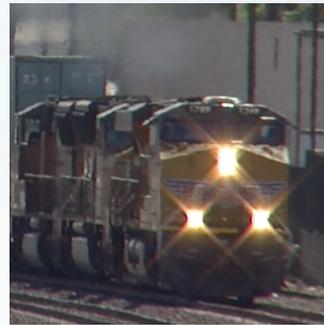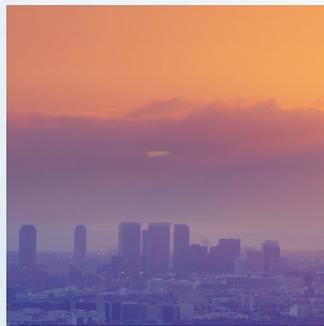# FINAL REPORT

Multiple Air Toxics Exposure Study in the South Coast Air Basin

MATES-IV

MAY 2015

SOUTH COAST
AIR QUALITY MANAGEMENT DISTRICT

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South Coast AQMD

Multiple Air Toxics Exposure Study in the South Coast Air Basin

MATES IV

FINAL REPORT

May 2015

South Coast Air Quality Management District
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EXECUTIVE SUMMARY

Executive Summary

The Multiple Air Toxics Exposure Study IV (MATES IV) is a monitoring and evaluation study conducted in the South Coast Air Basin (Basin). The study is a follow up to previous air toxics studies in the Basin and is part of the South Coast Air Quality Management District (SCAQMD) Governing Board Environmental Justice Initiative.

The MATES IV Study consists of several elements. These include a monitoring program, an updated emissions inventory of toxic air contaminants, and a modeling effort to characterize risk across the Basin. The study focuses on the carcinogenic risk from exposure to air toxics. It does not estimate mortality or other health effects from particulate exposures. The latter analyses are conducted as part of the updates to Air Quality Management Plans and are not included here.

A network of 10 fixed sites was used to monitor toxic air contaminants once every six days for one year. The locations of the sites were generally the same as in the MATES II and MATES III Studies to allow for comparisons over time. The one exception is the West Long Beach site, which was about 0.8 mile northwest of the location used in MATES III. The locations of the sites are shown in Figure ES-1.

As noted above, the study also includes computer modeling to estimate air toxic levels throughout the Basin. This allows estimates of air toxic risks in all areas of the Basin, as it is not feasible to conduct monitoring in all areas.

To provide technical guidance in the design of the study, a Technical Advisory Group was formed. The panel of experts from academia, environmental groups, industry, and public agencies provided valuable insight on the study design.

In the monitoring program, over 30 air pollutants were measured. These are listed in Table ES-1. These included both gaseous and particulate air toxics.

Table ES-1 Substances Measured in MATES IV

Acetaldehyde	Dichloroethane	Organic Carbon (OC)
Acetone	Elemental Carbon (EC)	PAHs
Arsenic	Ethyl Benzene	Perchloroethylene
Benzene	Formaldehyde	$PM_{2.5}$
Black Carbon (BC)	Hexavalent Chromium	PM_{10}
1,3-Butadiene	Lead	Selenium
Cadmium	Manganese	Styrene
Carbon Tetrachloride	Methylene Chloride	Toluene
Chloroform	Methyl ethyl ketone	Trichloroethylene
Copper	MTBE	Ultrafine Particles (UFP)
Dibromoethane	Naphthalene	Vinyl Chloride
Dichlorobenzene	Nickel	Xylene
		Zinc

The monitored and modeled concentrations of air toxics were then used to estimate the carcinogenic risks from ambient levels. Annual average concentrations were used to estimate a lifetime risk from exposure to these levels, consistent with guidelines established by the Office of Environmental Health Hazard Assessment (OEHHA) of the California Environmental Protection Agency (CalEPA). After release of the draft MATES IV Report, OEHHA adopted revised methodology to estimate carcinogenic risk. To provide a consistency with the draft report and previous MATES reports, we continue to present the risk results using the previous method. We also provide the estimates of risk based on the new methodology.

Key results of the study are presented below.

Fixed Site Monitoring

The levels of air toxics continued to decline compared to previous MATES studies. The most dramatic reduction is in the level of diesel particulate, which showed 70% reduction in average level measured at the 10 monitoring sites compared to MATES III. The carcinogenic risk from air toxics in the Basin, based on the average concentrations at the 10 monitoring sites, is 65% lower than the monitored average in MATES III. This risk refers to the expected number of additional cancers in a population of one million individuals if they were exposed to these levels over a 70-year lifetime. About 90% of the risk is attributed to emissions associated with mobile sources, with the remainder attributed to toxics emitted from stationary sources, which include large industrial operations such as refineries and metal processing facilities, as well as smaller businesses such as gas stations and chrome plating. The average risks from the annual average levels of air toxics calculated from the fixed monitoring sites data are shown in Figure ES-2 along with the key pollutant contributors to overall risk.

The air toxics risk at the fixed sites ranged from 320 to 480 per million. The risk by site is depicted in Figure ES-3. The results indicate that diesel particulate is the major contributor to air toxics risk, accounting on average for about 68% of the total. This compares to about 84% in MATES III. In Figure ES-4 the relative effect of using the updated calculation methodology is shown by monitoring site. On average, the calculated risk is about 2.5 times higher with the revised methodology.[1] We note that this is not a change in exposure levels and that the relative risks compared to MATES III are not changed.

Modeling

Regional air quality modeling is used to determine ambient air toxic concentrations throughout the Basin due to air toxic emissions from all sources. The model simulated concentrations of toxic compounds are translated into air toxic health risks based upon compound potency risk factors. This analysis complements the techniques used to assess concentration and risk from the data acquired at the fixed monitoring sites.

As in MATES III, MATES IV employed the Comprehensive Air Quality Model with Extensions (CAMx), enhanced with a reactive tracer modeling capability (RTRAC), as the dispersion and

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[1] In the October, 2014 Draft MATES IV Report, the increase in risk estimates was given as a 2.7 fold increase. This was based on using the 90th percentile of breathing rate distribution. In anticipation of CARB guidance for risk management, we have used the 80th percentile of the breathing rate distribution for ages greater than 2 years. This resulted in a 2.45 fold change in the estimate of risk.

chemistry modeling platform used to simulate annual impacts of both gas and particulate toxic compounds in the Basin. The version of the RTRAC in CAMx used in the modeling simulations includes an air toxics chemistry module that is used to treat the formation and destruction of reactive air toxic compounds.

Modeling was conducted on a domain that encompassed the Basin and the coastal shipping lanes using a 2 km by 2 km grid size. A projected emissions inventory for 2012 based on the 2012 AQMP emissions inventory, which included detailed source profiles of air toxic sources, provided the mobile and stationary source inputs for the MATES IV simulations. Although the actual measurements and modeling for MATES IV spanned July 1, 2012, to June 30, 2013, for simplicity, the MATES IV modeling utilized the 2012 emissions inventory.

The results of the regional modeling estimates of risk are depicted in Figure ES-5.   As shown, the areas of higher risk include those near the ports, Central Los Angeles, and along transportation corridors.

For comparison purposes, Table ES-2 shows the estimated population weighted risk across the Basin for the MATES III and MATES IV periods. The population weighted risk was about 57% lower compared to the MATES III period (2005).

Table ES-2 Modeled Air Toxics Risk Comparisons Using the CAMx Model

	MATES IV	MATES III	Change
Population weighted risk (per million)	367	853	-57%

Applying the revised OEHHA methodology to the modeled air toxics levels, the MATES IV estimated population weighted risk is 897 per million, an increase of about 2.5 times higher. Again we note that this is not a change in exposure levels, and that the relative risks compared to MATES III are not changed.

Figure ES-6 depicts the 2005 to 2012 change in estimated air toxics risk for each model grid cell estimated from the CAMx simulations. Overall, air toxics risk was reduced to varying levels across the Basin, with the largest improvements in the highest risk areas.

Noncancer Assessment

To assess the potential for noncancer health risks, the monitored average levels were compared to the chronic reference exposure levels (RELs) established by OEHHA. The chronic REL is the air concentration at or below which adverse noncancer health effects would not be expected in the general population with exposure for at least a significant fraction of a lifetime. The measured concentrations of air toxics were all below the established chronic RELs.

Caveats and Uncertainty

One source of uncertainty is that currently there is no technique to directly measure diesel particulates, the major contributor to risk in this study, so indirect estimates based on components of diesel exhaust must be used. The method chosen to estimate diesel particulate is to adjust measured EC levels by the ratio of emissions of EC and diesel from the emissions inventory estimates. This approach was reviewed by the Technical Advisory Group, and it is staff's judgment that this is an appropriate method to estimate the ambient levels of diesel particulate matter. During the MATES III Study, this method gave average estimates that were very similar to those estimated using a Chemical Mass Balance method. Additional detail is provided in Chapter 2.

There are also uncertainties in the risk potency values used to estimate lifetime risk of cancer. This study used the unit risks for cancer potency established by OEHHA and the annual average concentration measured or modeled to calculate risk. This methodology has long been used to estimate the relative risks from exposure to air toxics in California and is useful as a yardstick to compare potential risks from varied sources and emissions and to assess any changes in risks over time that may be associated with changing air quality.

The estimates of health risks are based on the state of current knowledge, and the process has undergone extensive scientific and public review. However, there is uncertainty associated with the processes of risk assessment. This uncertainty stems from the lack of data in many areas necessitating the use of assumptions. The assumptions are consistent with current scientific knowledge, but are often designed to be conservative and on the side of health protection in order to avoid underestimation of public health risks. However, community and environmental justice advocates have often commented that risks are underestimated due to unquantified effects of toxic pollutants.

As noted in the OEHHA risk assessment guidelines, sources of uncertainty, which may either overestimate or underestimate risk, include: (1) extrapolation of toxicity data in animals to humans; (2) uncertainty in the estimation of emissions; (3) uncertainty in the air dispersion models; and (4) uncertainty in the exposure estimates. Uncertainty may be defined as what is not currently known and may be reduced with further scientific studies. In addition to uncertainty, there is a natural range or variability in the human population in such properties as height, weight, and susceptibility to chemical toxicants.

Thus, the risk estimates should not be interpreted as actual rates of disease in the exposed population, but rather as estimates of potential risk, based on current knowledge and a number of assumptions. However, a consistent approach to risk assessment is useful to compare different sources, different substances, and different time frames in order to prioritize public health concerns.

Updates to Cancer Risk Estimation Methods

Staff notes that OEHHA has adopted updated methods for estimating cancer risks.[2] The new method includes utilizing higher estimates of cancer potency during early life exposures. There

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[2] California Environmental Protection Agency Office of Environmental Health Hazard Assessment, Air Toxics Hot

are also differences in the assumptions on breathing rates and length of residential exposures. Staff has calculated unit risk factors with the updated methodology to show the effect of applying the methodology. These calculated unit risk factors are shown in Appendix I. While the previous method is used to compare results with past studies, staff also presents the estimates using the updated methods. These are shown in Figure ES-7 for the regional modeled air toxics levels. Thus, while air toxic emissions, ambient levels, and resulting exposures have dropped significantly over the past several years, the updated OEHHA methods estimate that the risks from a certain level of air toxic exposure are significantly higher than previously assumed.

Conclusion

Compared to previous studies of air toxics in the Basin, this study found decreasing air toxics exposure, with the estimated Basin-wide population-weighted risk down by about 57% from the analysis done for the MATES III time period. The ambient air toxics data from the 10 fixed monitoring locations also demonstrated a similar reduction in air toxic levels and risks.

Policy Implications

While there has been substantial improvement in air quality regarding air toxics emissions and exposures, in staff's view the risks are still unacceptably high, especially near sources of toxic emissions such as the ports and transportation corridors. In addition, when updates to risk calculation methods are incorporated, the risks are substantially higher than previously estimated. Diesel particulate, while also substantially reduced from past MATES studies, continues to dominate the overall cancer risk from air toxics.

The results from this study continue to support a continued focus on the reduction of toxic emissions, particularly from diesel engines.

