TACs are about 0.247 tons per year, which is substantially less than off-site diesel PM emissions. Hence, they are not included in the analysis.

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

Table III-10: Cancer Potency Weighted Toxic AIR Contaminant Emissions from Significant Off-Site Stationary Sources Surrounding UP Colton Railyard

Compound	Cancer Potency Factor	Weighting Factor	Estimated Emission (tons/year)	Potency Weighted Toxic Emission (tons/year)
Diesel PM	1.1	1	43.5	**43.5**
1,3-Butadiene	0.6	0.55	0.021	**0.012**
Benzene	0.1	0.09	0.736	**0.066**
Carbon Tetrachloride§	0.15	0.14	0.000056	**0.000**
Formaldehyde	0.021	0.02	8.48	**0. 169**
Total (non-diesel PM)	**-**	**-**	**9.24***	**0.247**

*: Numbers may not add precisely due to rounding.

§ Very 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.

Table III-11: Emissions of Major Toxic Air Contaminants from Gasoline Sources in South Coast Air Basin

Compound	TACs Emissions (tons/year)			
	From All Sources	Potency Weighted**	From Gasoline Vehicles	Potency Weighted**
Diesel PM	7,746	**7,746**	-	-
1,3-Butadiene	695	**382**	420	**231**
Benzene	3,606	**325**	2,026	**182**
Formaldehyde	4,623	**92**	1,069	**21**
Acetaldehyde	1,743	**16**	314	**3**
Total (non-diesel PM)	10,668	**816**	3,829	**438**

**: Based on cancer potency weighting factors.

In addition, ARB staff evaluated the potential cancer risk levels caused by the use of gasoline in the South Coast Air Basin. Table III-11 shows the emissions of four major carcinogenic toxic air contaminants South Coast Air Basin gasoline sources in 2005 (ARB, 2006a). As indicated in Table III-11, 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.

IV. AIR DISPERSION MODELING FOR THE UP COLTON 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 Colton 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 Colton Railyard, ARB staff selected the U.S. EPA's newly approved air dispersion model AERMOD to estimate the impacts associated with diesel PM emissions in and around the railyard. AERMOD stands for American Meteorological Society / Environmental Protection Agency Regulatory Model Improvement Committee (**AER**MIC) **MOD**EL. It is a state-of-science air dispersion model and is a replacement for its predecessor, the U.S. EPA Industrial Sources Complex (ISC) air dispersion model.

AERMOD has become a U.S. EPA regulatory dispersion model specified by the *U.S. EPA Guideline for Air Quality Methods (*40 CFR Part 51, Appendix W*)* (U.S. EPA, 2005). AERMOD is also the recommended model in the *ARB 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 Colton Railyard are characterized as required by the ARB Guidelines (ARB, 2006c). Emission sources were treated as either point or volume sources in the dispersion modeling. Point source treatment includes calculated plume rise based on source stack dimensions and exhaust parameters, and hour-by-hour meteorological conditions; volume source treatment includes user-specified release height and initial horizontal and vertical dispersion. Larger stationary emission sources (e.g., idling locomotives and cranes where present) were treated as a series of point sources within their areas of operation. Spacing between sources was selected based on the magnitude of emissions and the proximity to off-site receptors. Smaller and moving sources (e.g., idling and moving trucks, and moving locomotives) were treated as a series of volume sources. Source spacing and initial dispersion coefficients for volume sources were also selected based on the magnitude of the emissions and the proximity to off-site receptors.

The emission rates for individual locomotives are a function of locomotive makes, notch setting, activity time, duration, and operating location. Emission source parameters for locomotive model classifications at the yard, including emission source height, diameter, exhaust temperature, and exhaust velocity. While the BNSF assumed more specific temperatures and stack heights from their switchers and line haul locomotives fleets, the UP used data from the *Roseville Railyard Study* (ARB, 2004) based on the most prevalent locomotive model of switchers and line hauls to parameterize locomotive emission settings. In total, the assumptions on the locomotive emission parameters are slightly different between UP and BNSF; however, both are within reasonable ranges according to their activities, and the slight differences in stack height have an insignificant impact on predicted air concentrations, within 2 percent, based on a sensitivity analysis conducted by ARB staff.

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

C. Meteorological Data

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.

The UP Colton railyard does not monitor meteorological variables on site. Wind speed, wind direction, temperature, and cloud cover data from the Ontario International Airport were used for this project. To the extent that airflow patterns are spatially variable due to elevated terrain and land sea effects near the coast, judgment was exercised to select the monitoring stations that are most representative of conditions at the UP Colton Railyard and Ontario winds would be the most representative of conditions at the yard.

The selection of Ontario International Airport for surface winds data was largely dependent on the limited availability of data from other stations for the same years for which upper air data were available. There are several SCAQMD surface stations in the general vicinity of the railyard for which historical (1981) data are available, but only in a form usable in AERMOD's predecessor, ISCST3. AERMET, the meteorological preprocessor for AERMOD, required (at a minimum) data from one surface National Weather Service (NWS) station and one upper air NWS station. Ontario International Airport was used for surface data, and the Miramar Marine Corps NWS Air Station in San Diego was used for upper air data. Missing hourly surface data from Ontario International Airport were replaced by the last previous values available in the same dataset.

According to ARB railyard health risk assessment guidelines (ARB, 2006d), five years of meteorological data are recommended to be used in the air toxic health risk assessment. Surface parameters supplied to the model were specified for the area surrounding the surface meteorological monitoring site as recommended by AERMOD and the ARB *Health Risk Assessment Guidance for Railyard and Intermodal Facilities* (ARB, 2006d). Eleven years worth of meteorological data from Ontario International Airport, for years 1990 through 2000, were processed with AERMET to assure that an adequate number of years of acceptable data completeness and quality would be available for AERMOD modeling. The meteorological data from 1999 were selected for the railyard dispersion modeling because it was one of the two years recorded after the anemometer height was adjusted, and it was the year with the most conservative (i.e., largest) distances of impact from a specified source (Sierra Research Report).

It is expected that year-to-year variability would not cause significant differences in the modeled health impacts, and hence would justify needing to subject the full set of receptors to only one year of meteorological data. This conclusion is based on modeling sensitivity analyses that were carried out by ARB staff using five years of meteorological data for the Stockton area (See Appendix G). The five annual average concentration patterns were compared with one another and with the average predictions for the full five-year period. Differences between these were found to be negligible in terms of spatial concentration patterns, locations of highest concentrations, and absolute concentrations. Therefore, whether five-year or one-year meteorological data are used, the modeling results show similar estimated exposures and potential cancer risks surrounding the railyard facility.

Figure IV-1 presents the wind rose and Figure IV-2 provides the wind class frequency distributions for the meteorological data used in UP Colton Railyard air dispersion modeling. The yearly average wind speed is 2.8 meters per second. The prevailing wind over the modeling domain blows from southwest to northeast.

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

Figure IV-1: Wind Rose Plot for Ontario International Airport Station in 2005

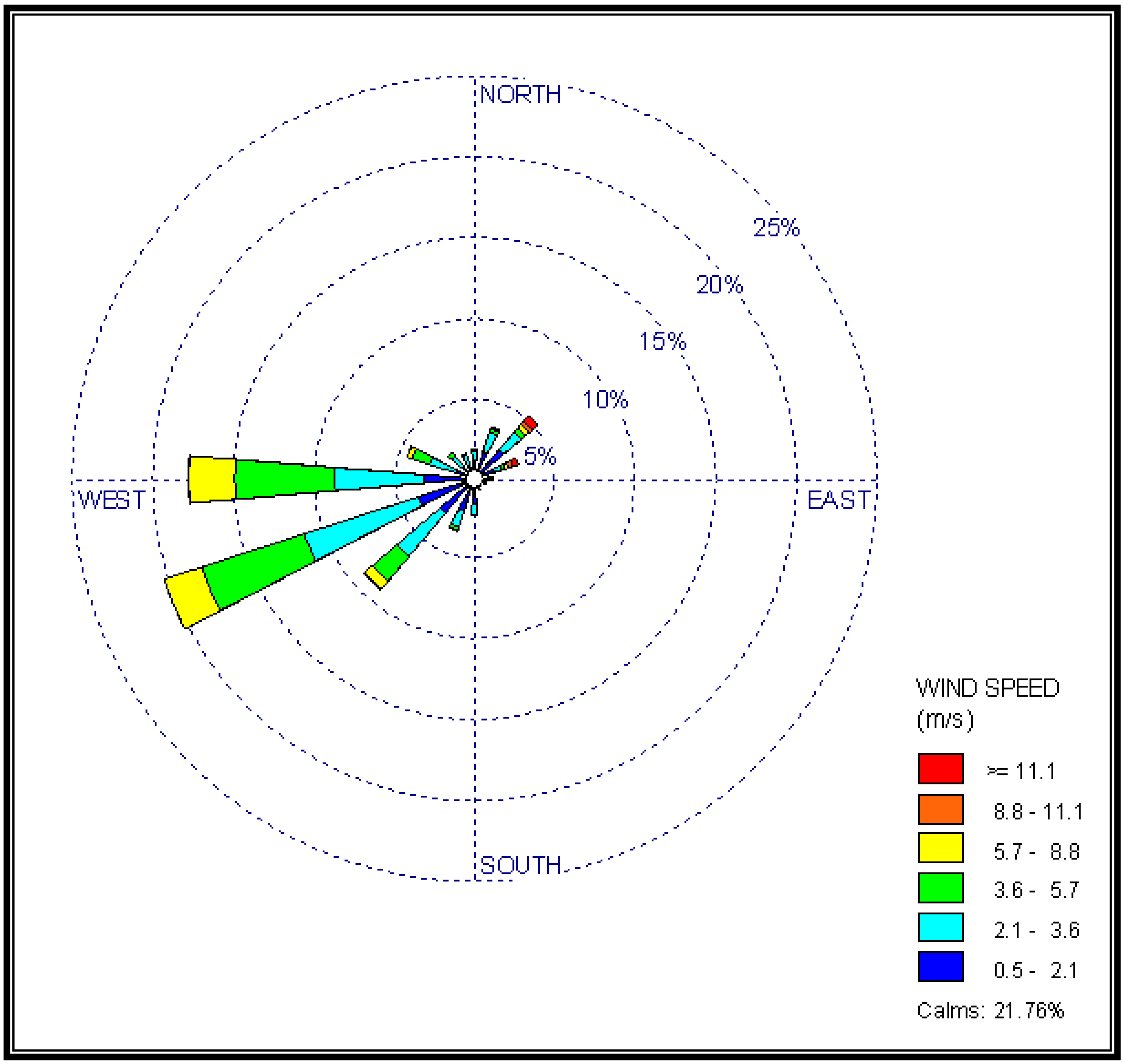
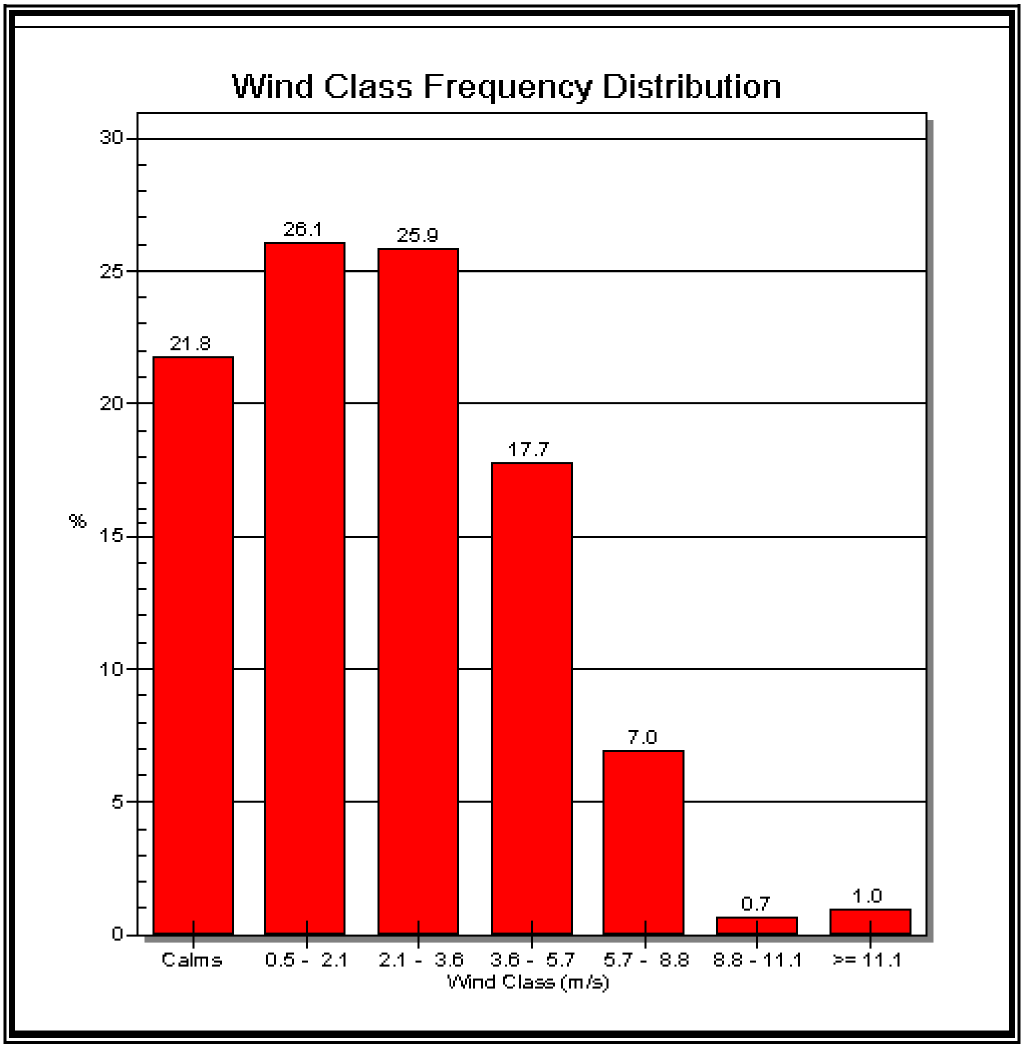


Figure IV-2: Wind Class Frequency Distribution Plot for Ontario International Airport Station Data in 2005



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.