Figure ES-1 Map of MATES IV Monitoring Sites

MATES IV Air Toxics Risk
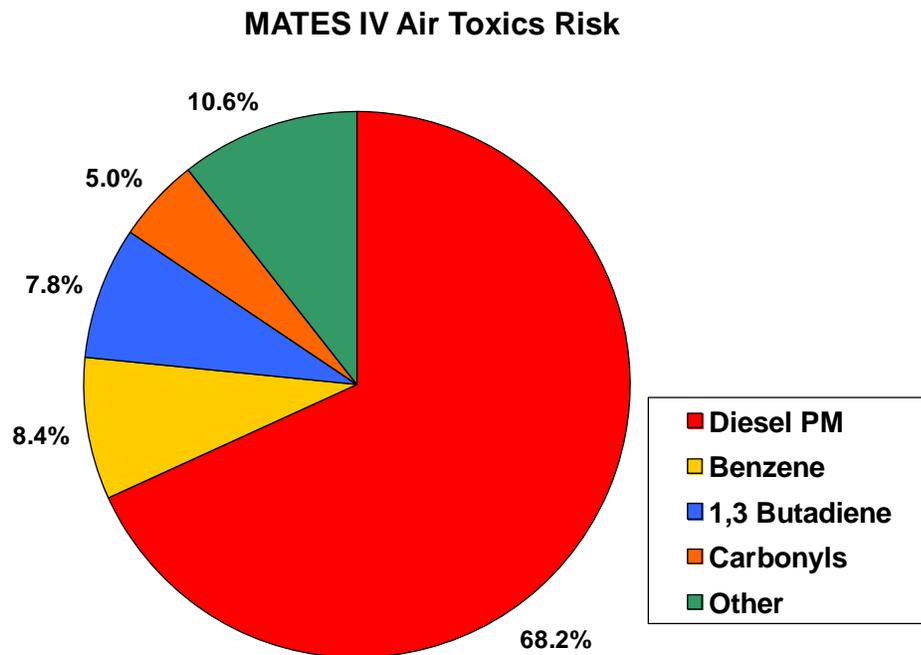
Basinwide Risk: 418 per million
Based on Average of 10 Fixed Monitoring sites

Figure ES-2 Average Risk from Monitoring Sites

Air Toxics Risk - MATES IV
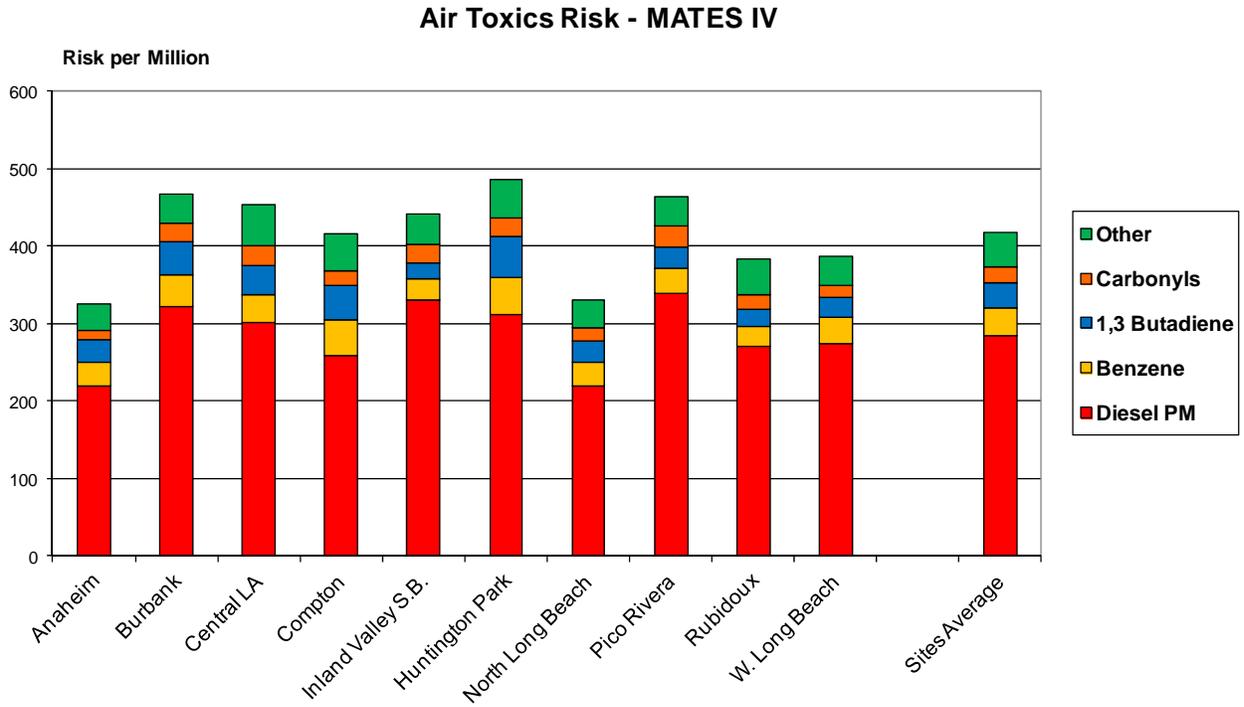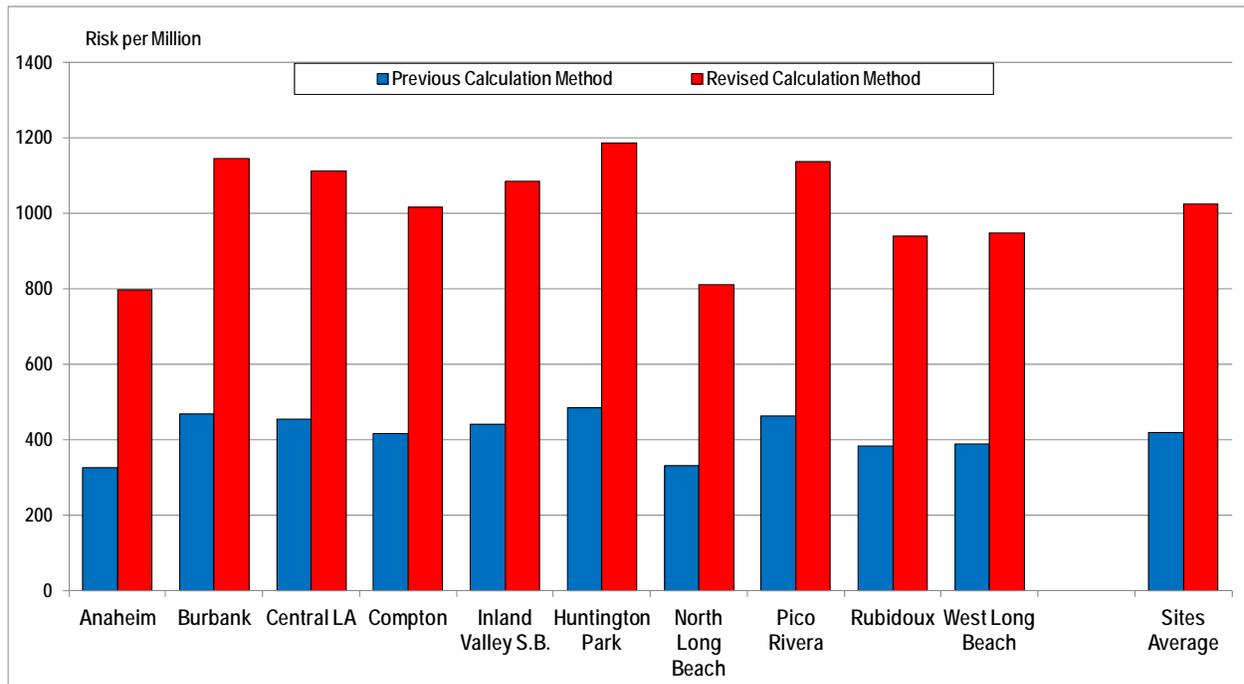
Figure ES-3.