According to the *ARB Railyard Health Risk Assessment Guidance* (ARB, 2006), 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 different receptor grid networks were used for the UP Colton Railyard air dispersion modeling assessment. The ARB's Guidance requires coarse and fine modeling receptor grids, in which the Cartesian receptor networks used in model simulations include a coarse receptor grid of 500 m x 500 m for the modeling analysis. A fine grid of 50 m x 50 m surrounding the railyard was used for modeling within 300 m of the fence line. A medium-fine grid of 100 m x 100 m was used for receptors between 300 and 600 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 600 and 1000 m.

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 Colton Railyard.

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

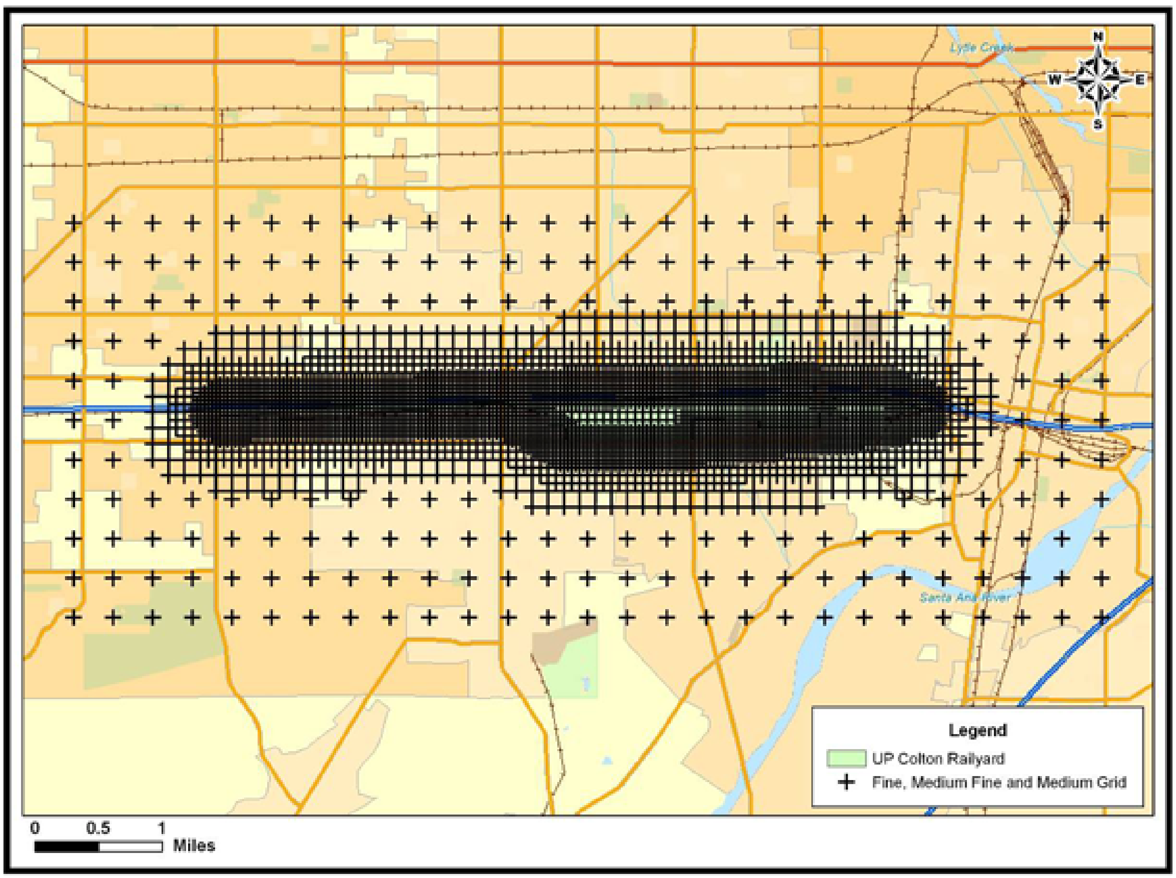
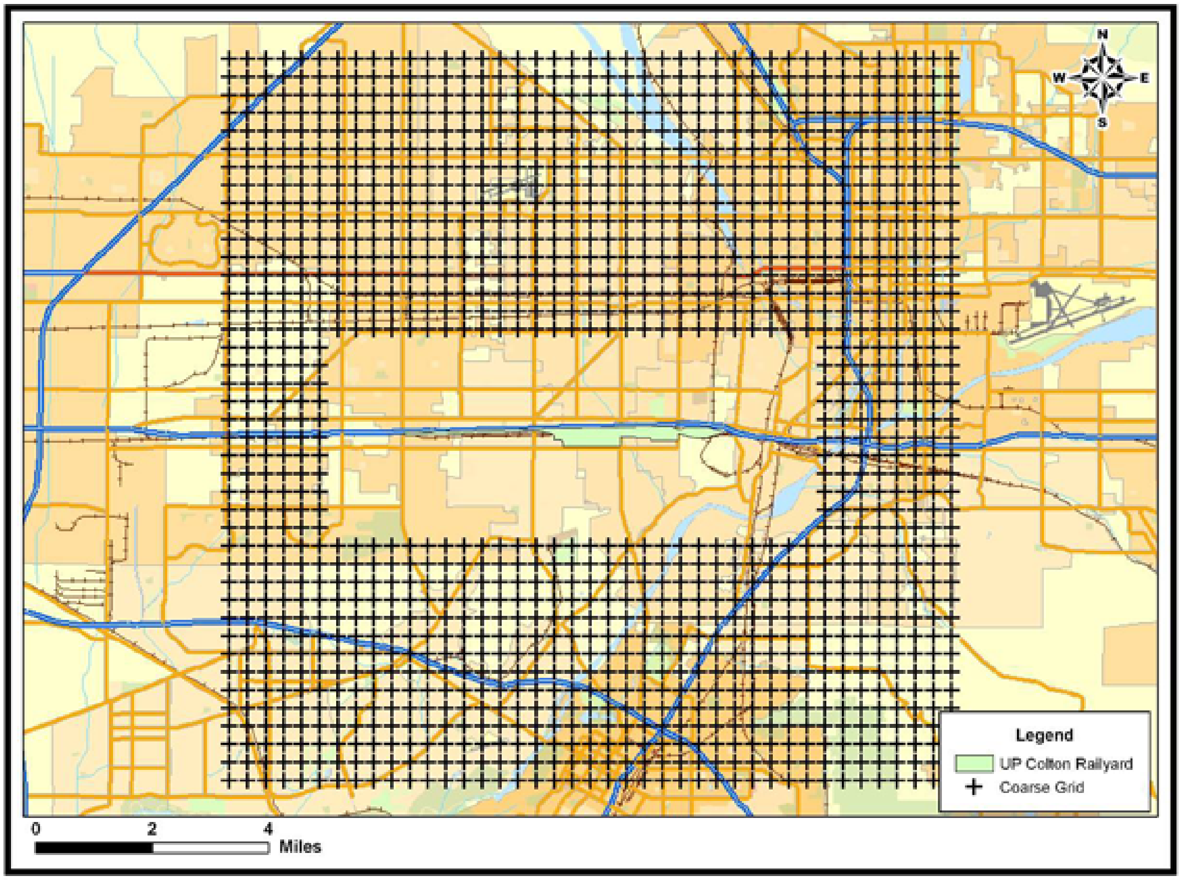


Figure IV-4: Coarse Grid Receptor Networks Used in Air Dispersion Modeling for UP Colton Railyard



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. Although UP included building wake effects in their modeling analyses, BNSF conducted a sensitivity analysis and found that the building wake effect has an insignificant impact on the diesel PM air concentrations of the railyard (ENVIRON, 2006b). Detailed treatment of building wake effects is documented in the air dispersion modeling report by the Sierra Research, Inc.

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. 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 are provided in Sierra Research Report.

V. HEALTH RISK ASSESSMENT OF THE UP COLTON 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 Colton 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.

The 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. As indicated by the OEHHA Guidelines, the Tier-1 evaluation is useful in comparing risks among a number of facilities and similar sources.

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 ARB has also developed *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 times 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 in the UP Colton Railyard. A relatively small amount of gasoline toxic air contaminants is generated from the gasoline storage tanks (including isopentane, toluene, benzene, etc.). Some other toxic air contaminants, such as xylene, toluene and ethyl benzene are emitted from the wastewater treatment plant. The detailed emission inventories for these TACs are presented in the *Toxic Air Contaminant Emissions Inventory and Air Dispersion Modeling Report for the UP Colton Rail Yard, Bloomington , California* (Sierra Research, 2007). The total amount of these toxic air contaminants emissions is about 0.21 tons or 420 pounds per year, compared to the 16.5 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 in Table II-3), these non-diesel PM toxic air contaminants emissions are about a factor of 80 less than a potency weighted emissions as compared to diesel PM (0.21tons per year vs. 16.54 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 Colton Railyard. ARB staff also evaluated other toxic air contaminant (TACs) emissions around the UP Colton Railyard. The total emissions of toxic air contaminants, other than diesel PM emitted from the stationary sources, were estimated about 25 tons per year. Over 70 toxic air contaminant species are identified among these emissions, in which ammonia, toluene and xylene are the three major contributors with emissions estimated at 5, 2, and 3 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 9.0 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 V-1. As can be seen in Table V-1, the potency weighted toxic emissions for these TACs are about 0.247 tons per year, which is substantially less than the diesel PM emissions.

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 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 V-1: Cancer Potency Weighted Toxic Air Contaminant Emissions from Significant Off-Site Stationary Sources Surrounding UP Colton Railyard

Compound	Cancer Potency Factor	Weighting Factor	Estimated Emission (tons/year)	Potency Weighted Toxic Emission (tons/year)
Diesel PM	1.1	1	43.5	**43.5**
1,3-Butadiene	0.6	0.55	0.021	**0.012**
Benzene	0.1	0.09	0.736	**0.066**
Carbon Tetrachloride**	0.15	0.14	0.000056	**0.000**
Formaldehyde	0.021	0.02	8.48	**0. 169**
Total (non-diesel PM)	**-**	**-**	**9.23***	**0.247**

*: Numbers may not add precisely due to rounding.