Figure ES-4. MATES IV Cancer Risk Results Comparison Between Previous and Updated OEHHA Risk Calculation Methodologies
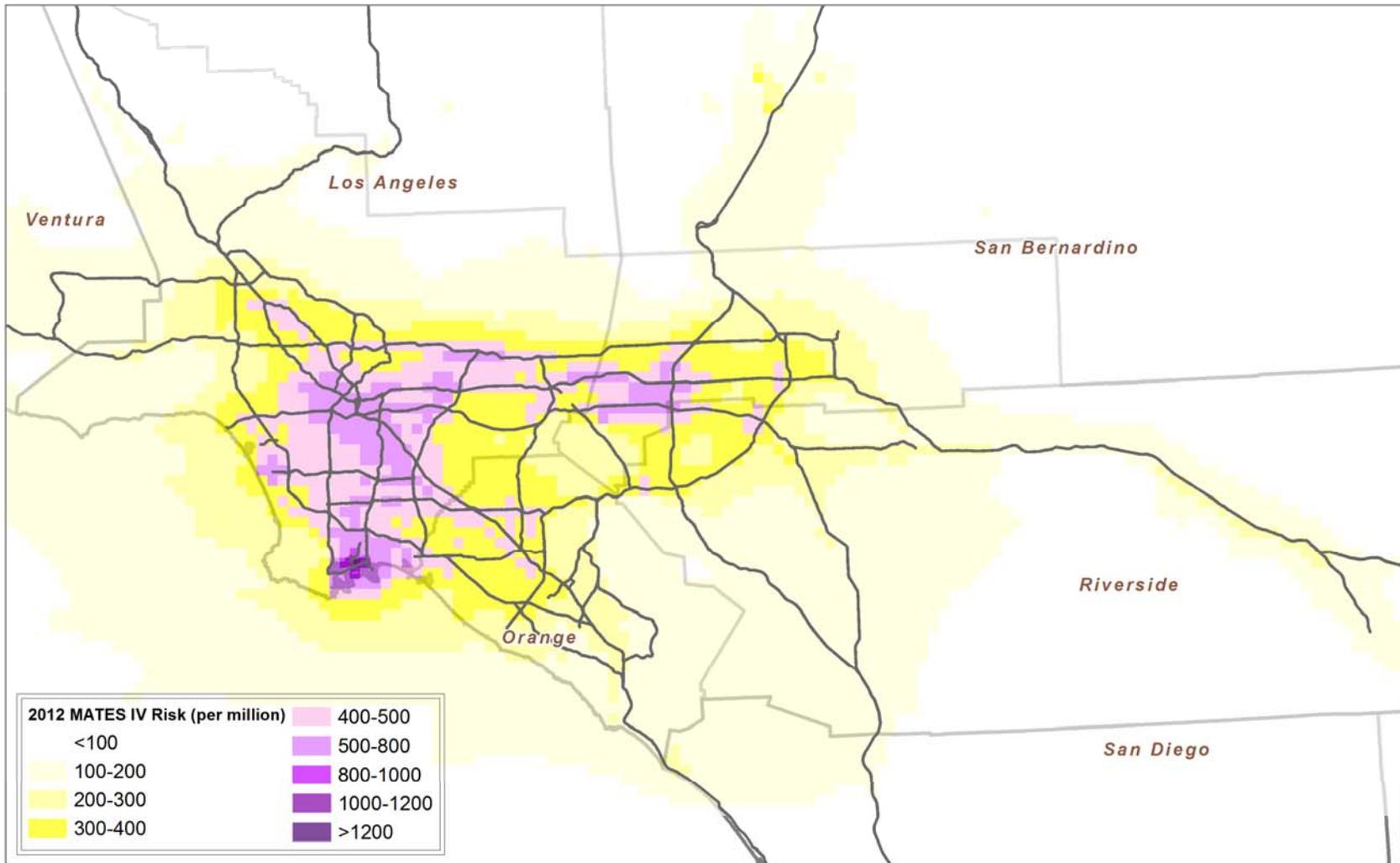
Figure ES-5
MATES IV Modeled Air Toxics Risk Estimates
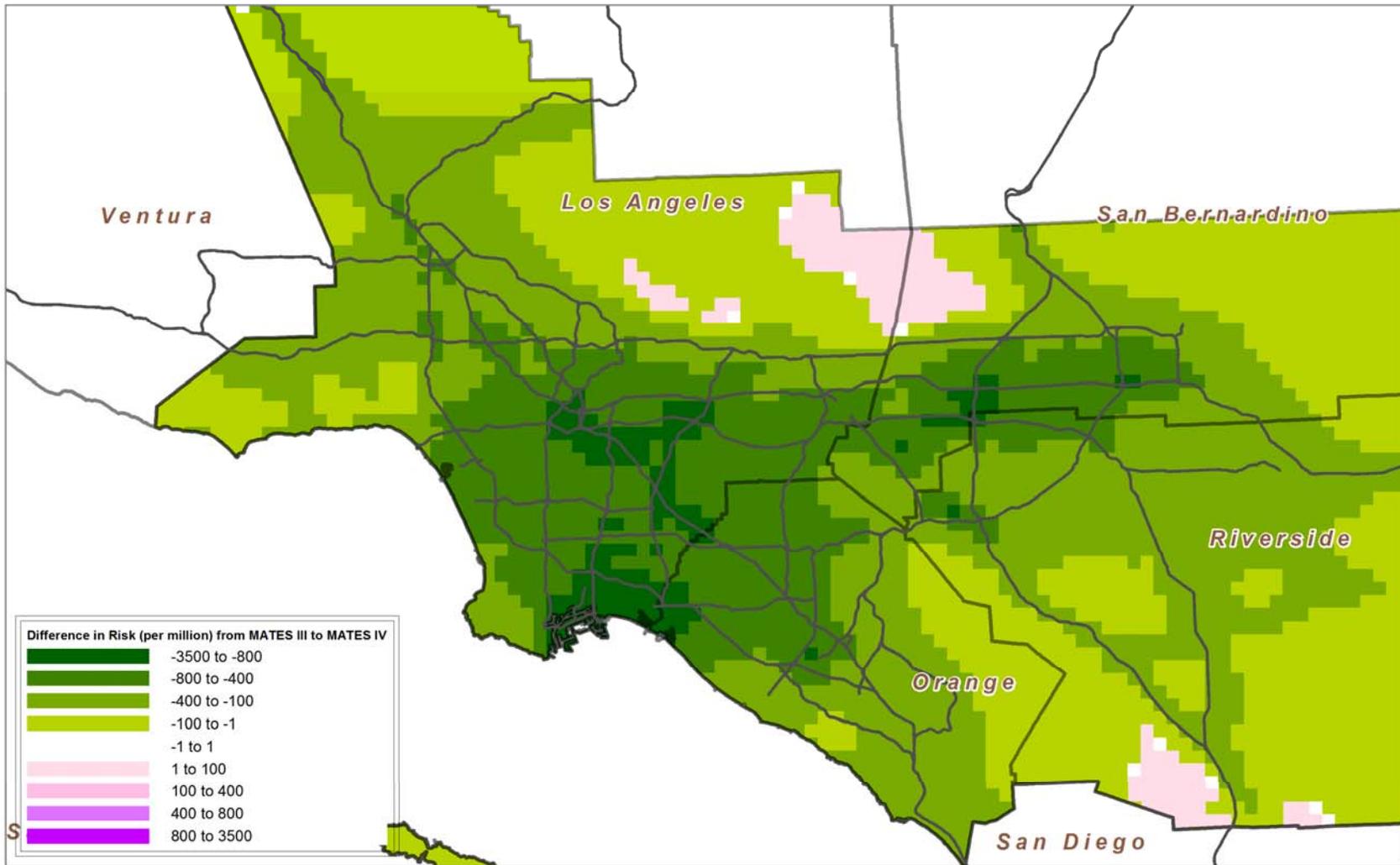
Figure ES-6
Change in Air Toxics Estimated Risk (per million) from 2005 to 2012
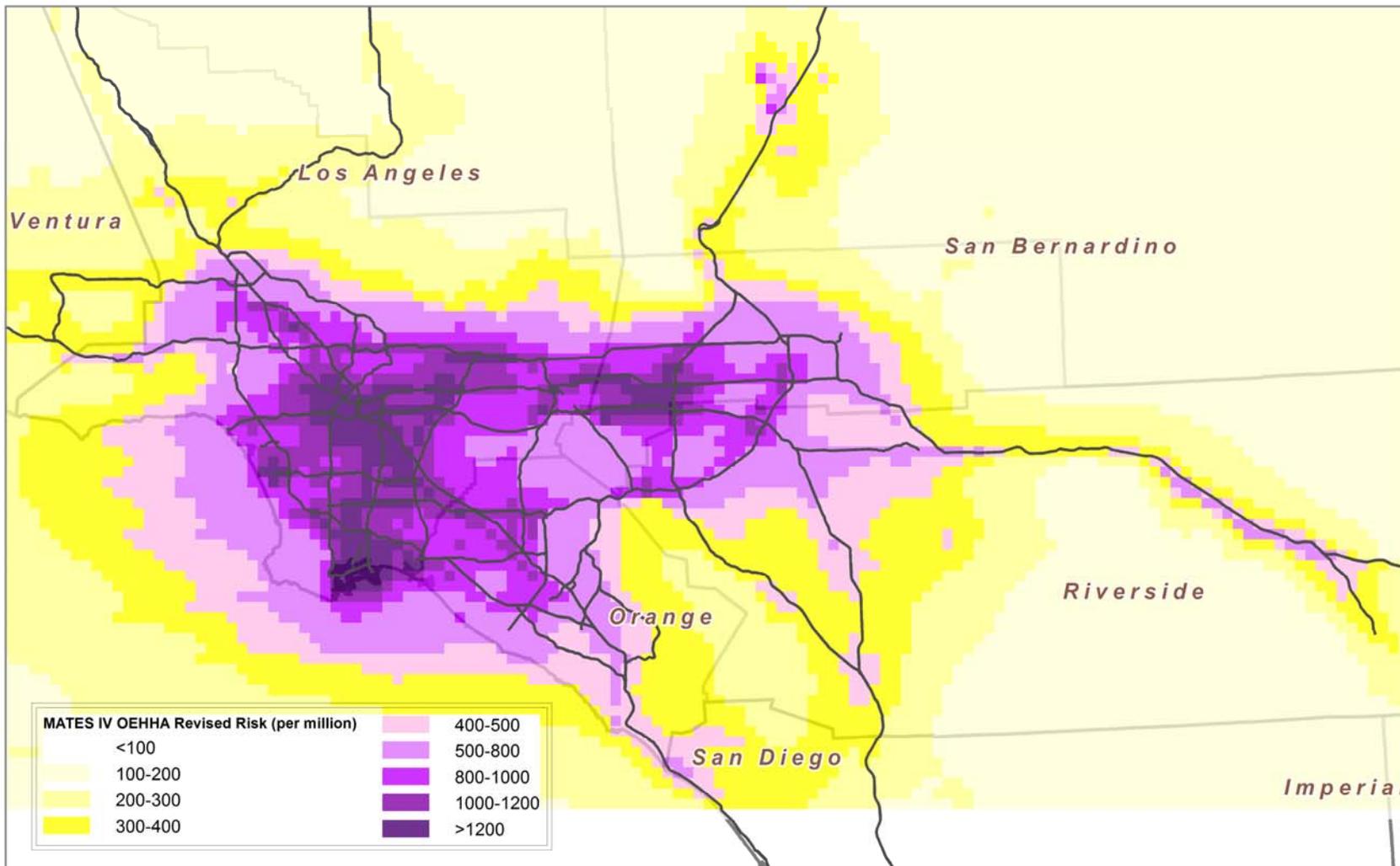
Figure ES-7
MATES IV Modeled Air Toxics Risks Estimates Using Updated OEHHA Methodology

CHAPTER 1
INTRODUCTION

Chapter 1.   Introduction

1.1   Background

The South Coast Air Basin (Basin), a highly urbanized area, is home to over 17 million people who own and operate about 11 million motor vehicles and contains some of the highest concentrations of industrial and commercial operations in the country. It also has some of the worst air quality in the U.S. In 1986, SCAQMD conducted the first MATES study to determine the Basin-wide risks associated with major airborne carcinogens. At the time, the state of technology was such that only 10 known air toxic compounds could be analyzed. In 1998, a second MATES study (MATES II) represented one of the most comprehensive air toxics measurement programs conducted in an urban environment. MATES II included a monitoring program of 40 known air toxic compounds, an updated emissions inventory of toxic air contaminants, and a modeling effort to characterize health risks from hazardous air pollutants. A third study, MATES III, was conducted in the 2004-2006 timeframe. It consisted of a two-year monitoring program as well as updates to the air toxics emissions inventory and a regional modeling analysis of exposures to air toxics in the Basin.

Since these studies were first conducted, numerous emissions control programs have been implemented at the national, state, and local levels; and toxics emissions have been declining. However, at the community level, there remains heightened awareness of toxic air contaminant exposures. There are also environmental justice concerns that programs designed to reduce emissions may not be effective in reducing risks from toxic air contaminants in certain areas, particularly in communities with lower income or multiple sources of air toxics.

This report presents the results of the fourth air toxics monitoring and exposure study conducted by the SCAQMD (MATES IV). It consists of a one-year monitoring study, an updated air toxic emissions inventory, as well as updates to monitored and modeled exposures and risk estimated from air toxics. The objective is to update the characterization of ambient air toxic concentrations and potential exposures to air toxics in the Basin.

This study, as the previous MATES studies, focuses on the carcinogenic risks from exposures to air toxics. It does not include an analysis of noncancer mortality from exposure to particulates. An analysis of mortality and other health effects from exposure to particulates was conducted as part of the periodic updates to the Air Quality Management Plans.

The results of this effort can be used to determine spatial patterns of exposure to hazardous air pollutants in the Basin, assess the effectiveness of current air toxic control measures, provide long-term trends of air toxic levels, and help to develop appropriate control strategies for reducing exposures to toxics associated with significant public health risks.

There are three main components to the study, as listed below:

- Air Toxics Monitoring and Analyses
- Air Toxics Emissions Inventory Updates
- Air Toxic Modeling and Risk Assessments

In addition to air toxics, the monitoring portion of the study included continuous measurements of black carbon and ultrafine particles. These components are further described in the chapters that follow.

1.2   Estimates of Risks

A health risk assessment evaluates the potential health impacts from exposures to substances released from a facility or found in the air. These assessments provide estimates of potential long-term cancer and noncancer health risks. The assessments do not collect information on specific individuals but are estimates of potential effects in the population at large.

Potential health risks were estimated using methodology consistent with the procedures recommended in the 2003 OEHHA "Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments" (Guidance Manual). As discussed in the Guidance Manual, the risk assessment process generally consists of four parts; namely hazard identification, exposure assessment, dose response assessment, and risk characterization. The risk assessment steps, as applied in this study, are briefly summarized below.

Hazard Identification

Hazard identification involves determination of whether a hazard exists; and, if so, if the substance of concern is a potential human carcinogen or is associated with other types of adverse health effects in humans. For this study, the list of air toxics in the OEHHA Guidelines was used in conjunction with information on ambient levels of air toxics from previous studies, as well as input from the Technical Advisory Group, to determine which substances on which to focus for this assessment. This list is provided in Appendix I.

Exposure Assessment

The purpose of an exposure assessment is to estimate the extent of public exposure for a substance. This can involve quantification of emissions from a source, modeling of environmental transport and fate, and estimation of exposure levels over some period of time. In this study, annual averages of the air toxics of concern were estimated in two ways. For the fixed site monitoring station data, annual averages were calculated and used as an estimate of exposure. For the modeling analysis, emissions over the Basin were estimated and allocated to 2 kilometer by 2 kilometer geographic grids, and a regional dispersion model was used to estimate the annual average concentrations in each grid cell.

Dose Response Assessment

The dose response assessment characterizes the relationship between exposure to a substance and the incidence of an adverse health effect in an exposed population. For estimating cancer risk, the dose-response is expressed in terms of a potency slope that is used to calculate the probability of cancer associated with a given exposure. These cancer potency factors are expressed as the 95th statistical upper confidence limit of the slope of the dose response curve assuming a continuous lifetime exposure to a substance at a dose of one milligram per kilogram of body weight. For effects other than cancer, dose-response data are used to develop acute and chronic reference exposure levels (RELs). The RELs are defined as the concentrations at or below which no adverse noncancer health effects would be found in the general population. The acute RELs

are designed to be protective for infrequent one-hour exposures. The chronic RELs are designed to be protective for continuous exposure for at least a significant fraction of a lifetime.