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

Compound	TACs Emissions (tons/year)			
	From All Sources	Potency Weighted**	From Gasoline Vehicles	Potency Weighted**
Diesel PM	7,746	**7,746**	-	-
1,3-Butadiene	695	**382**	420	**231**
Benzene	3,606	**325**	2,026	**182**
Formaldehyde	4,623	**92**	1,069	**21**
Acetaldehyde	1,743	**16**	314	**3**
Total (non-diesel PM)	10,668	**816**	3,829	**438**

**: Based on cancer potency weighting factors.

** Very 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.

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 Colton Railyard are displayed by using isopleths, based on the 80^{th} 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 Bloomington area surrounding the UP Colton 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 exposure at the point of maximum impact be reported. The point of maximum impact (PMI), which is defined as a location or the receptor point with the highest cancer risk level outside of the facility boundary, with or without residential exposure, is predicted to be located at the northeast side of the railyard fence line (see Figure V-1). This is directly downwind of high emission density areas for the prevailing southwesterly wind, where locomotive activities (line haul, switchers, and locomotive service shop) generates about 50% of the facility-wide diesel PM emissions (see the emission allocation in Appendix E). The cancer risk at the PMI is estimated to be about 575 chances in a million. The land use in the vicinity of the PMI is primarily zoned as industrial use. However, there may be residents living in this zoned area. In the residential zoned area, the potential cancer risk of maximally exposed individual resident (MEIR) or maximum individual cancer risk (MICR) is estimated at about 150 chances in a million. As indicated by Roseville Railyard Study (ARB, 2004a), the location of the PMI may vary depending upon the settings of the model inputs and parameters, such as meteorological data set or emission allocations in the railyard. Therefore, given the estimated emissions, modeling settings, and the assumptions applied to the risk assessment, there are great uncertainties associated with the estimation of point of maximum impact (PMI) and maximum individual cancer risk (MICR). These indications should not be interpreted as a literal prediction disease incidence but more as a tool for comparison. In addition, the estimated point of maximum impact location and maximum individual cancer risk value may not be replicated by air monitoring.

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

As indicated by Figure V-1, the UP Colton Railyard can be divided into three areas, eastern, central and western; the area with the greatest impact has an estimated potential cancer risk of over 250 chances in a million, occurring in a very small area next to the northeastern side of the railyard fence line, right next to freeway I-10. The estimated cancer risk is about 250 chances per million within approximately 200 yards from the northeastern side of railyard property boundary. At about 400 yards from the eastern side of the railyard boundary, 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 half mile from the eastern side of the railyard, then to 25 in a million at approximately a 1 mile distance from the railyard boundaries. At about 2 miles from the eastern part of the railyard boundaries, the estimated cancer risks are at 10 in a million or lower. For the central part of the railyard the cancer risk is 100 in a million at about quarter a mile from the railyard boundary, and at about half a mile the cancer risk is approximately 50 in a million. At about 1 mile the cancer risk is 25 in a million, and at about 1.5 miles the cancer risk is about 10 in a million or lower.

On the western side, the area with the greatest impact has an estimated potential cancer risk of over 100 chances in a million. This location is approximately 200 yards from the western part of the railyard boundary. At about quarter a mile the estimated cancer risk decreases to 50 in a million and then at half a mile, the estimated cancer risk is 25 in a million or lower. At about 1 mile the estimated the cancer risk decreases to about 10 in a million.

The OEHHA Guidelines recommend 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 Levels (Chances in a Million)				
70	10	25	50	100	250
30	4	11	21	43	107
9*	2.5	6.3	12.5	25	62.5
40‡	2	5	10	20	50

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

The more populated areas near the UP Colton Railyard are located to the west, north and southwest 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 17,000 acres where about 91,000 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 UP Colton Railyard Diesel PM Emissions

Estimated Cancer Risk (chances per million)	Impacted Area (Acres)	Estimated Population Exposed
10 - 25	11,000	60,000
25-50	3,500	26,000
50-100	1,600	5,000
>100	635	320
>10	**17,000***	**91,000***

***** Numbers may not add up due to rounding

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

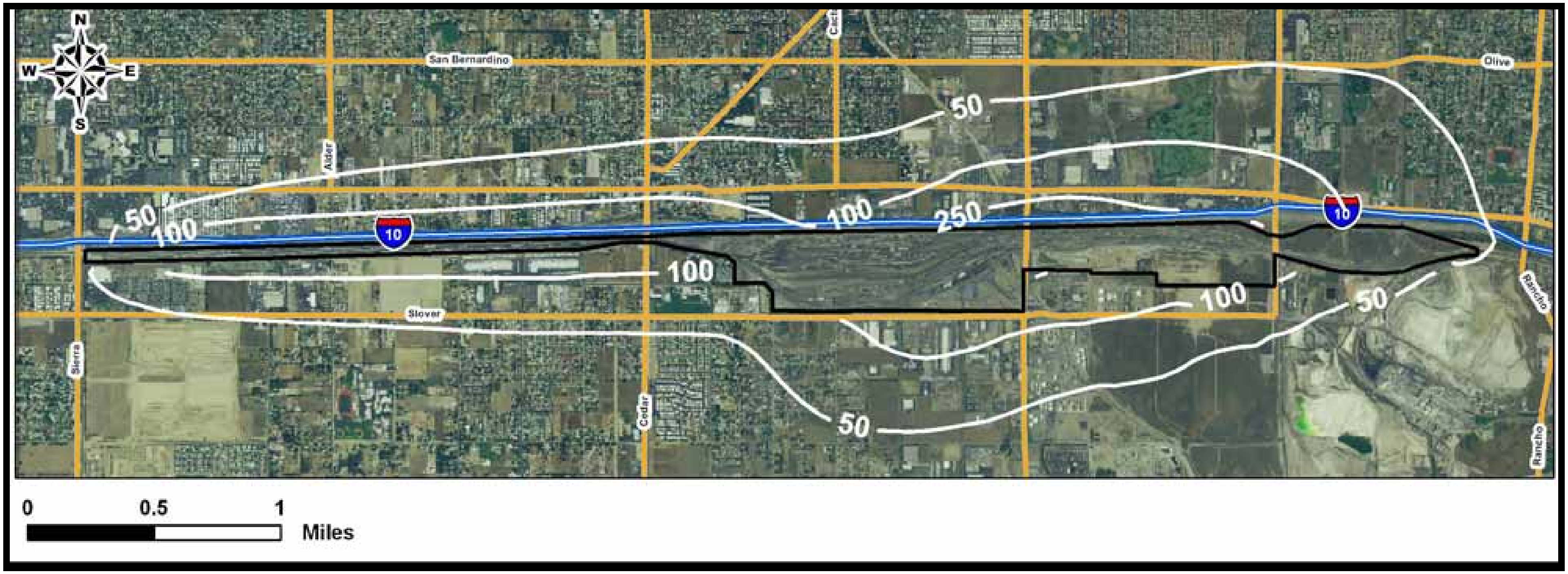
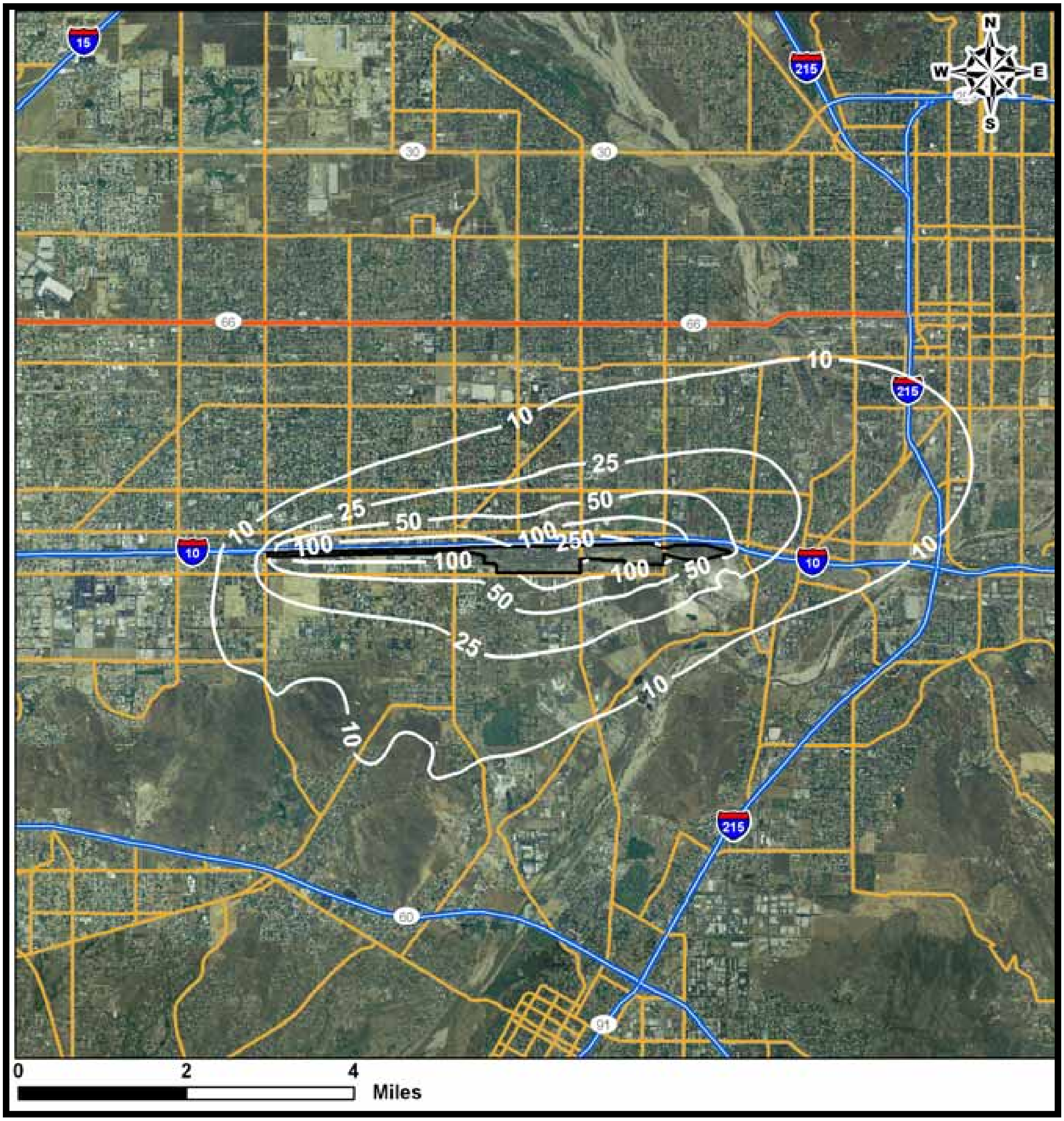


Figure V-2: Estimated Regional Cancer Risks (chances per million people) from the UP Colton Railyard



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).

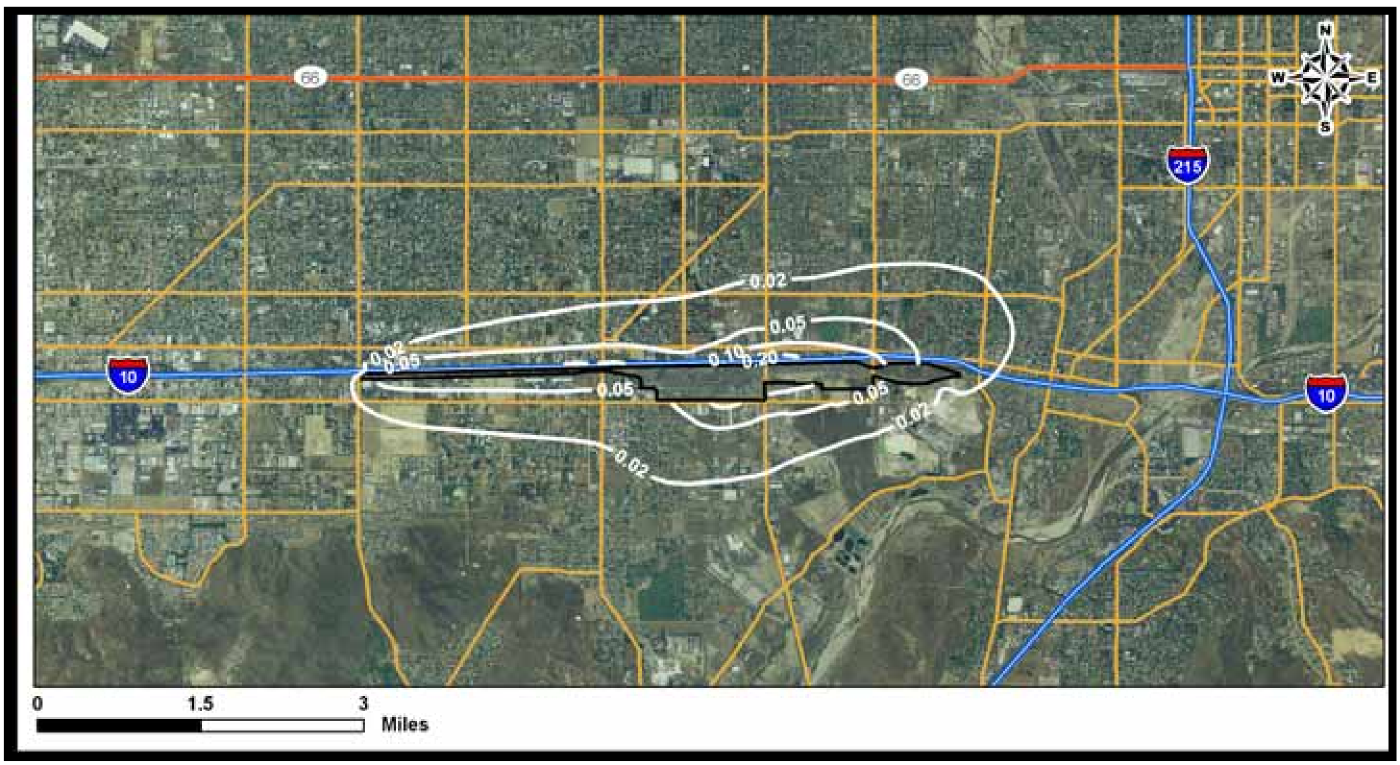
It is important to note that Reference Exposure Level (REL) for diesel PM is essentially the U.S. EPA Reference Concentration first developed in the early 1990s based on histological changes in the lungs of rats. Since the identification of diesel PM as a Toxic Air Contaminant (TAC), California has evaluated 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 Colton 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. The zone of impact where non-cancer chronic health hazard indexes are over 0.02 is an estimated area of 4500 acres.

Figure V-3 presents the spatial distribution of non-cancer chronic risks by health hazard index isopleths that range from 0.02 to 0.2 around the yard facility.

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



c) Non-Cancer Acute Risk

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

Due to the uncertainties in the toxicological and epidemiological studies, diesel PM as a whole was not assigned a short-term acute REL. It is only specific compounds of diesel exhaust (e.g., acrolein) that independently have potential acute effects (such as irritation of the eyes and respiratory tract), and an assigned acute REL. However, acrolein is primarily used as a chemical intermediate in the manufacture of adhesives and paper. It has also been found as a byproduct of any burning process, such as fire, and tobacco smoke. Acrolein is a chemically reactive and unstable compound, and easily reacts with a variety of chemical compounds in the atmosphere. Compared to the other compounds in the diesel exhaust, the concentration of acrolein has a much lower chance of reaching a distant off-site receptor. More importantly, given the multitude of activities ongoing at facilities as complex as railyards, there are much higher levels of uncertainties associated with hourly-specific emission data and estimated maximum concentrations, which are essential to assess acute risk. Therefore, non-cancer acute risk is not addressed quantitatively in this study. From a risk management perspective, ARB staff believes it is reasonable to focus on diesel PM cancer risk because it is the predominant risk driver and the most effective parameter to evaluate risk reduction actions. Further, actions to reduce diesel PM will also reduce non-cancer risks.

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

ARB staff evaluated the impacts from off-site pollution sources near the UP Colton Railyard facility using the U.S. EPA-approved AERMOD dispersion model. Specifically, off-site mobile and stationary diesel PM emission sources located within a one-mile distance from the boundary\ of the UP Colton railyard was included. Diesel PM off-site emissions used in the off-site modeling runs consisted of about 42 tons per year from roadways and 1.5 tons per year from stationary facilities, representing emissions for 2005. The diesel PM emissions from UP Colton Railyard is 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 Colton Railyard. This result is expected because the diesel PM emissions from the significant off-site sources are equivalent to three times of the UP Colton 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 25 chances in a million levels associated with off-site diesel PM emissions encompasses approximately 20,000 acres where about 100,000 residents live. For comparison with the UP Colton Railyard health risks, the same level of potential cancer risks (25 chances in a million) covers about 6,000 acres with a population of approximately 30,000. 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. 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	26,000	133,800
25 -50	9,100	46,300
50-100	5,700	38,800
100-250	3,700	12,750
>250	1,300	3,900
>10	**46,000***	**235,550***

*: Approximate estimates due to partial of these isopleths extend beyond the air dispersion model domain.
* Numbers may not add due to rounding.

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

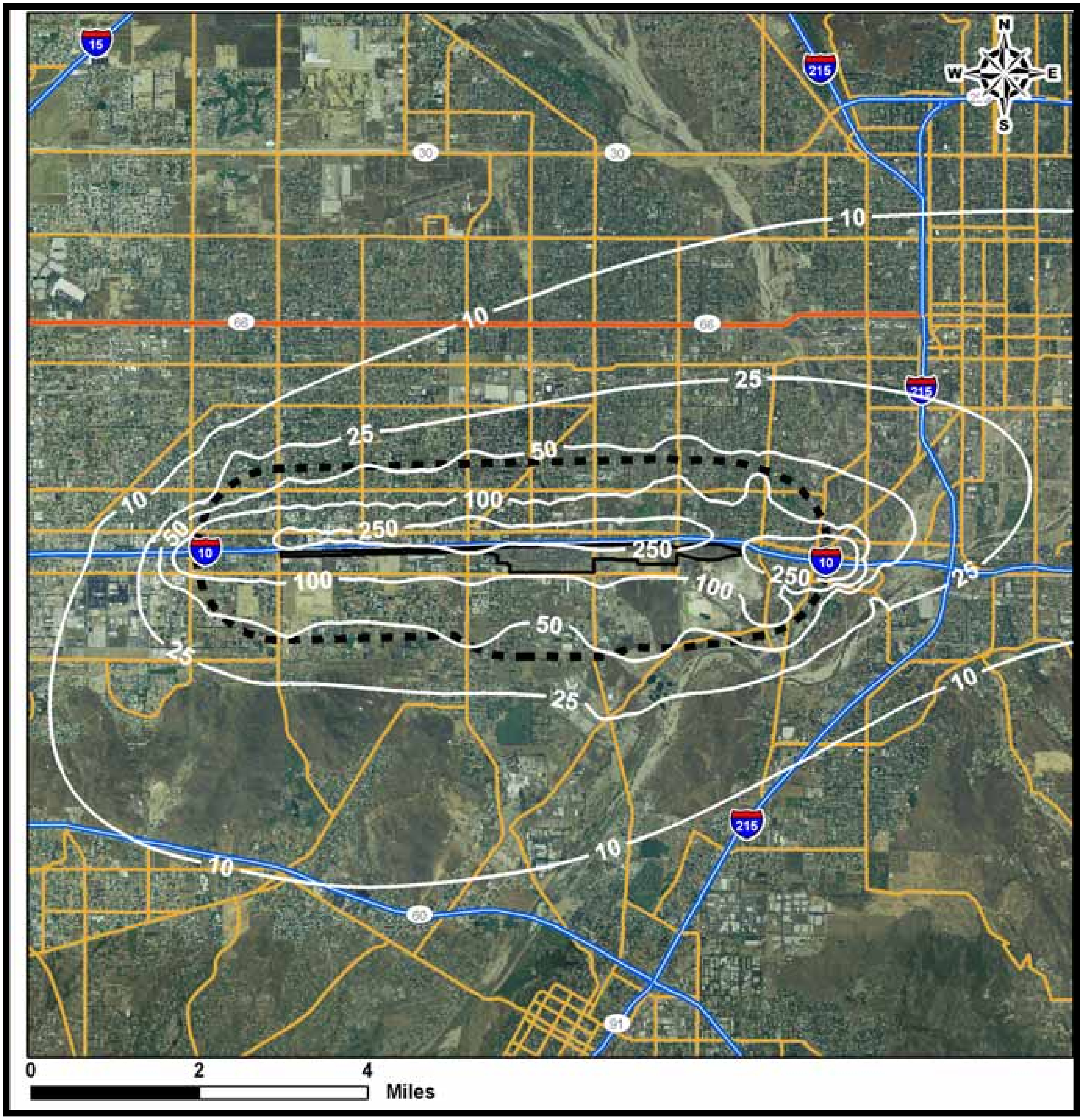
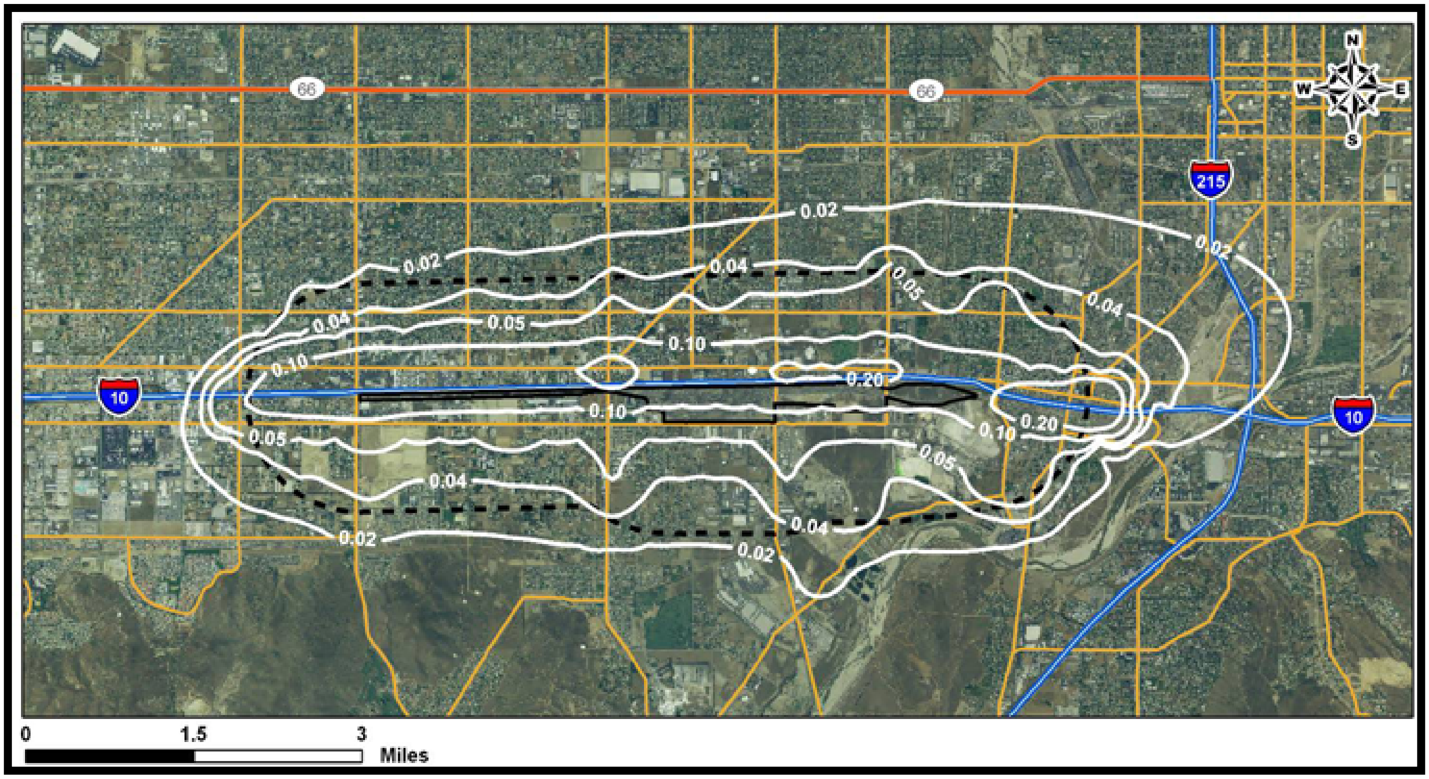


Figure V-5: Estimated Non-Cancer Chronic Health Hazard Index from Off-site Diesel PM Emissions



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 29 sensitive receptors within one-mile of the UP Colton, including 20 schools, 5 child care centers and 4 health facilities or hospitals. Table V-6 shows the number of sensitive receptors in various levels of cancer risks associated with diesel PM emission from the UP Colton 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	10
25 – 50	12
50 – 100	6
> 100	1
>10	**29**

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[6].

For locomotive sources at the UP Colton 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. In addition to recorded activity data, surveys and communications with facility personnel, and correlations from other existing data, (e.g., from the Roseville Railyard Study (ARB, 2004a)), all were used to verify the emission estimations in the emission inventory.

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

As discussed previously, emission factors are often used for emission estimates according to different operating cycles. The Roseville Railyard Study (ARB, 2004) developed representative diesel PM emission factors for locomotives in different duty

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

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

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 who's hematological, nervous, endocrine, and immune systems are still developing and who may be more sensitive to the effects of carcinogens on their developing systems, are not included in the worker population and risk estimates based on occupational epidemiological data are more uncertain for children than adults.