For this study, the dose-response estimates developed by OEHHA are used to estimate the potential for adverse health effects. Note that these estimates sometimes differ from those developed by the U.S. EPA. For example, OEHHA has developed a cancer potency factor for diesel exhaust, whereas the U.S. EPA has elected not to do so. The U.S. EPA does state, however, that diesel exhaust is likely to be carcinogenic to humans and has adopted regulations designed to reduce diesel exhaust exposure. While some of the potency estimates OEHHA has developed for other air toxics produce different estimates of risks than those that would be calculated using the U.S. EPA values, the risk from diesel exhaust calculated using OEHHA's cancer potency factor is the dominant contributor to the estimated air toxics cancer risk in this study.

Risk Characterization

In this step, the estimated concentration of a substance is combined with the potency factors and RELs to determine the potential for health effects. In this study, the estimated or measured annual average levels for potential carcinogens are multiplied by the potency factor expressed as unit risks. The unit risk is the probability associated with a lifetime exposure to a level of one microgram per cubic meter of air of a given substance. The unit risk factors developed by OEHHA and used in this study are listed in Appendix I.

The potential cancer risk for a given substance is expressed as the incremental number of potential cancer cases that could be developed per million people, assuming that the population is exposed to the substance at a constant annual average concentration over a presumed 70-year lifetime. These risks are usually presented in chances per million. For example, if the cancer risks were estimated to be 100 per million, the probability of an individual developing cancer due to a lifetime of exposure would be one hundred in a million, or one in ten thousand. In other words, this predicts an additional 100 cases of cancer in a population of a million people over a 70-year lifetime.

Perspectives of Risk

To provide perspective, it is often helpful to compare the risks estimated from assessments of environmental exposures to the overall rates of health effects in the general population. For example, it is often estimated that the incidence of cancer over a lifetime in the U.S. population is in the range of 1 in 4 to 1 in 3. This translates into a risk of about 300,000 in a million. It has also been estimated that the bulk of cancers from known risk factors are associated with lifestyle factors such as tobacco use, diet, and being overweight. One such study, the Harvard Report on Cancer Prevention, estimated that of all cancers associated with known risk factors, about 30% were related to tobacco, about 30% were related to diet and obesity, and about 2% were associated with environmental pollution related exposures.

Source of Uncertainty

The estimates of health risks are based on the state of current knowledge, and the process has undergone extensive scientific and public review. However, there is uncertainty associated with

the processes of risk assessment. This uncertainty stems from the lack of data in many areas, thus necessitating the use of certain assumptions. The assumptions are consistent with current scientific knowledge, but are often designed to be conservative and on the side of health protection in order to avoid potential underestimation of public health risks.

As noted in the OEHHA guidelines, sources of uncertainty, which may either overestimate or underestimate risk, include: (1) extrapolation of toxicity data from animal studies to humans, (2) uncertainty in the estimation of emissions, (3) uncertainty in the air dispersion models, and (4) uncertainty in the exposure estimates. Uncertainty may be defined as what is not currently known and may be reduced with further scientific studies. In addition to uncertainty, there is a natural range or variability in the human population in such properties as height, weight, age, and susceptibility to chemical toxicants.

Thus, the risk estimates should not be interpreted as actual rates of disease in the exposed population, but rather as estimates of potential risk, based on current knowledge and a number of assumptions. However, a consistent approach to risk assessment is useful in comparing different sources and different substances in order to prioritize public health concerns.

1.3   Updates to Cancer Risk Estimation Methods

After the release of the draft MATES IV Report, OEHHA adopted revised methodology to estimate carcinogenic risk. To provide a consistency with the draft report and previous MATES reports, we continue to present the risk results using the previous method as described above. We also provide the estimates of risk based on the new methodology to show the difference between the two methodologies.

The new OEHHA method for estimating cancer risks includes utilizing higher estimates of cancer potency during early life exposures. There are also differences in the assumptions on breathing rates and length of residential exposures. Staff has calculated unit risk factors with the updated methodology to show the effect of applying the methodology. These calculated unit risk factors are shown in Appendix I. While the previous method is used to compare results with past studies, staff also presents the estimates using the updated methods. Thus, while air toxic emissions, ambient levels, and resulting exposures and risks have dropped significantly over the past several years, the updated OEHHA methods estimate that the risks from a certain level of air toxic exposure are significantly higher than previously assumed.

1.4   References

The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments, Office of Environmental Health Hazard Assessment, California Environmental Protection Agency, 2003.

Harvard Report on Cancer Prevention Volume 1: Causes of Human Cancer
Cancer Causes & Control, Volume 7 Supplement November 1996

CHAPTER 2
AIR TOXICS MONITORING AND ANALYSES

Chapter 2.   Air Toxics Monitoring and Analyses

2.1   Substances Monitored

The chemical compounds (Table 2-1) monitored in MATES IV include the toxics posing the most significant contributors to health risks as found in previous studies in the Basin. Additional measurements include organic carbon, elemental carbon, and total carbon, as well as particulate matter (PM), including $PM_{2.5}$. Acrolein was initially considered to be included. However, there was no suitable method available for routine analyses at the time the study began. Other compounds are also reported, since they are additionally captured in both the sampling and analytical protocols.

Table 2-1 Substances Monitored in MATES IV

Acetaldehyde	Dichloroethane	Organic Carbon (OC)
Acetone	Elemental Carbon (EC)	PAHs
Arsenic	Ethyl Benzene	Perchloroethylene
Benzene	Formaldehyde	$PM_{2.5}$
Black Carbon (BC)	Hexavalent Chromium	PM_{10}
1,3-Butadiene	Lead	Selenium
Cadmium	Manganese	Styrene
Carbon Tetrachloride	Methylene Chloride	Toluene
Chloroform	Methyl ethyl ketone	Trichloroethylene
Copper	MTBE	Ultrafine Particles (UFP)
Dibromoethane	Naphthalene	Vinyl Chloride
Dichlorobenzene	Nickel	Xylene
		Zinc

These substances are the same as measured in MATES III with the addition of black carbon and ultrafine particles.

2.2   Monitoring Sites

The monitoring sites are generally identical to those used in the MATES II and III Studies, other than for the West Long Beach site. These sites were originally selected to measure numerous air toxic compounds at different locations in the Basin in order to establish a baseline of existing air toxic ambient concentrations, as well as risk data, and to assist in the assessment of modeling performance accuracy. The West Long Beach site for the MATES IV Study is about 0.8 mile northwest of the MATES III site, as the previous site was no longer available. A comparison of levels for several monitored substances for the two West Long Beach sites from previous periods is show in Appendix V. The concentrations were generally comparable and well correlated between the two sites. Maintaining the same or similar locations across the MATES studies is critical for assessing long-term air toxic trends.

The locations for the 10 fixed sites reflect key locations within the Basin and are geographically dispersed. Fixed site locations include areas varying in land-use types to obtain a good spatial representation of the Basin, including expected areas of possible elevated toxics levels (e.g.

industrial and commercial) and those areas that are not directly near source emissions (neighborhoods). The sites also reflect resource constraints and the leveraging of existing monitoring programs and the availability of specialized equipment. The sites used in MATES IV are shown in Figure 2-1.

The 10 sites were originally selected with the input from the MATES II Technical Review Group and the Environmental Justice Task Force, and precise locations are listed in Table 2-2. Five were selected to provide continuity with the CARB long-term trend sites (Los Angeles, Burbank, Long Beach, Rubidoux and Inland Valley San Bernardino).   The Pico Rivera site was selected because monitoring equipment was available from the EPA-sponsored PAMS Program. Anaheim was chosen for geographic equity, such that at least one site existed in each of the four counties. West Long Beach, Compton, and Huntington Park were sites selected to examine environmental justice concerns. Because the fixed site locations are based on EPA guidelines for "neighborhood scale" monitoring, each of these sites may also be representative of adjacent communities.

Table 2-2   Mates IV Site Locations

Site	Address
Anaheim	1630 Pampas Ln
Burbank	228 W. Palm Ave.
Compton	720 N. Bullis Rd.
Inland Valley San Bernardino	14360 Arrow Highway
Huntington Park	6301 S. Santa Fe Ave.
North Long Beach	3648 N. Long Beach Blvd.
Central Los Angeles	1630 N. Main St.
Pico Rivera	3713 B-San Gabriel River Parkway
Rubidoux	5888 Mission Blvd.
West Long Beach	2425 Webster Ave.

At each site, sampling equipment included particulate samplers, VOC canisters, and carbonyl samplers, as well as equipment to measure key meteorological parameters.
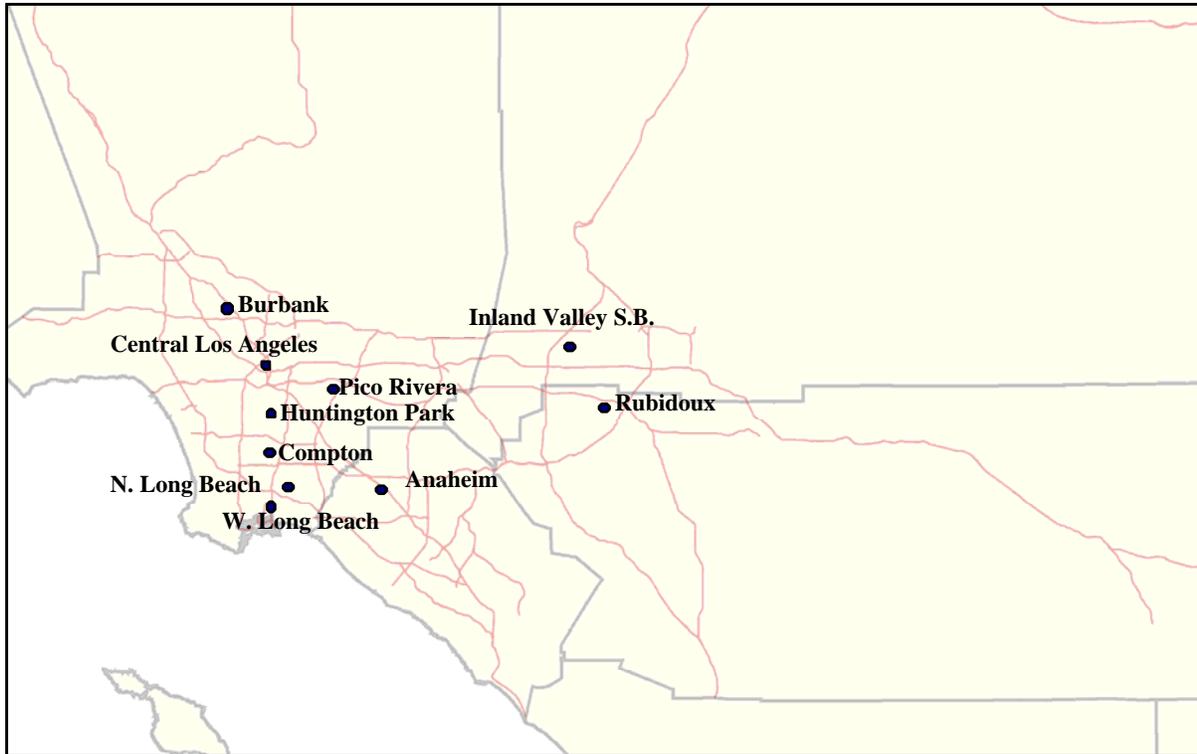
Figure 2-1 Location of MATES IV Monitoring Locations

2.2.1   Local Scale Monitoring

In addition to the 10 fixed sites, mobile monitoring platforms were deployed that focused on local scale studies at locations for short time periods.

Programs such as MATES are designed to monitor and characterize toxic emissions over the entire Basin. However, ambient monitoring is necessarily conducted at a limited number of locations, and modeling is limited to a spatial resolution of 2 km. Communities located very near industrial sources or large mobile source facilities (such as marine ports, railyards and commercial airports) can be affected by higher air contaminant levels than can be captured in the typical MATES analysis. Near-road monitoring studies and dispersion modeling results for point sources indicate that exposure can vary greatly over distances much shorter than 2 km. The local-scale monitoring program of MATES IV aims to characterize the impacts of large sources on nearby communities by utilizing portable platforms designed to sample for a period of several weeks at selected locations with an emphasis on diesel particulate matter (DPM) and ultrafine particle (UFP) emissions. The studies are designed to assess gradients in ambient pollutant levels within communities as well as provide a comparison to the fixed MATES monitoring sites. The communities chosen for sampling were chosen based on proximity to potential sources as well as environmental justice concerns.

A unique set of rapidly deployable mobile air toxics monitoring platforms using the latest technologies for continuous measurements were utilized. Continuous data, combined with continuous meteorological data, is extremely valuable in determining source locations, emission profiles, and exposure variability.

The platforms were equipped with a DustTrak DRX (TSI, Inc.) that measures the mass concentrations of different size fractions of PM continuously. UFP measurements are achieved with a Condensation Particle Counter (CPC, model 3781; TSI, Inc.), which monitors number concentrations of particles down to 6 nm in size and up to concentrations of 500,000 particles per cubic centimeter ($\#/cm^3$). A portable Aethalometer (AE22; Magee, Inc.) for real-time measurements of BC was also installed as an indicator of DPM.

The monitoring sites and results are summarized in Chapter 5.

2.3   Ambient Sampling Schedule

The MATES IV project conducted air toxics monitoring at 10 locations over a one-year period. Sampling for MATES IV followed a one-in-six day, 24-hour integrated-sampling schedule, matching the U.S EPA sampling schedule. As noted previously, black carbon (BC) and ultrafine particles (UFP, particles smaller than 0.1 μm in size) are measured in addition to the air toxics. These measurements are conducted with continuous sampling methods as described below.

All data will be submitted to the U.S. EPA's Air Quality System (AQS) after review and validation. Sampling occurred from July 2012 through June 2013.

2.4   Monitoring and Laboratory Analysis

For MATES IV, meteorological equipment and sampling equipment for canisters, PM_{10} and $PM_{2.5}$ filters, and carbonyl cartridges from the existing air monitoring network were used to the extent possible. The SCAQMD laboratory provided the analytical equipment and conducted the routine analysis. The analytical methods to measure the ambient species are briefly described below and in Table 2-3. Detailed protocols are described in Appendix III.

Table 2-3   Sampling and Analysis Methods for MATES IV

Species	Sampling	Laboratory Analysis
Volatile Organic Compounds (VOCs)	Summa Polished/ Silica-Lined Canisters	Gas chromatograph – Mass spectrometer (GC-MS) with automated pre-concentration and cryo-focusing
Carbonyls	DNPH Cartridge	Solvent recovery and subsequent analysis via high performance liquid chromatography (HPLC)
Hexavalent Chromium	Cellulose Fiber Filters	Treatment with buffer solution to maintain proper pH and then subsequent analysis via ion chromatograph (IC)
Elemental and Organic Carbon	PM Filters	Section of PM filter removed and analyzed on a laser corrected carbon analyzer
TSP Metals	PM Filters	ICPMS
Black Carbon	Continuous	Aethalometer
UFP	Continuous	Condensation Particle Counters

Volatile Organic Compounds
Volatile organic compounds (VOCs) are measured from air samples collected in either summa polished or silica-lined six-liter canisters using an automated canister sampler to fill at a constant rate over a 24-hour time period, depending upon the site. The filled canisters are brought back to the laboratory for analysis within 48 hours of the sample being collected. VOCs are identified

and measured using gas chromatograph mass spectrometry (GC-MS). The SCAQMD currently has two GC-MS instruments running U.S. EPA's TO-14 and TO-15 methods. These instruments are equipped with automated canister pre-concentrators attached to the GC to enable continuous analysis.

Carbonyl Compounds
Carbonyl compounds are sampled by drawing air continuously through a DNPH (2,4-Dinitrophenylhedrazine) cartridge. The carbonyl compounds undergo derivatization with DNPH, and the derivatives are analyzed using High Performance Liquid Chromatography (HPLC) in accordance with U.S. EPA Method TO-11.

PAHS
Naphthalene and other polycyclic aromatic hydrocarbons (PAHs), components of both mobile source and stationary source emissions, were measured at selected monitoring sites.   PAHs were measured at three of the MATES IV monitoring stations: Central Los Angeles, North Long Beach, and Rubidoux. Samples were collected and analyzed under the EPA NATTS Program. The Central Los Angeles and Rubidoux sites are part of the NATTS network, and the Long Beach site was added for a period of one year coinciding with the MATES IV monitoring.

Hexavalent Chromium
Hexavalent chromium (Chrome VI) is analyzed using ion chromatography (IC). Sample collection involves drawing air at a prescribed rate for 24 hours through a cellulose fiber filter. The filter is treated with sodium bicarbonate to prevent conversion of Chrome VI to Chrome III. Chrome VI is extracted from the filter by sonication and subsequently analyzed using IC.

Particulate Matter
Total suspended particulates (TSP), particulates less than 10 microns (PM_{10}) and particulates less than 2.5 microns ($PM_{2.5}$) are collected separately over a 24-hour period using size selective inlets according to U.S. EPA's Federal Reference Methods (40CFR50).

Metals in TSP samples are determined using ICPMS, and metals in $PM_{2.5}$ samples are determined by Energy Dispersive X-Ray Fluorescence Spectrometry. Identification of ions within the PM samples is performed by IC.

Carbon analysis is conducted by taking a small circular disk from sampled PM_{10} or $PM_{2.5}$ filters. The small circular disk is placed into a carbon analyzer which utilizes thermal optical transmittance method (IMPROVE method) to measure the OC and EC content of the filter.

BC and UFP
BC measurements were carried out using Aethalometers.   Briefly, this instrument utilizes the light-absorbing properties of BC which is related to the particulate BC mass concentration.

UFP number concentration data were collected continuously (i.e. one-min. time resolution) using water-based Condensation Particle Counters. This instrument provides the total number concentration of particles above 7 nm in real-time.

Additional details of the methods are in Appendix III.

Results for the BC and UFP monitoring are summarized in Chapter 5.

Diesel Particulate Matter
For MATES II, diesel PM was estimated using ambient measurements of EC combined with Basin-wide EC emissions inventories to determine the contribution of diesel emissions to ambient PM levels. For MATES III, several methodologies to assess the levels of diesel PM were explored. These methods included the following:

- Using ambient EC levels as in MATES II
- Using ambient EC and the ratio of $PM_{2.5,}$ EC, and diesel PM emissions from the 2005 emissions inventory
- Using the EPA Chemical Mass Balance model (CMB) to apportion source emissions to $PM_{2.5}$

Based on the results of these analyses, the CMB and the ratio of EC to diesel PM from the emissions inventory were used to estimate ambient levels of diesel PM in MATES III. The overall Basin average was nearly the same for these methods. Given this close correspondence, the method based on the ratio of EC to diesel PM emissions, updated with the most recent emissions inventory, was used for the MATES IV diesel PM estimates.

2.5   Quality Assurance and Quality Control (QA/QC)

The SCAQMD is one of the four Primary Quality Assurance Organizations (PQAO) responsible for air monitoring in California, and is committed to achieving the highest possible data quality level in the MATES and several other environmental monitoring programs. The Quality Management Plan (QMP), which is the foundation document for ensuring high quality and defensible data (approved in 2009) presents SCAQMD quality system and describes the organizational structure, functional responsibilities of management and staff, lines of authority, and general methodology for assessing all activities conducted in support of air monitoring and analysis, air quality assessment and other environmental measurement activities conducted by the agency.

The quality goals and QA requirements for the particle and gaseous pollutants measured during MATES are found in various Quality Assurance Project Plan (QAPP) documents as outlined in the following paragraphs. These QAPPs also describe the responsibilities within the organization for carrying out each program and meeting specific QA/QC objectives. They address the Data Quality Objectives (DQOs) of accuracy, bias, comparability, completeness, detectability and representativeness, list the Method Quality Objectives (MQOs) of precision, bias, completeness, sensitivity and, where applicable, flow rate accuracy for the analytes of interest. They document the Standard Operating Procedures (SOPs) and Operational Assistance Guides (OAGs) which are directions for specific performing measurement activities. Finally, they list the required QA/QC requirement for each activity and provide instructions for data review, QA oversight, and corrective actions.

The quality goals and QA requirements (with the exception of siting) for monitoring ambient levels of volatile organic compounds (VOCs), carbonyls, hexavalent chromium , and polycyclic aromatic hydrocarbons (PAHs) were adopted from the U.S. EPA National Air Toxics Trends Stations (NATTS) Program. These requirements can be found in the SCAQMD NATTS QAPP,

which was last revised in 2013 and is currently under review by the U.S. EPA Region 9.

The quality goals and QA requirements (with the exception of siting) for monitoring the main components of fine particulate matter ($PM_{2.5}$) including Organic and Elemental Carbon (OC/EC), Anions and Cations, and trace metals were adopted from the U.S. EPA Chemical Speciation Network (CSN) program. These requirements can be found in the SCAQMD $PM_{2.5}$ Speciation QAPP, which was last revised in 2013 and was approved by the U.S. EPA Region 9 in 2014.

The quality goals and QA requirements (with the exception of siting) for monitoring fine and coarse PM ($PM_{2.5}$ and PM_{10} FRM) were adopted from the U.S. EPA Criteria Pollutant Monitoring Program. These requirements can be found in the SCAQMD Criteria Pollutant Monitoring Program QAPP, which was last revised in 2012 and approved by the U.S. EPA Region 9 in 2013.

The quality goals and QA requirements (with the exception of siting) for monitoring ultrafine particles (UFPs) and black carbon (BC) can be found in the SCAQMD Special Monitoring Program QAPP, which also describes the protocols and procedures followed by SCAQMD for monitoring other "non-criteria" pollutants and performing short-term measurement studies similar to those conducted during MATES IV (see Chapter 5 for details). The current version of this QAPP was last revised in 2013 and is currently awaiting approval by the U.S. EPA Region 9.

The SCAQMD objectives, procedures, documentation, and data review techniques assure the MATES program will produce data that are accurate, precise, reliable and legally defensible. The technical procedures for QA/QC include annual system audits on all equipment in the laboratory and at all MATES sampling sites. Quality control procedures also include proper record keeping, standard checks, routine calibrations of the sampling and analytical equipment, and collecting collocated samples at regular intervals.

2.6   Findings

The findings are presented in terms of the annual average concentrations of air toxics measured at each site as well as Basin-wide, and then by the estimated cancer risks resulting from exposures to these average concentrations. Air toxic levels are also compared to levels found in the MATES II and the MATES III Studies to assess trends in levels of air toxics in the Basin. In the following charts, the error bars denote the 95% confidence interval of the average. In general, concentrations of most toxics substantially decreased compared to levels measured previously.

2.6.1   Volatile Organic Compounds (VOCs)

Figures 2-2 and 2-3 present levels for benzene and 1,3-butadiene, which are emitted predominantly from gasoline-powered mobile sources. Benzene shows a continuing reduction in annual average levels. These decreases are likely reflective of reduced emissions from vehicle fleet turnover to newer vehicles and use of reformulated gasoline. 1,3-butadiene shows a similar annual level compared to MATES III. This may in part be due to challenges of measuring low levels of this substance and its high reactivity.

Levels of the chlorinated solvents perchloroethylene and methylene chloride are shown in Figures 2-4 and 2-5. Perchloroethylene shows a continuing reduction in levels, likely a result of a number of air quality rules leading to the gradual phase-out of its use as an industrial and dry cleaning solvent in the South Coast. Methylene chloride shows similar levels on average, with some sites showing increased averages. These levels likely reflect the use as a solvent and may be influenced by specific activities near the monitoring locations.

Formaldehyde and acetaldehyde concentrations are shown in Figures 2-6 and 2-7. There was a reduction in the average levels compared to the MATES II and MATES III Studies. Formaldehyde is emitted from mobile sources and is also formed as a secondary pollutant through chemical reactions in the atmosphere.

2.6.2   Metals

Levels of several air toxic and other metals are shown in Figures 2-8 to 2-12.

The air toxics arsenic and cadmium levels are shown in Figures 2-8 and 2-9. Both metals show declines, but for cadmium this may be more affected by improved analysis techniques allowing for lower reporting levels for MATES IV compared to previous studies.

Figures 2-10 and 2-11 show the levels of two more air toxics, lead and nickel. Lead concentrations were reduced compared to MATES II and III, and the values are well below the Ambient Air Quality Standard for lead of 150 ng/m^3. Nickel concentrations also decreased Basin-wide and at most sites.