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

This study adopts the standard Tier 1 approach recommended by the OEHHA for exposure and risk assessment. A Tier 1 approach is an end-point estimate methodology without the consideration of site-specific data distributions. It also assumes that an individual is exposed to an annual average concentration of a pollutant continuously for a specific time period. The OEHHA recommends the lifetime 70-year exposure duration with a 24-hour per day exposure be used for determining residential cancer risks. This will ensure a person residing in the vicinity of a facility for a lifetime will be included in the evaluation of risk posed by the facility. Lifetime 70-year exposure is a conservative estimate, but it is a historical benchmark for comparing facility impacts on receptors and for evaluating the effectiveness of air pollution control measures. Although it is not likely that most people will reside at a single residence for 70 years, it is common that people will spend their entire lives in a major urban area. While residing in urban areas, it is very possible to be exposed to the emissions of another facility at the next residence. In order to help ensure that people do not accumulate an excess unacceptable cancer risk from cumulative exposure to stationary facilities at multiple residences, the 70-year exposure duration is used for risk management decisions. However, if a facility is notifying the public regarding health risk, it is a useful indication for a person who has resided in his or her current residence less than 70 years to know that the calculated estimate of his or her cancer risk is less than that calculated for a 70-year risk (OEHHA, 2003). It is important that the risk estimates generated in this study not be interpreted as the expected rates of disease in the exposed population, but rather as estimates of potential risk. Risk assessment is best viewed as a comparative tool rather than a literal prediction of diesel incidence in a community.

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

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APPENDIX A

METHODOLOGY FOR ESTIMATING OFF-SITE 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 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 (mph)	LHDDT1 VMT (miles)	LHDDT2 VMT (miles)	MHDDT VMT (miles)	HHDDT VMT (miles)
49761	12	45	0.37	0.48	3.17	5.51
49761	3	45	0.14	0.18	1.16	2.00
49761	3	35	0.16	0.21	1.37	2.38
50234	4	55	0.19	0.26	1.68	2.92

Step 2: Derive Gram per Mile Emission Factors

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

Finally, a matrix of emission factors by speed and vehicle type was assembled for each county for light heavy-duty diesel trucks 1 and 2 (LHDDT1 and LHDDT2), medium heavy-duty diesel trucks (MHDDT) and heavy heavy-duty diesel trucks (HHDDT). The following is an example of such a matrix (Table 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 micro-scale 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 micro-scale modeling results would be health-protective, the generic release parameters assumed relatively low height and buoyancy. Two generic defaults were used. First, if the emitting process was identifiable as a vent or other fugitive-type release, the default parameters assigned were a height of five feet, diameter of two feet, temperature of 100 degrees Fahrenheit, and velocity of 25 feet per second. For all remaining unspecified and unassigned releases, the final generic default parameters assigned were a height of twenty feet, diameter of two feet, temperature of 100 degrees Fahrenheit, and velocity of 25 feet per second. All English units used in the CEIDARS database were converted to metric units for use in the micro-scale modeling input files.

APPENDIX C

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

Impacts from Off-site Diesel PM (DPM) Sources for the UP Colton RailYard, Bloomington, CA

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

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: 41.9 TPY DPM Stationary Sources: 1.5 TPY DPM	PTSD/MSAB
Receptor Grid	41x41 Cartesian grid covering 400 km^2 with uniform spacing of 500 meters. Grid origin: (455000, 3760000) in UTM Zone 11.	Sierra Research
Meteorological Data	AERMET-Processed data for 1999 *Surface*: Ontario Intl. Airport *Upper Air*: San Diego Miramar	Sierra Research
Surface Data	Albedo: *Not provided** Bowen Ratio: *Not provided** Surface Roughness: *Not provided**	Sierra Research

*Surface parameters were defined by the consultants during the AERMET meteorological pre-processing. However, only the AERMET model-ready output files, which do not contain these parameters, were provided by Sierra Research.

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 Colton rail facility with the modeling domain indicated by the black outline.

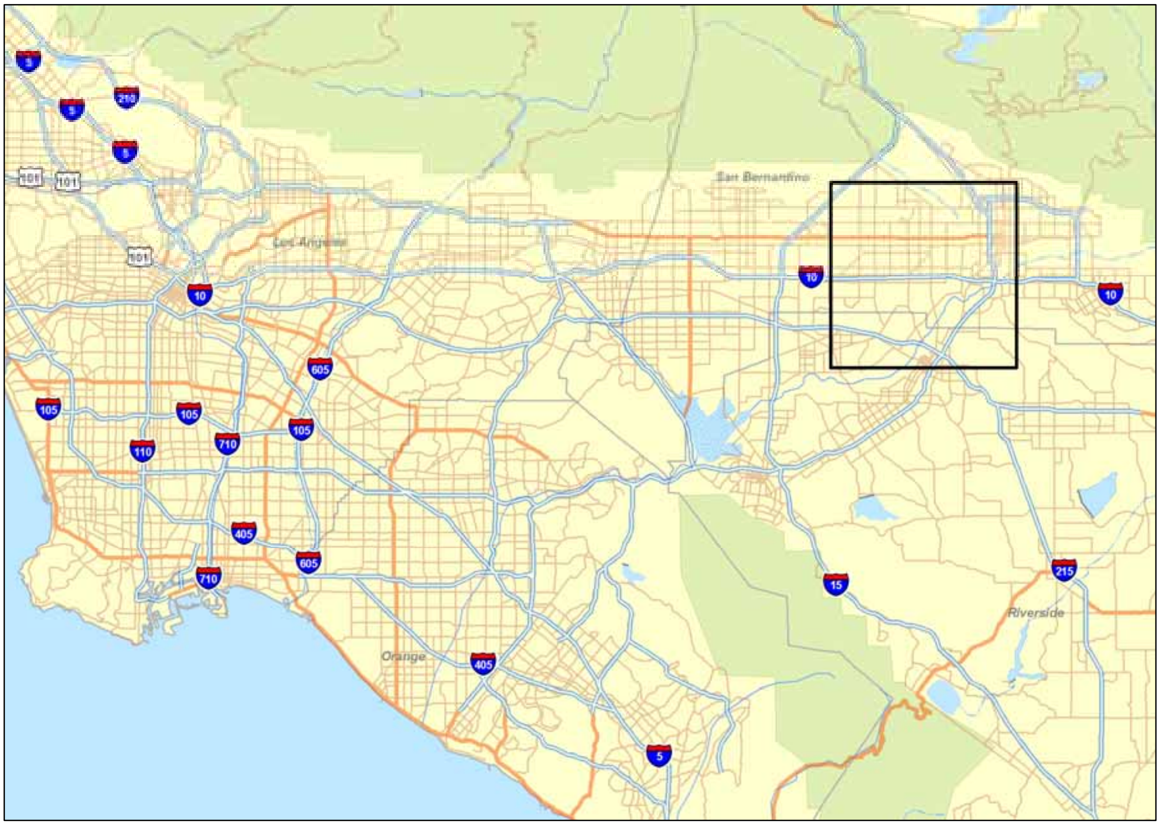
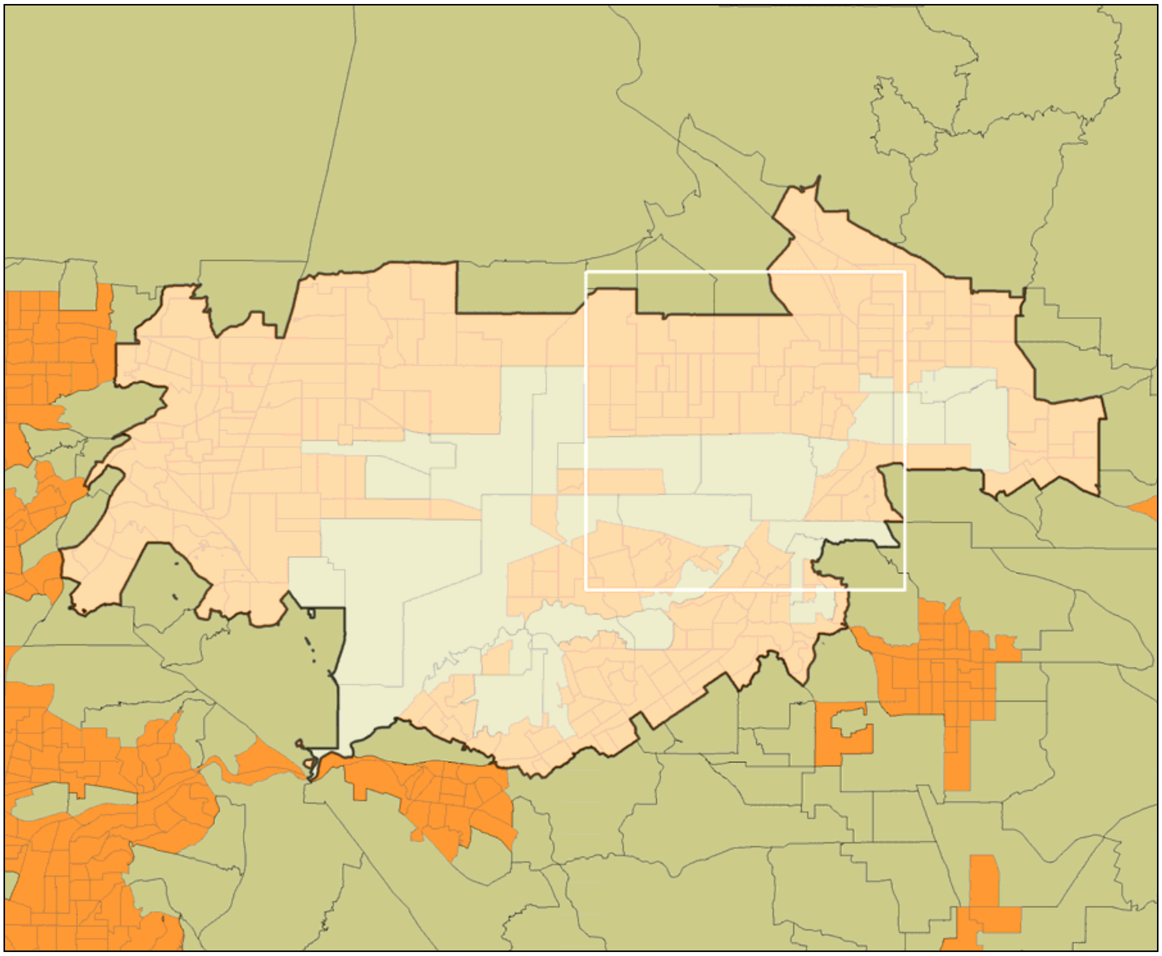


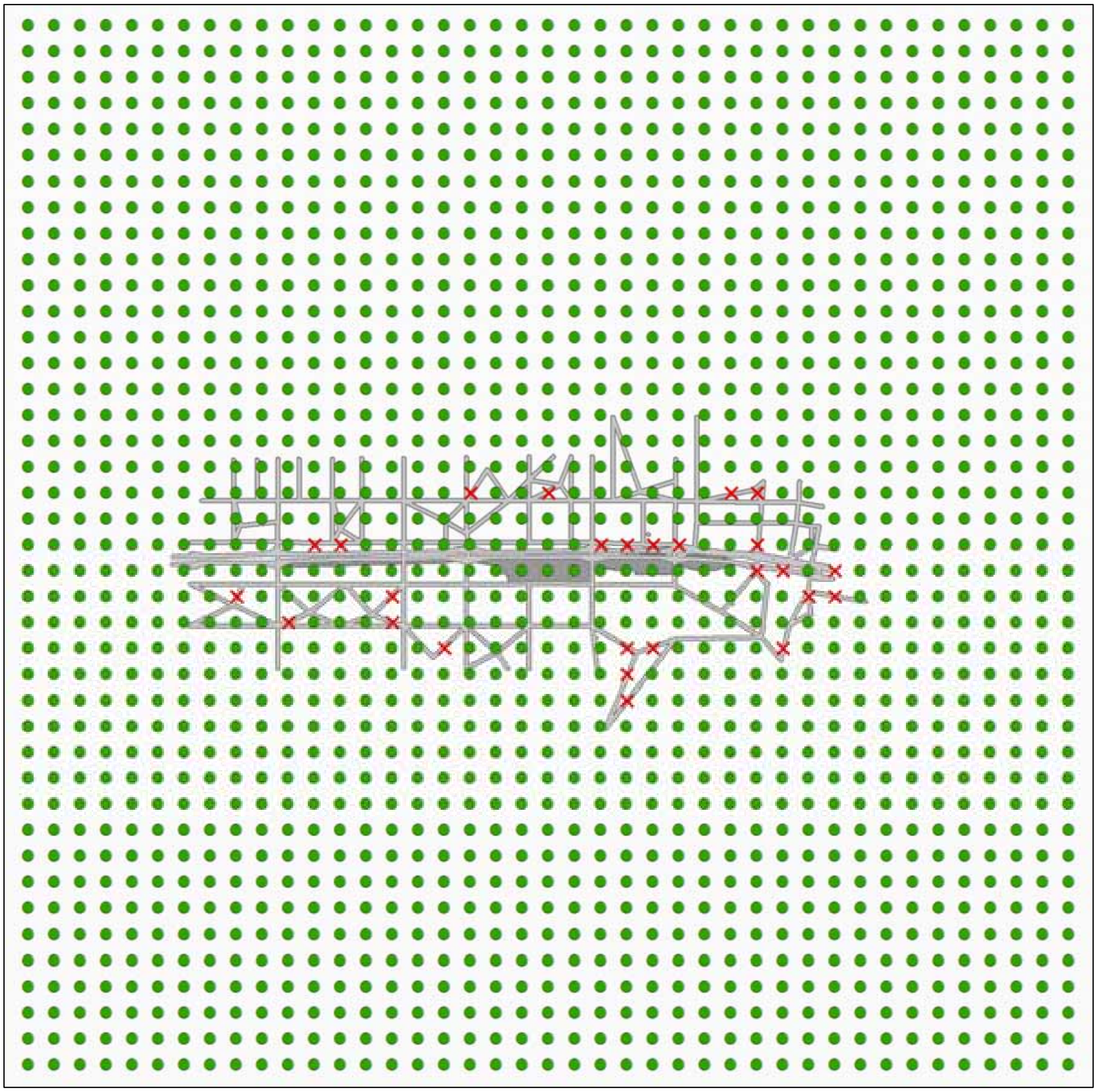
Figure 1 illustrates the region surrounding the UP Colton modeling domain. The domain has dimensions 20 km x 20 km and contains a grid of 1681 receptors with 500 meter uniform grid spacing.

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



AERMOD requires an estimate of the urban population for urban source modeling. The urban population parameter was determined by estimating the area of continuous urban features as defined by the model guidelines (AERMOD Implementation Guide September 27, 2005). According to the guidelines, areas with a population of at least 750 people per square kilometer are considered urban. The UP Colton 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 1,029,675.

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



The off-site stationary and on-road emission sources used in the UP Colton 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 one mile of the perimeter of the rail yard facility. Diesel PM off-site emissions used in the off-site modeling runs consisted of 41.9 tons per year from roadways and 1.5 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, 1655 of the original 1681 receptors remained.

The same meteorological data used by Sierra Research were used for the off-site modeling runs. The data were compiled by Sierra Research from the Ontario International Airport (34.06°N, 117.61°W). Upper air data for the same time period were obtained from the San Diego Miramar upper air station (32.833°N, 117.117°W). The model runs used one year of meteorological data from 1999.

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

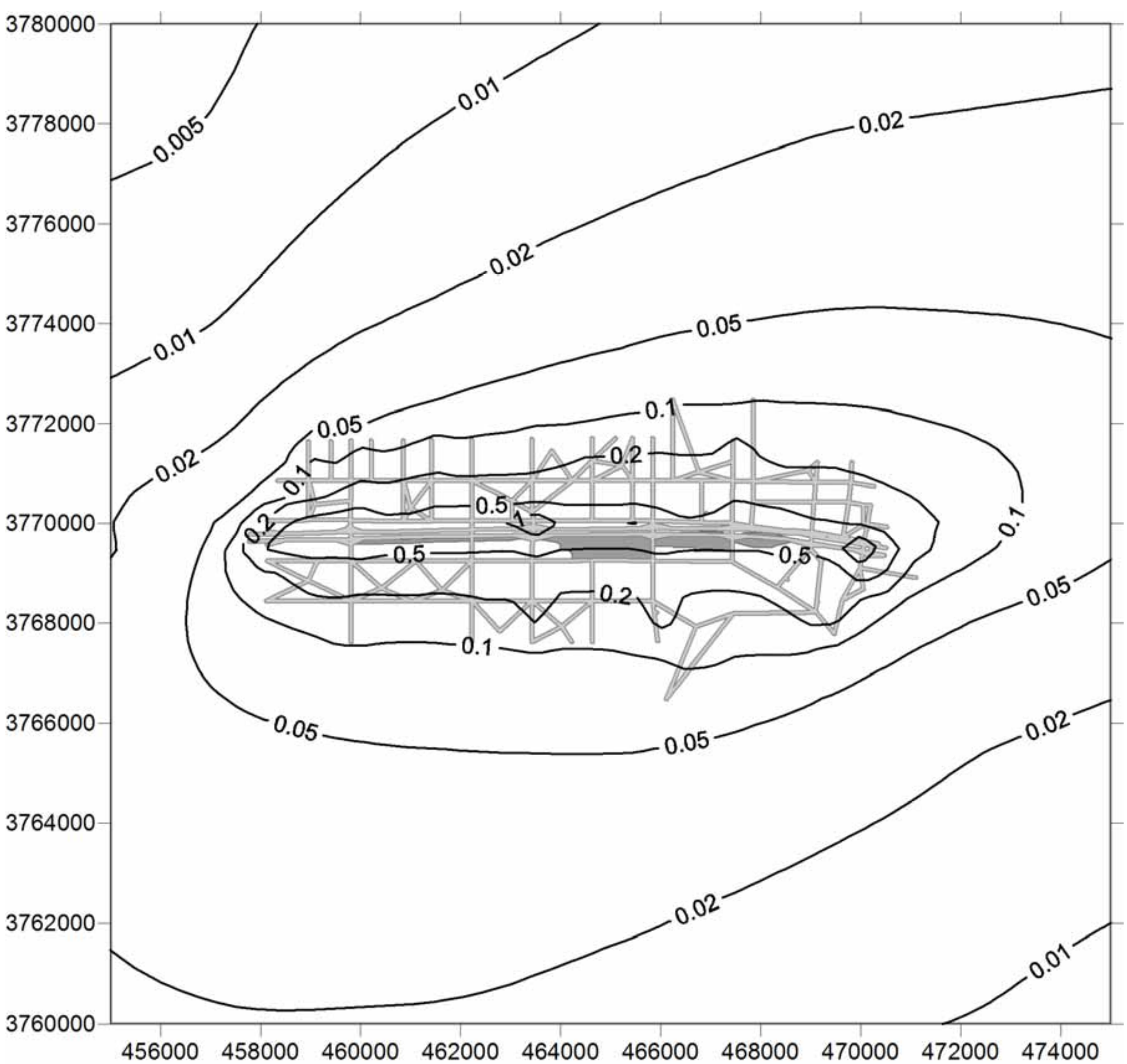


Figure 4 shows annual average diesel PM concentrations from the off-site emissions. Highest values occur near major freeways; the five highest concentrations at a receptor and their locations are provided in Table 2.

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

X	Y	Mobile	Stationary	Total Off-site
470000	3769500	1.546	0.018	1.564
463500	3770000	1.420	0.003	1.423
465500	3770000	1.005	0.010	1.015
463000	3770000	1.005	0.003	1.008
465000	3770000	0.957	0.007	0.964

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APPENDIX D

TABLES OF LOCOMOTIVE DIESEL PM EMISSION FACTORS

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

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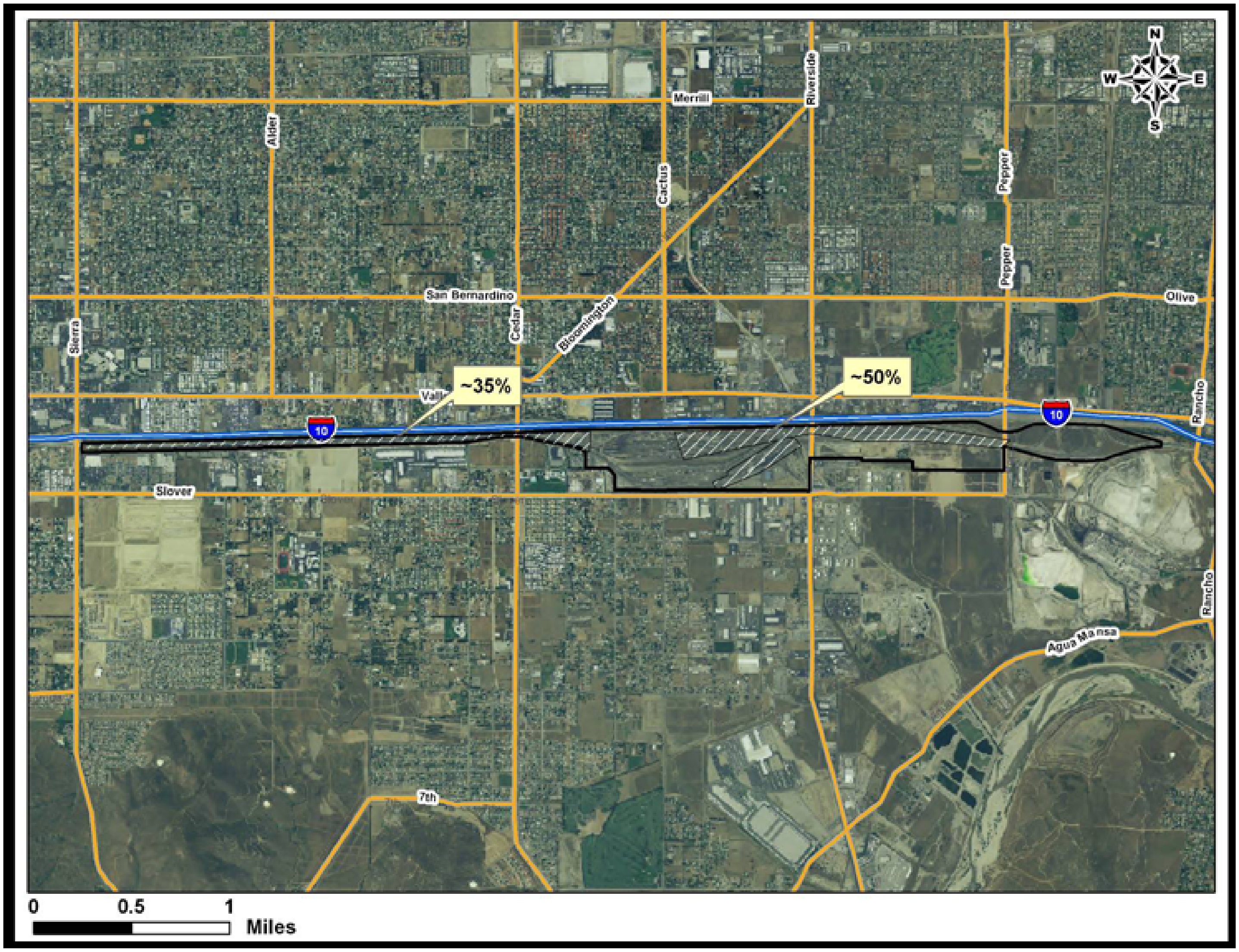
APPENDIX E

SPATIAL ALLOCATIONS OF MAJOR DIESEL PM EMISSION SOURCES AT THE UP COLTON RAILYARD

This Appendix is provided as a visual aid to understand where significant sources of diesel PM are generated within the UP Colton Railyard. This visual layout indicates that about 50% of the emissions occur in the mid-eastern part and 35% occur in the western part of the Up Colton railyard.

Figure 1. The UP Colton Railyard shown with the Shaded Area accounting for about 85 Percent of Facility-Wide Diesel PM Emissions.



Note: According to the emissions inventory for the UP Colton Railyard about 35% percent of DPM emissions occur in the western section of the yard, as there is significant switcher and line haul activity in this area. About 50% of DPM emissions occur in the eastern section of the yard due to switcher activity as well as service activity.

Figure 2. Spatial Allocation of Locomotive Emissions at UP Colton Railyard.