Hexavalent chromium concentrations are shown in Figure 2-12. It should be noted that as found in previous studies, localized increases in hexavalent chromium can occur near facilities using hexavalent chromium-containing materials, such as metal platers, facilities using chromium containing paints, or cement manufacturing plants. The monitoring locations in this study, however, are focused on regional levels of air toxics. Thus, localized areas of increased exposure may not be picked up in the monitoring. The annual averages at the monitoring locations were substantially lower than the previous MATES studies. This may be due in part to better sampling and analysis methods with lower blank sample levels as well as ongoing emissions reductions (see discussion below).

For the MATES III Study, the Rubidoux site showed an increase in average hexavalent chromium levels which were eventually traced to cement plants in the area. This led to the adoption of amendments to SCAQMD rules for cement facilities addressing hexavalent chromium emissions. The levels from MATES IV reflect these rule changes as well as reduced activity at the cement plants with hexavalent chromium levels greatly reduced and now comparable to those of other sites.

In previous studies, it was recognized that there can be a measurable value for hexavalent chromium in unsampled (blank) filters. To determine the extent of this, trip blanks were periodically taken and the average values are also shown in Figure 2-12. Note that the blank values have been substantially reduced with improvements in the measurement methodologies. These include more sensitive instrumentation, and a rigorous washing of the collection filters before use. When estimating risk from exposure to hexavalent chromium, the average blank

value is subtracted from the site averages.

2.6.3   Elemental Carbon

Elemental carbon (EC) was measured in $PM_{2.5}$ samples as well as the PM_{10} samples. The results are shown in Figures 2-13 and 2-14. Both showed significant reductions in average levels compared to previous studies. PM_{10} EC was lower by about 25% compared to the MATES III levels, and $PM_{2.5}$ EC was lower by 35%. These reductions are likely due to reduced emissions from mobile sources, including diesel fueled vehicles, as a result of various rules limiting emissions.

2.6.4   Diesel PM

In the MATES II Study, EC was used as a surrogate for diesel particulate levels, as staff determined that this was the best method available during the MATES II Study. For the MATES III Study, staff also used the Chemical Mass Balance (CMB) source apportionment technique to estimate the contribution from diesel, as well as from other major source categories, to the measured particulate levels. The CMB model was utilized based on the recommendation of the MATES III Technical Advisory Group.

To compare the different methods to estimate diesel particulate levels, the method used in MATES II, which was based on the emissions ratios of diesel particulate and elemental carbon from a study conducted in the South Coast in the 1980's, and a method based on the ratio of $PM_{2.5}$ emissions from the 2005 emissions inventory were also calculated. For MATES II, the $PM_{2.5}$ elemental carbon levels were multiplied by 1.04 to estimate diesel particulate. For MATES III, the 2005 inventory resulted in a ratio of diesel particulate to elemental carbon emissions of 1.95. The CMB model used in MATES III used several measured species of $PM_{2.5}$ compared to $PM_{2.5}$ emissions source profiles to estimate the contribution of these sources to ambient $PM_{2.5}$ levels.

The MATES III estimates using the ratio and CMB methods were compared and are shown in Table 2-4.

As shown in the table, both the CMB model and the updated $PM_{2.5}$ emissions ratio method gave comparable estimates of the overall average for DPM.

Table 2-4 MATES III Estimates of Average Diesel PM, μg/m3

Estimation Method	MATES III Year One	MATES III Year Two
MATES II method: PM_{10} EC x 1.04	2.18	2.14
2005 Inventory: $PM_{2.5}$ EC x 1.95	3.37	3.70
CMB	2.87 – 3.13	3.52 – 3.84

Given the comparability found in MATES III, the expense of the CMB analysis, and in consultation with the MATES IV Technical Advisory Group, DPM in the MATES IV Study was estimated using the ratio of the emissions of diesel particulate to elemental carbon in the $PM_{2.5}$ fraction (updated for the 2012 emissions inventory) multiplied by the ambient levels of $PM_{2.5}$ EC

to give an estimate of ambient DPM. The complete 2012 emissions estimates are provided in Appendix VIII and the total emissions and resulting ratio are shown in Table 2-5.

Table 2-5 2012 Emissions of Diesel PM and EC, lbs./day

$PM_{2.5}$ Diesel PM	$PM_{2.5}$ EC	DPM/EC Ratio
18,867	23,163	0.815

To compare the estimated diesel PM levels from MATES IV and MATES III, the emissions ratio method was applied to the $PM_{2.5}$ EC levels. These estimates are shown in Figure 2-15. Since there were changes in both the $PM_{2.5}$ EC as well as the emissions inventory ratio of EC to DPM, the reductions in diesel PM ambient concentration estimates are larger than the declines in EC levels. The concentrations of diesel PM were thus about 70% lower in MATES IV compared to MATES III. This difference is consistent with that of the emissions inventory, which showed a decline in diesel $PM_{2.5}$ emissions of about 66% from the 2005 inventory to the 2012 inventory. Additional discussion of this approach is in Appendix XI.

2.6.5   Naphthalene and Other PAH Compounds

Limited measurements of naphthalene and other PAHs (polycyclic aromatic hydrocarbons) were taken at three sites, as shown in Figure 2-16.

Naphthalene levels were on average much higher than that of other PAHs, in line with previous observations in the Basin. For the three sites, Central Los Angeles showed the highest average levels of naphthalene. A similar pattern for the sum of the other PAHs was found. Figure 2-16 also shows the comparison with MATES III data indicating that levels were generally lower during the MATES IV time frame. The levels of naphthalene, for example, were lower in MATES IV by about 25% at the Central Los Angeles site and lower by about 46% at the Rubidoux site.

2.7   Cancer Risk Estimates

There are inherent uncertainties in risk assessment, as discussed in the Introduction of this report and in the OEHHA Air Toxics Hot Spots Program Risk Assessment Guidelines (August 2003)[1]. Despite these uncertainties, risk assessment remains the most useful tool to estimate the potential health risks due to low level environmental exposures. This tool is also useful as a yardstick to measure progress in attaining healthful air quality.

In the MATES II and III Studies, cancer risks were estimated for exposure to the measured ambient levels of air toxics. The estimates assume that a lifetime exposure (70 years) occurs at these levels, consistent with guidance on risk assessment established by OEHHA. We use the same methodology to estimate risks from the levels of toxics measured during MATES IV.

Figures 2-17 and 2-18 show the estimated cancer risks for the toxics measured at each site for the MATES IV Study. Included for the three sites where measurements were taken are the risks

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[1] California Environmental Protection Agency Office of Environmental Health Hazard Assessment, Air Toxics Hot Spots Program Risk Assessment Guidelines. The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments. August 2003.

from naphthalene and other PAHs for which there are adopted cancer potency values. The sites average includes the PAHs using the three-site average value. Note that the PAHs are relatively small contributors to the overall average risk. The average level of naphthalene, the largest contributor, was 104 ng/m^3 across the three sites. This equates to a 70-year risk of about three in one million.

Average risks are dramatically reduced from previous studies. The average risk is about 420 per million. This compares to about 1,400 per million in the MATES II Study, and about 1,200 per million in the MATES III Study. As shown in the charts, diesel particulate has been and still is the major contributor to air toxics risk, and the bulk of the reductions in risks can be attributed to lower levels of ambient diesel particulate. It should be noted that different methods were used to estimate diesel particulate levels in the MATES II Study, so the results are not strictly comparable. However, based on the discussion above, the MATES II Study method may have underestimated the levels of diesel particulate.

On average, diesel particulate contributes about 68% of the total air toxics risk. This is a lower portion of the overall risk compared to the MATES III estimate of about 84%.

2.7.1   Updates to Cancer Risk Estimation Methods

Staff notes that after the Draft MATES IV Report was released, OEHHA updated the methods for estimating cancer risks.[2] The revised method includes utilizing higher estimates of cancer potency during early life exposures. There are also differences in the assumptions on breathing rates and length of residential exposures. When combined together, staff estimates that risks for the same inhalation exposure level are about 2.5 times higher using the proposed updated methods.[3] This would be reflected in the average lifetime air toxics risk estimated from the monitoring sites data going from 418 per million to 1023 per million. The previous method is used to compare results with past studies throughout this report. However, whether the previous method or the updated method is applied, the same relative changes in risks would result when compared to previous MATES study measurements.

A comparison of risks using the updated methodology for the 10 monitoring sites is shown in Figure 2-19.

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[2] California Environmental Protection Agency Office of Environmental Health Hazard Assessment, Air Toxics Hot Spots Program Risk Assessment Guidelines.   The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments, February, 2014

[3] In the October, 2014 Draft MATES IV Report, the increased in risk estimates was given as a 2.7 fold increase. This was based on using the 90th percentile of breathing rate distribution. In anticipation of CARB guidance for risk management, we have used the 80th percentile of the breathing rate distribution for ages greater than 2 years. This resulted in a 2.45 fold change in the estimate of risk.
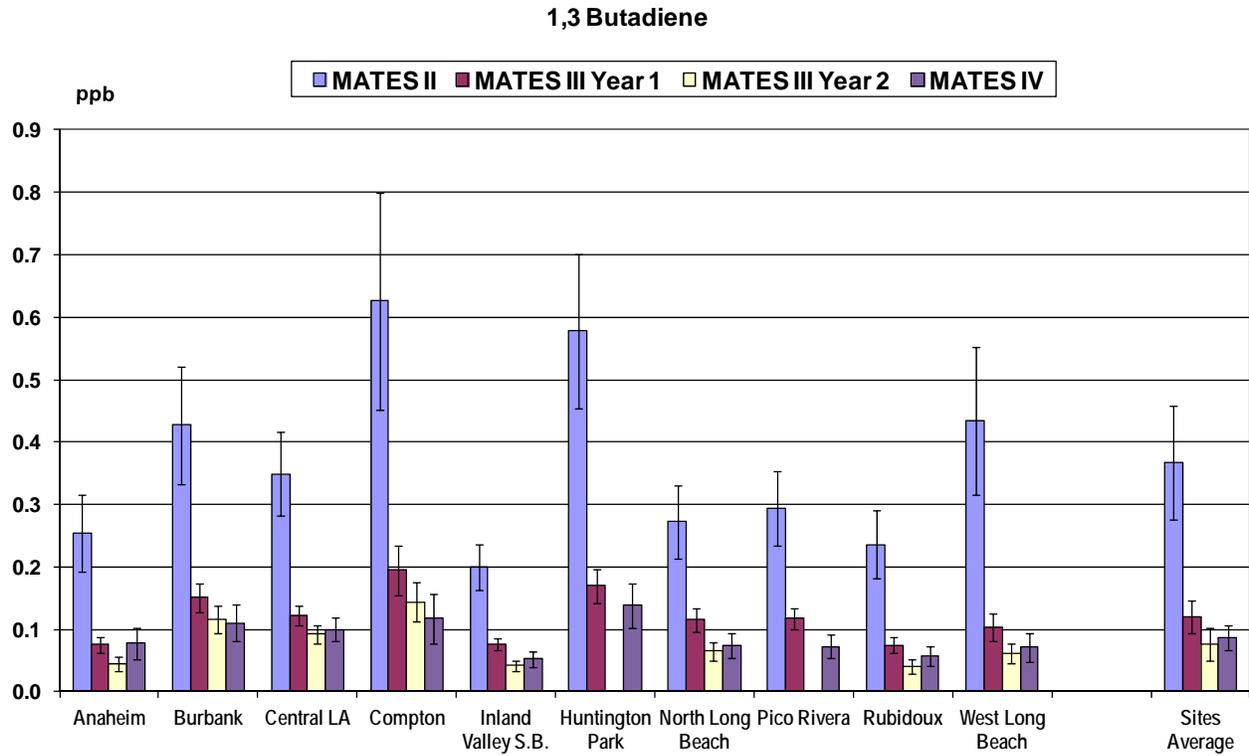
1,3 Butadiene

Figure 2-2 Average Concentrations of 1,3-Butadiene
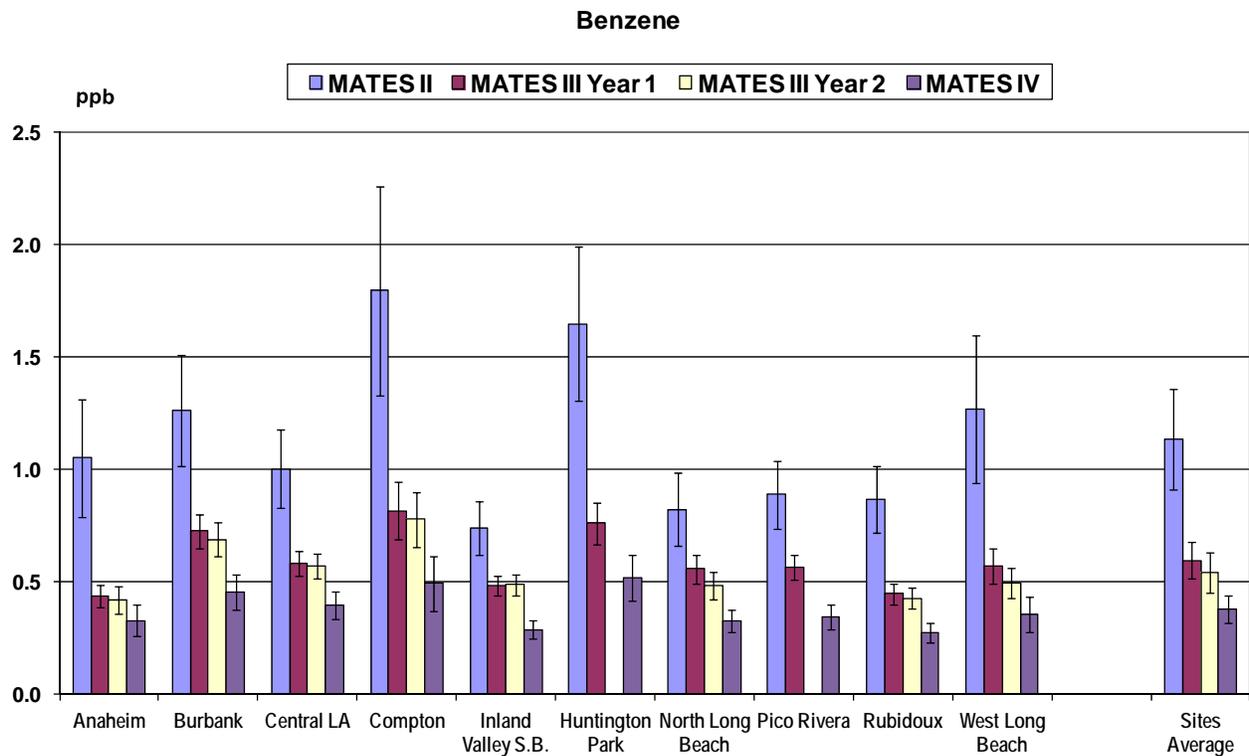
Benzene

Figure 2-3 Average Concentrations of Benzene

Perchloroethylene
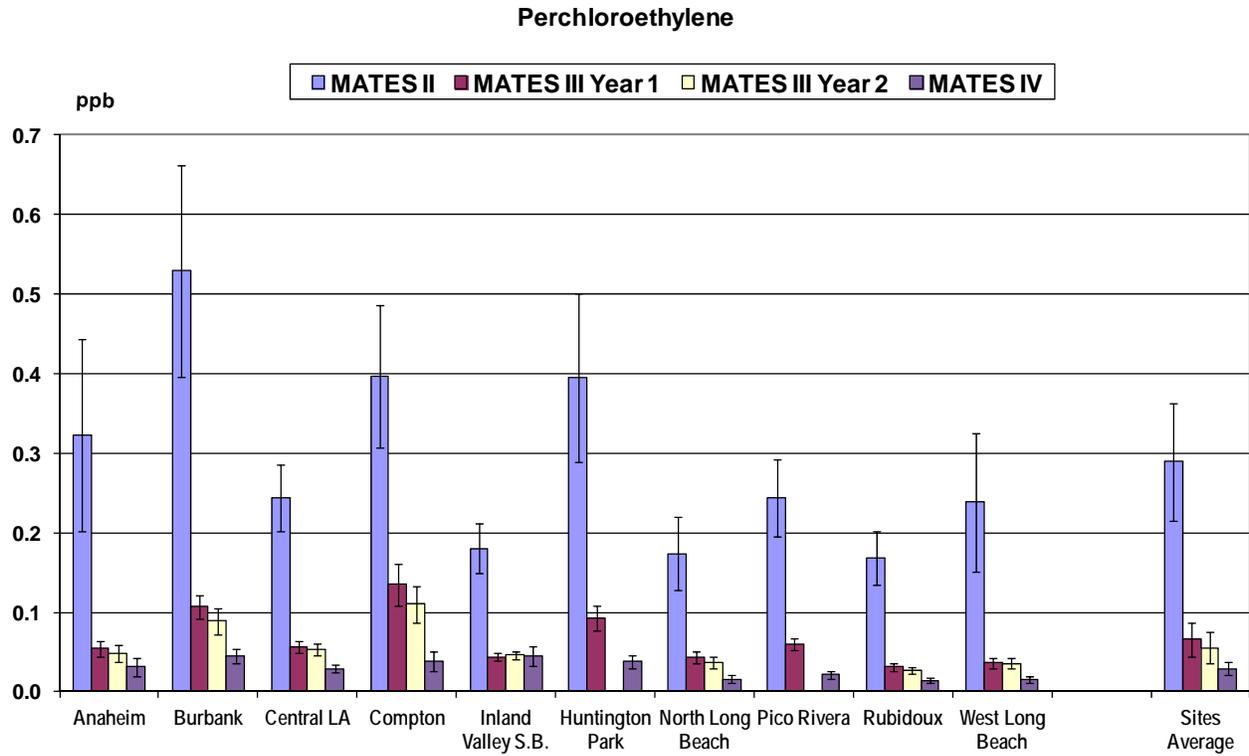
Figure 2-4 Average Concentrations of Perchloroethylene

Methylene Chloride
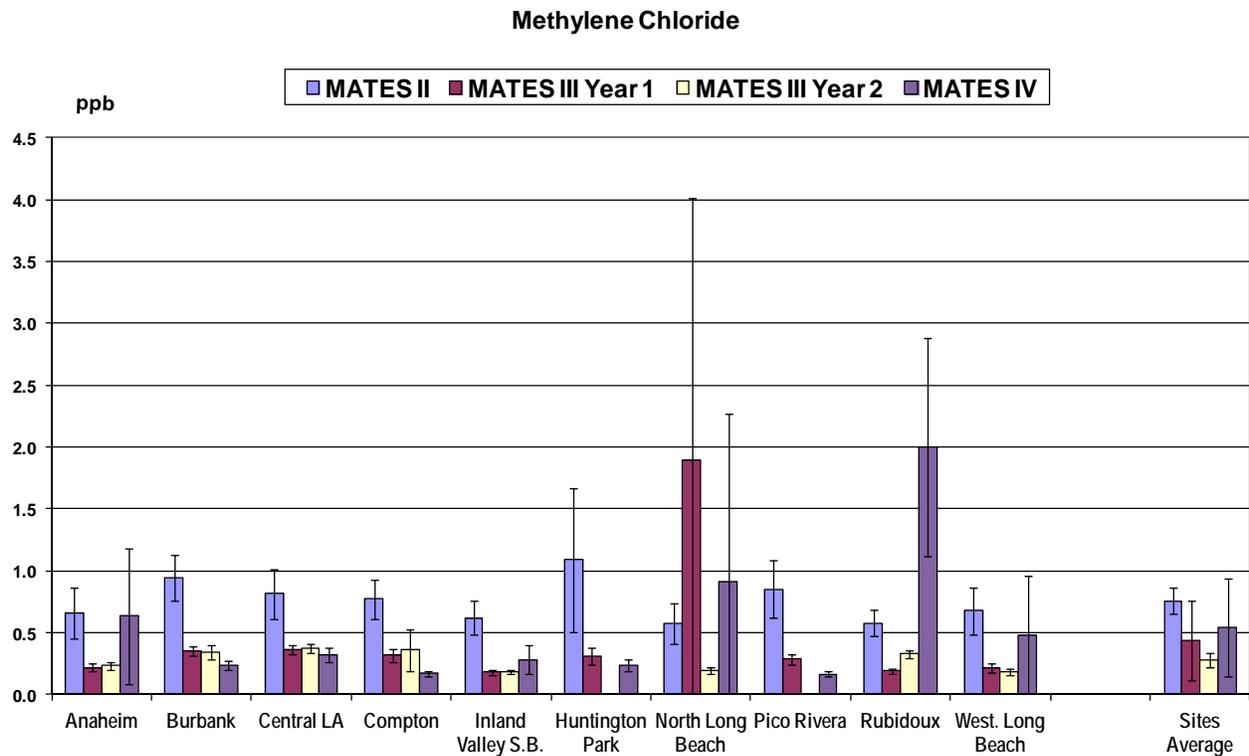
Figure 2-5 Average Concentrations of Methylene Chloride
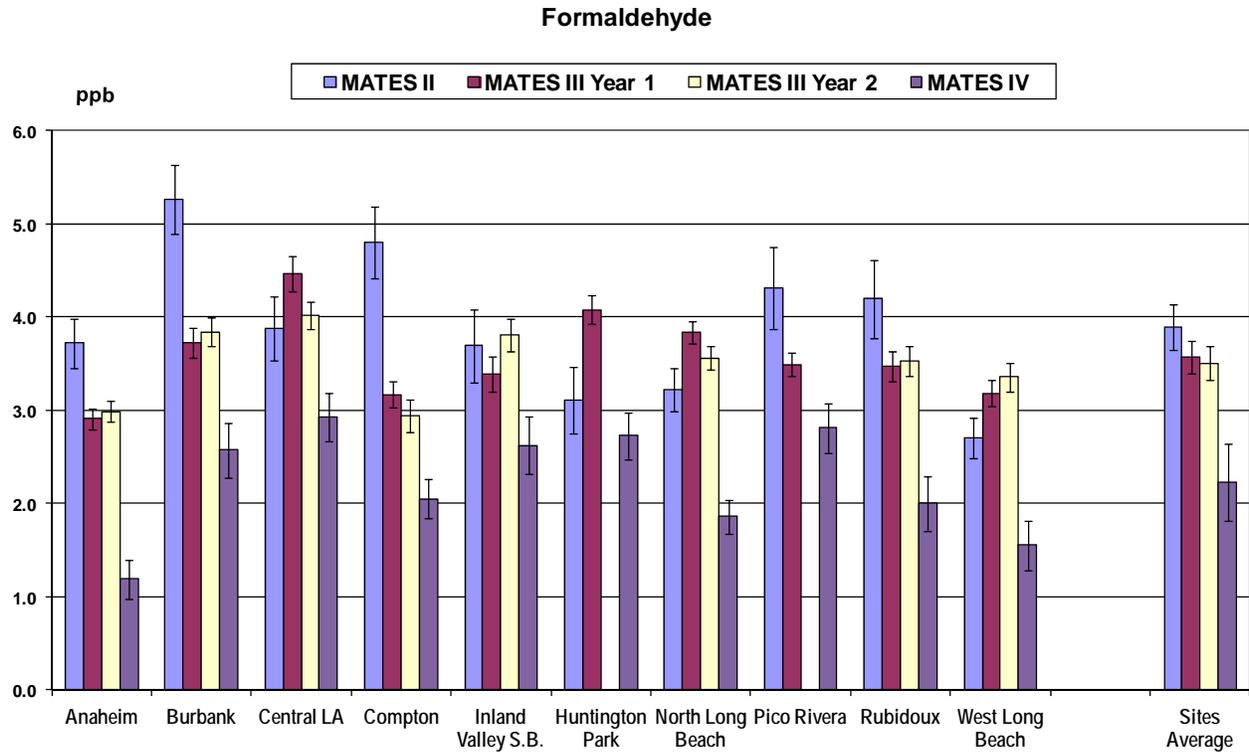
Formaldehyde