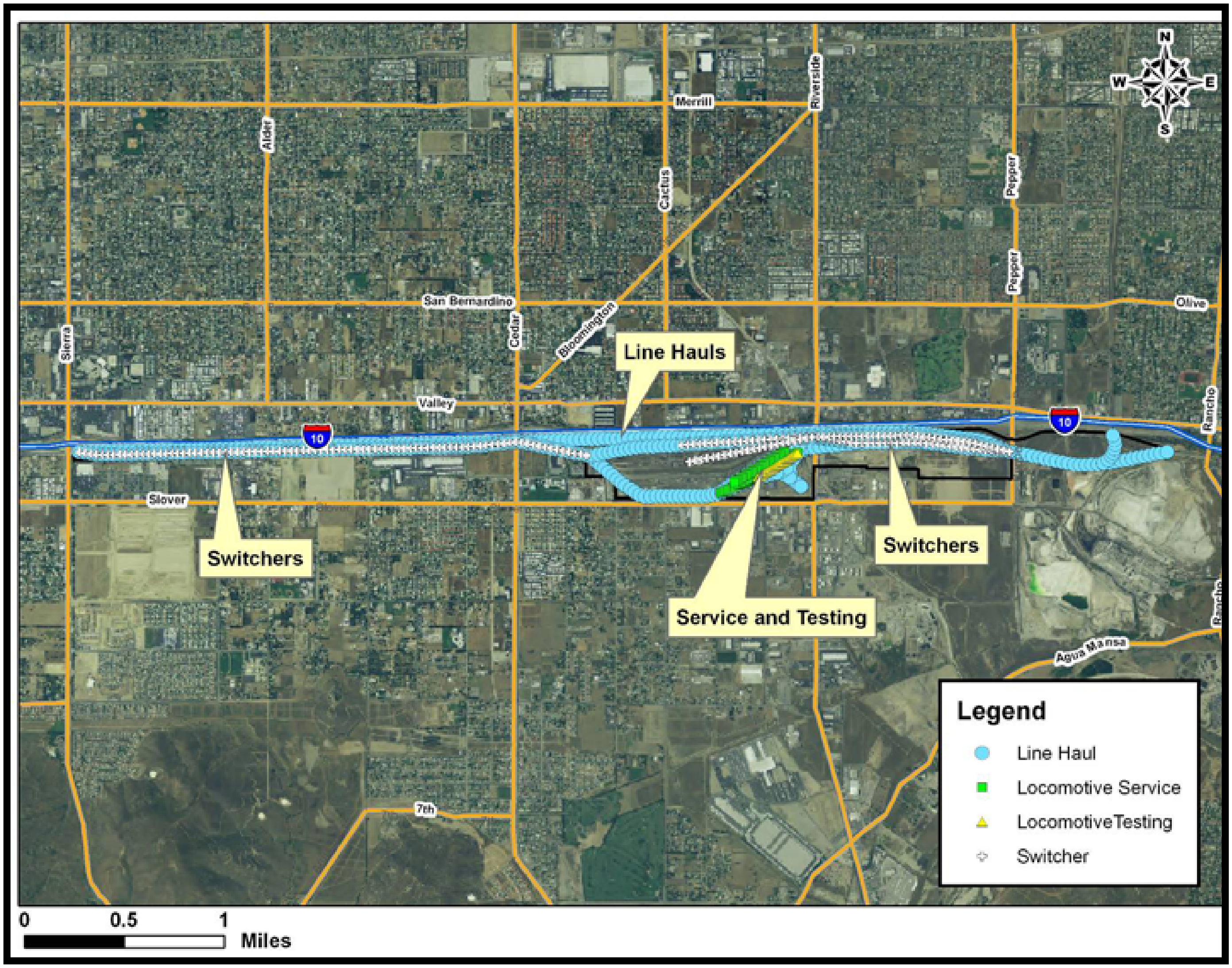


Figure 3. Spatial Allocation of Diesel PM Emissions from Line Haul Locomotives at UP Colton Railyard.

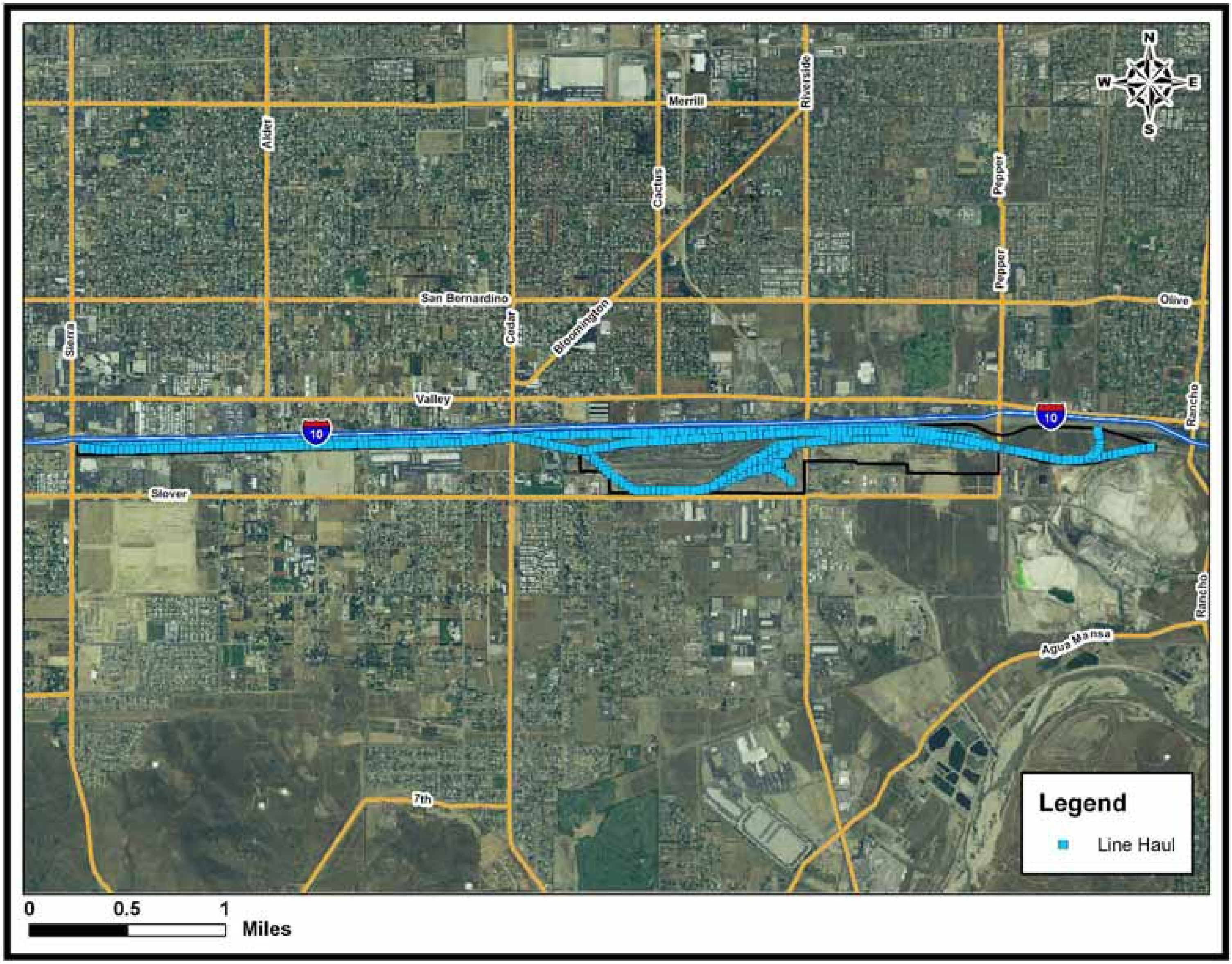


Figure 4. Spatial Allocation of Diesel PM Emissions from Switch Locomotives at UP Colton Railyard.

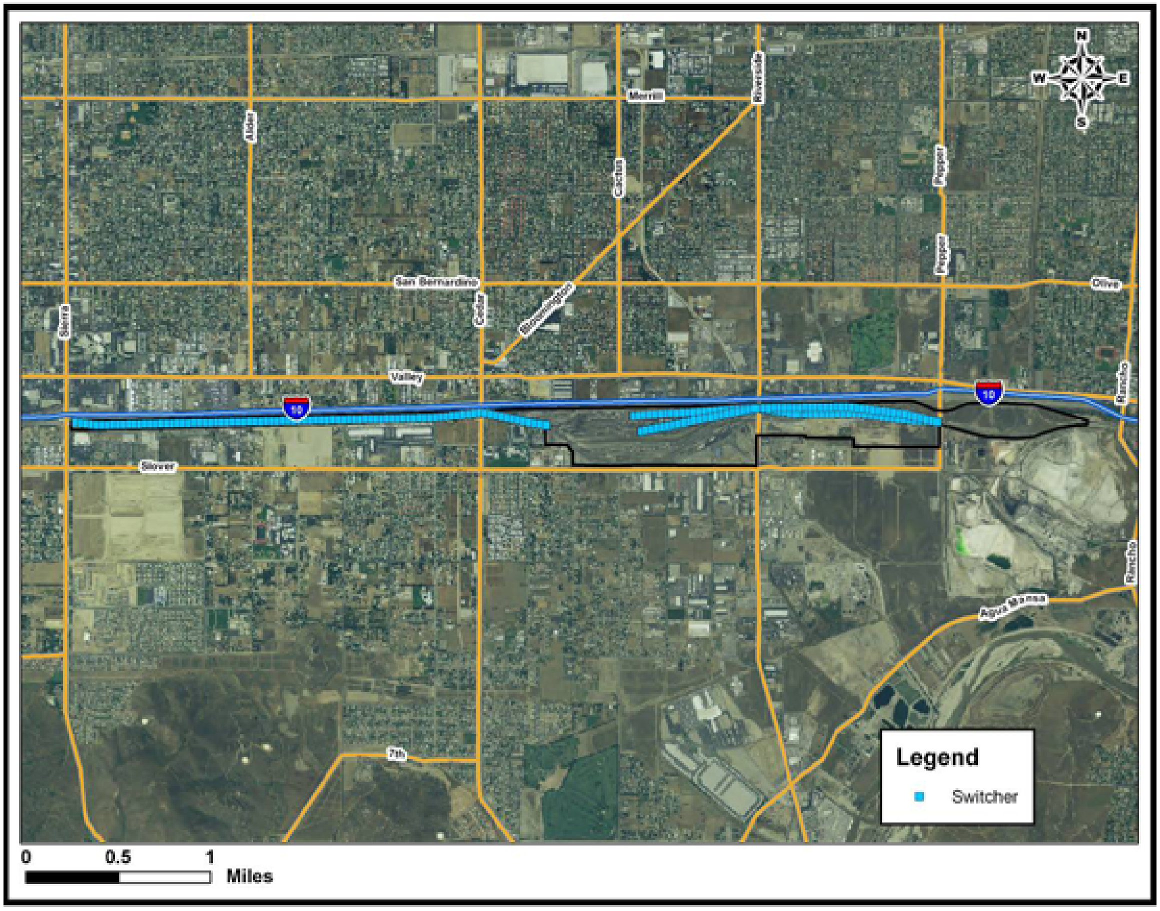


Figure 5. Spatial Allocation of Diesel PM Emissions from Locomotive Testing at UP Colton Railyard.

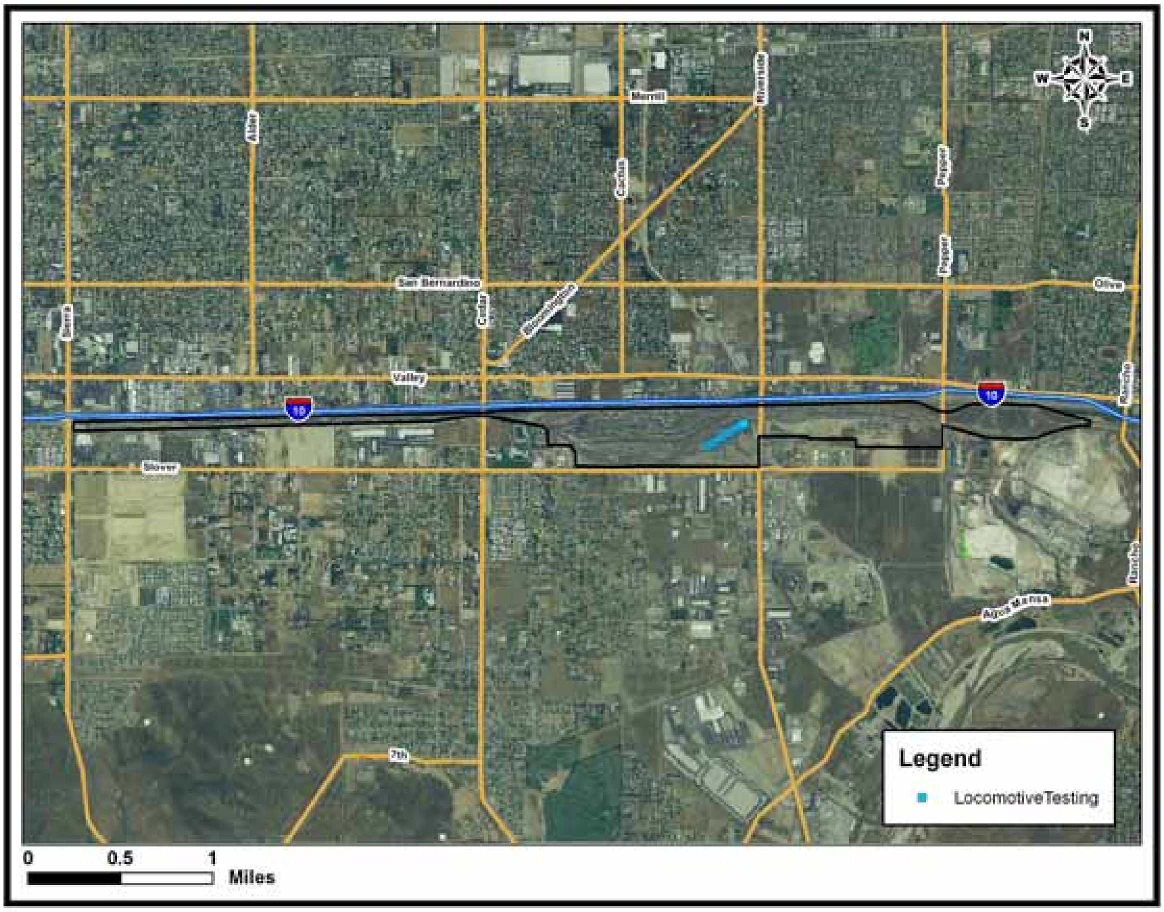


Figure 6. Spatial Allocation of Diesel PM Emissions from Locomotive Servicing at UP Colton Railyard.

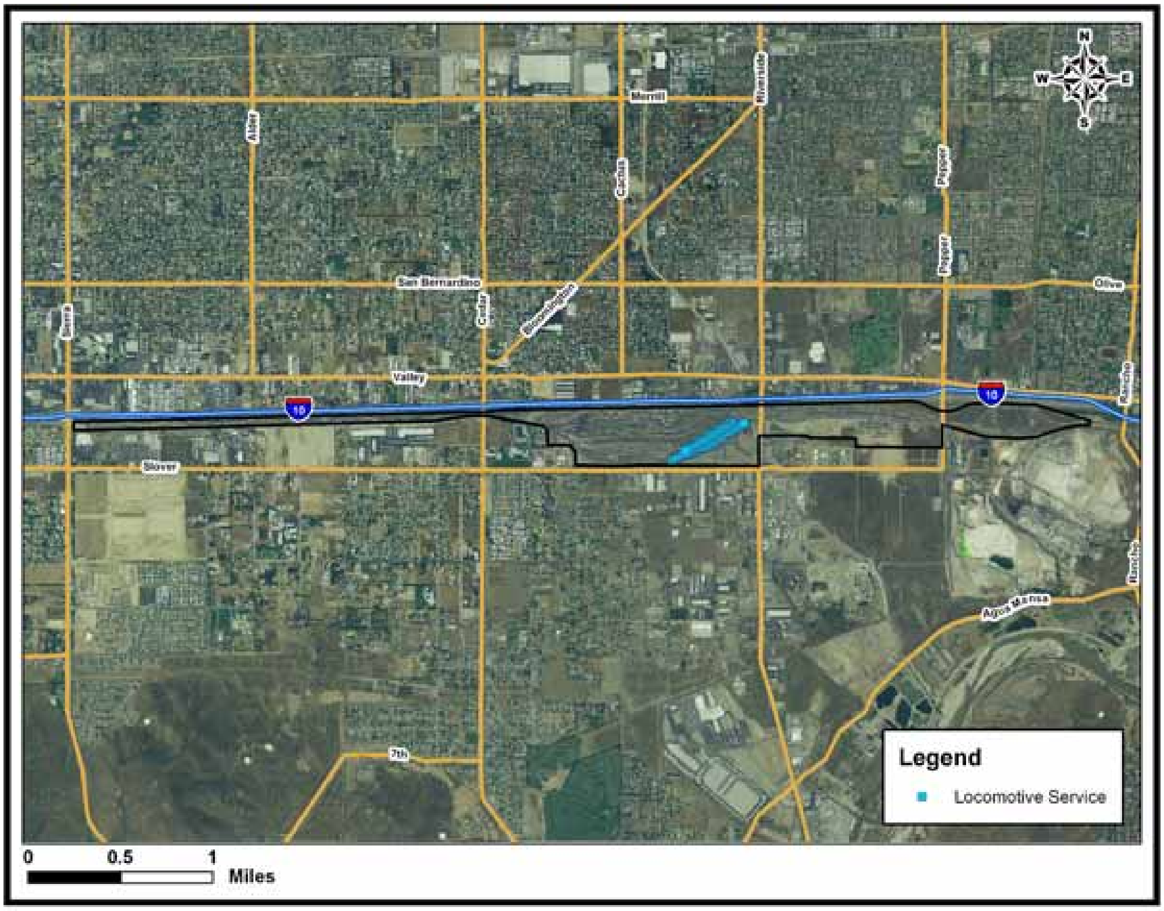
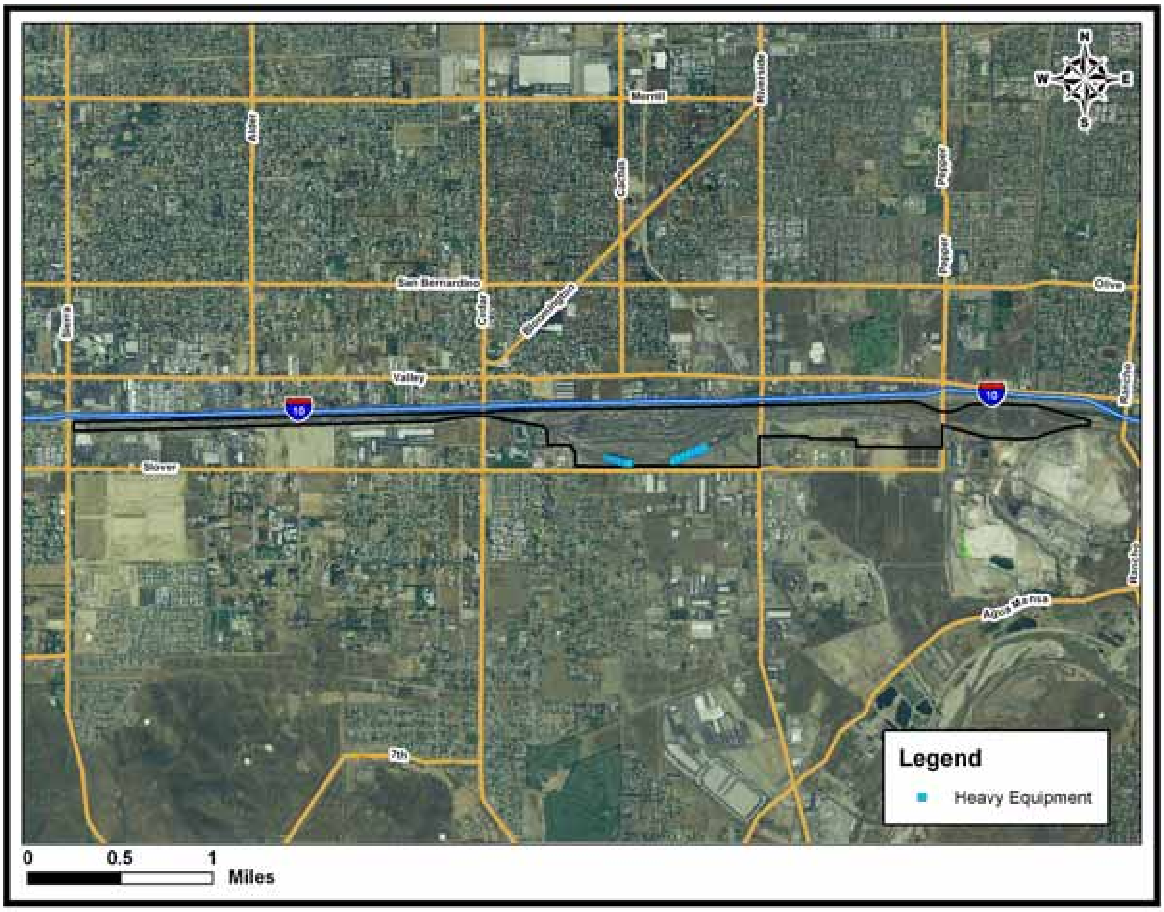


Figure 7. Spatial Allocation of Diesel PM Emissions from Heavy Equipment at UP Colton Railyard.



Appendix F

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

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

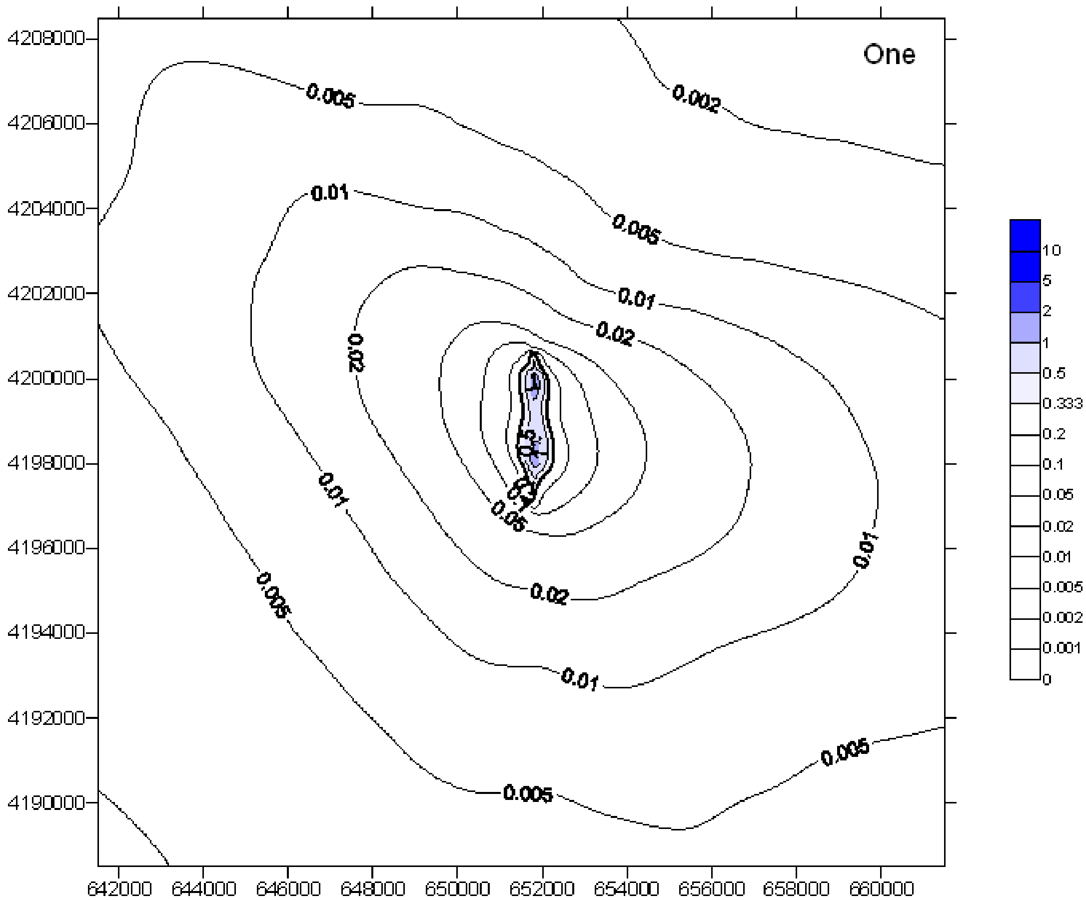


Figure 2. AERMOD's Simulated Diesel PM Concentrations (due to On-site and Off-site Diesel PM Emissions) around UP Stockton Railyard Using Five-year Meteorological Data.