Figure 2-6 Average Concentrations of Formaldehyde
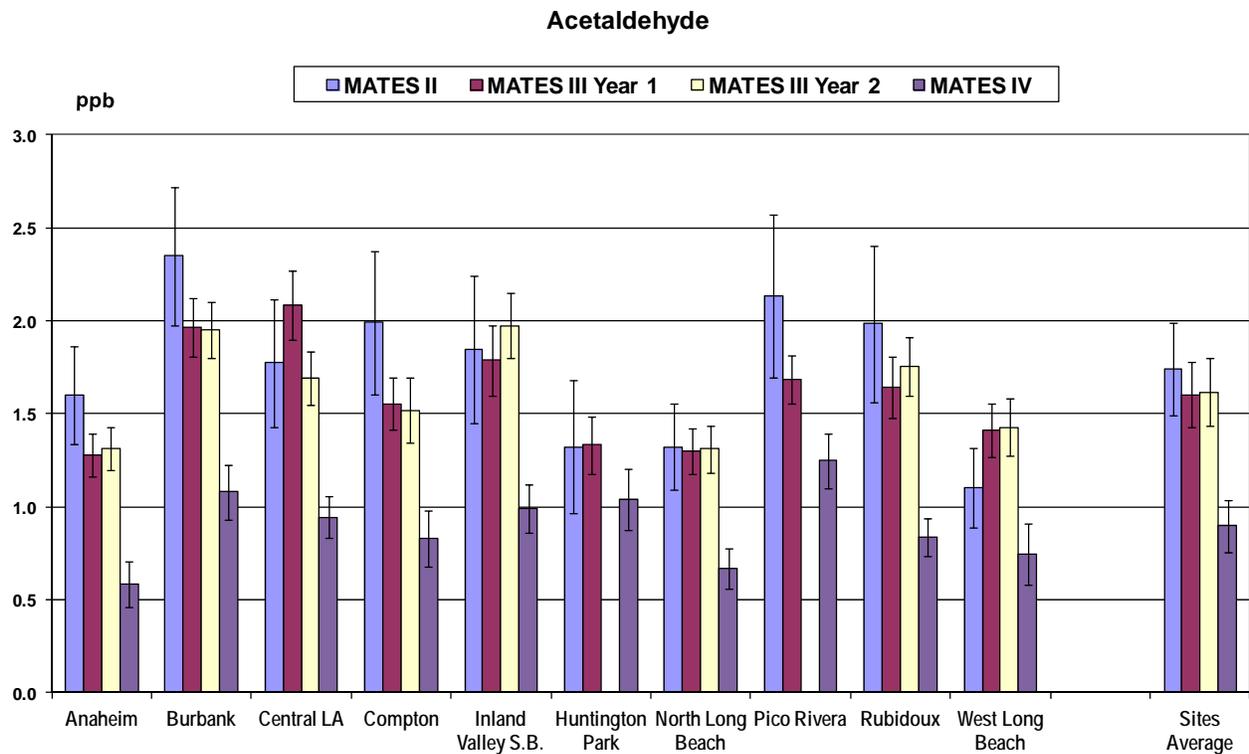
Acetaldehyde

Figure 2-7 Average Concentrations of Acetaldehyde
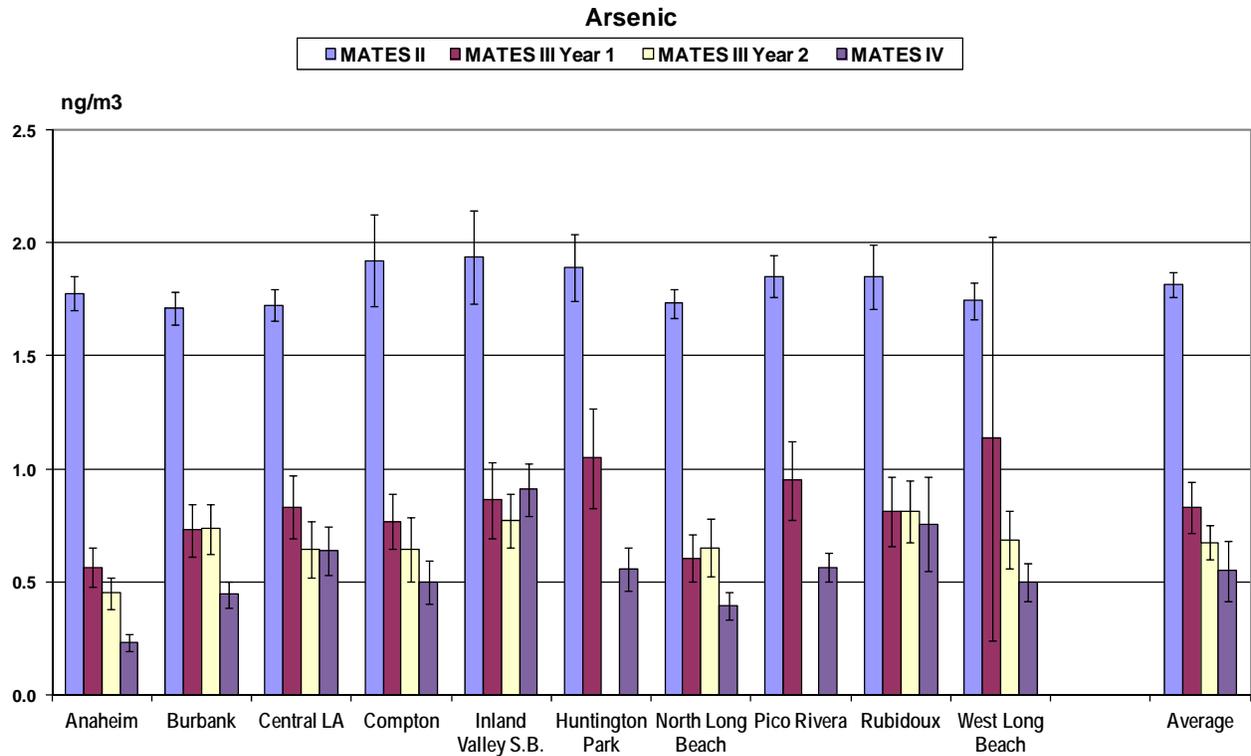
Arsenic

Figure 2-8 Average Concentrations of Arsenic in Total Suspended Particulate (TSP)
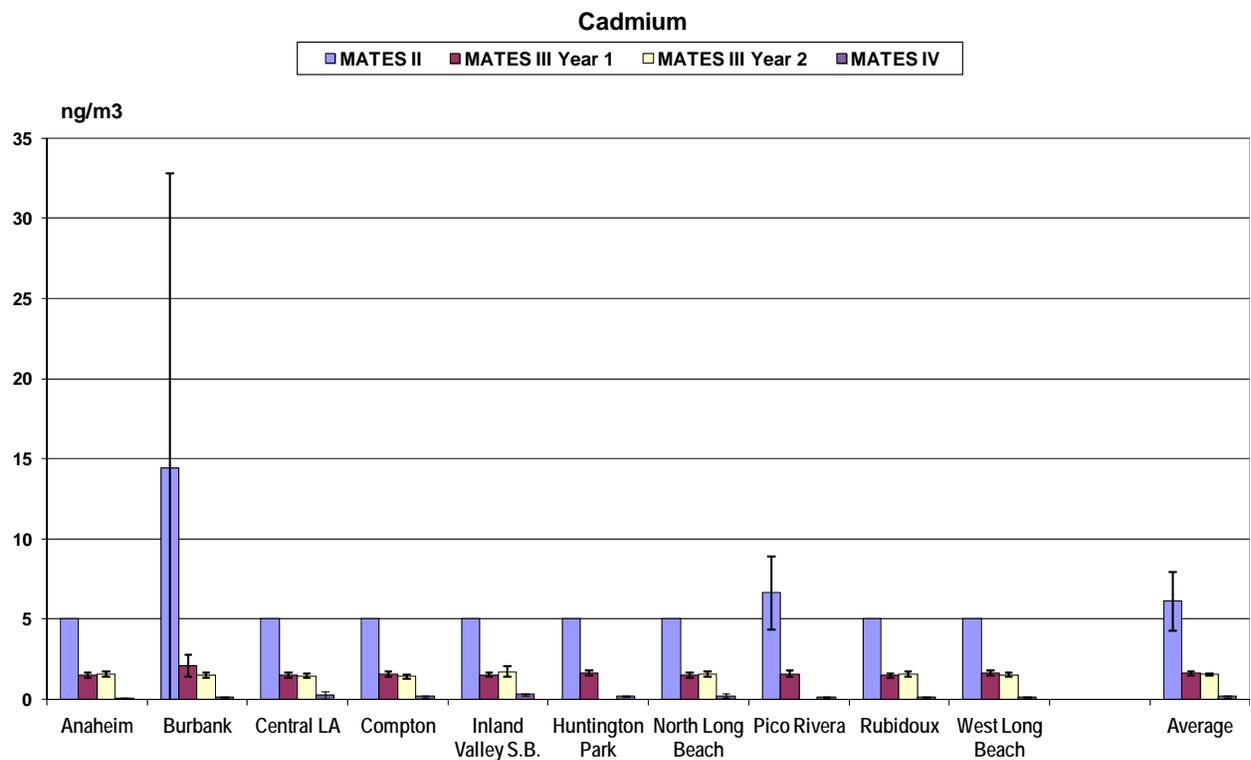
Cadmium

Figure 2-9 Average Concentrations of Cadmium in Total Suspended Particulate (TSP)
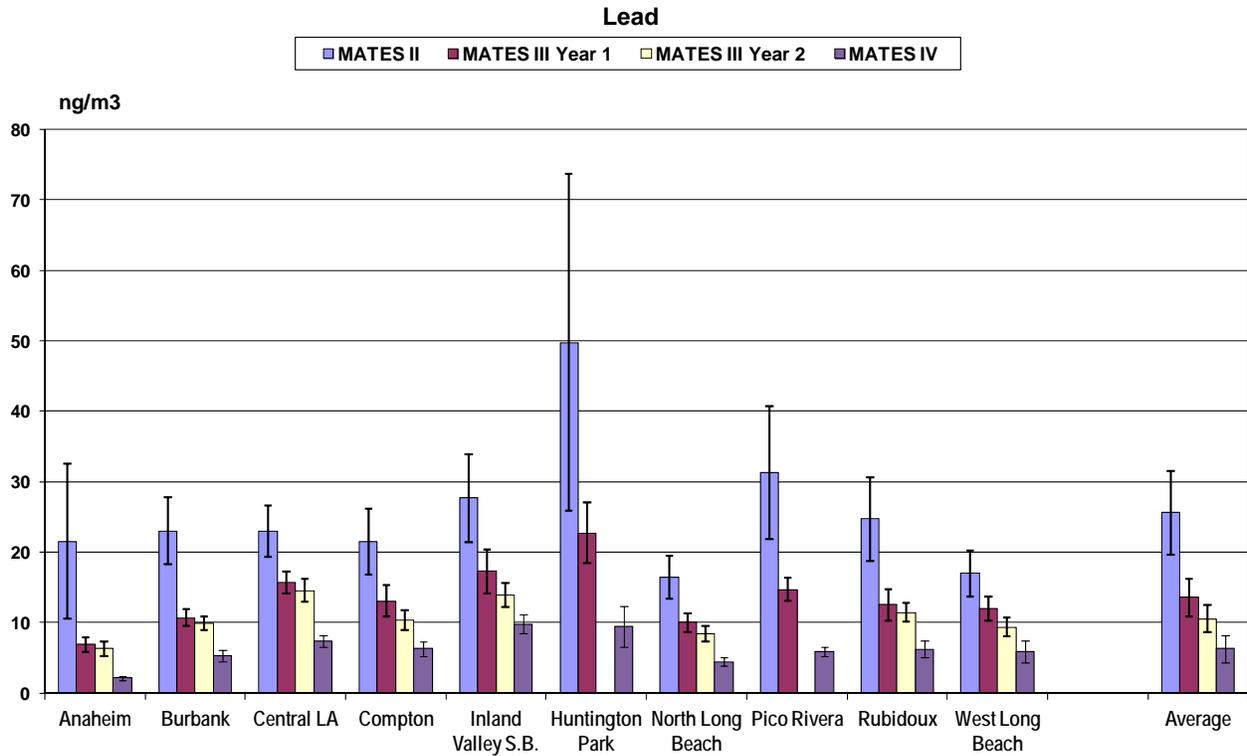
Lead

Figure 2-10 Average Concentrations of Lead in Total Suspended Particulate (TSP)
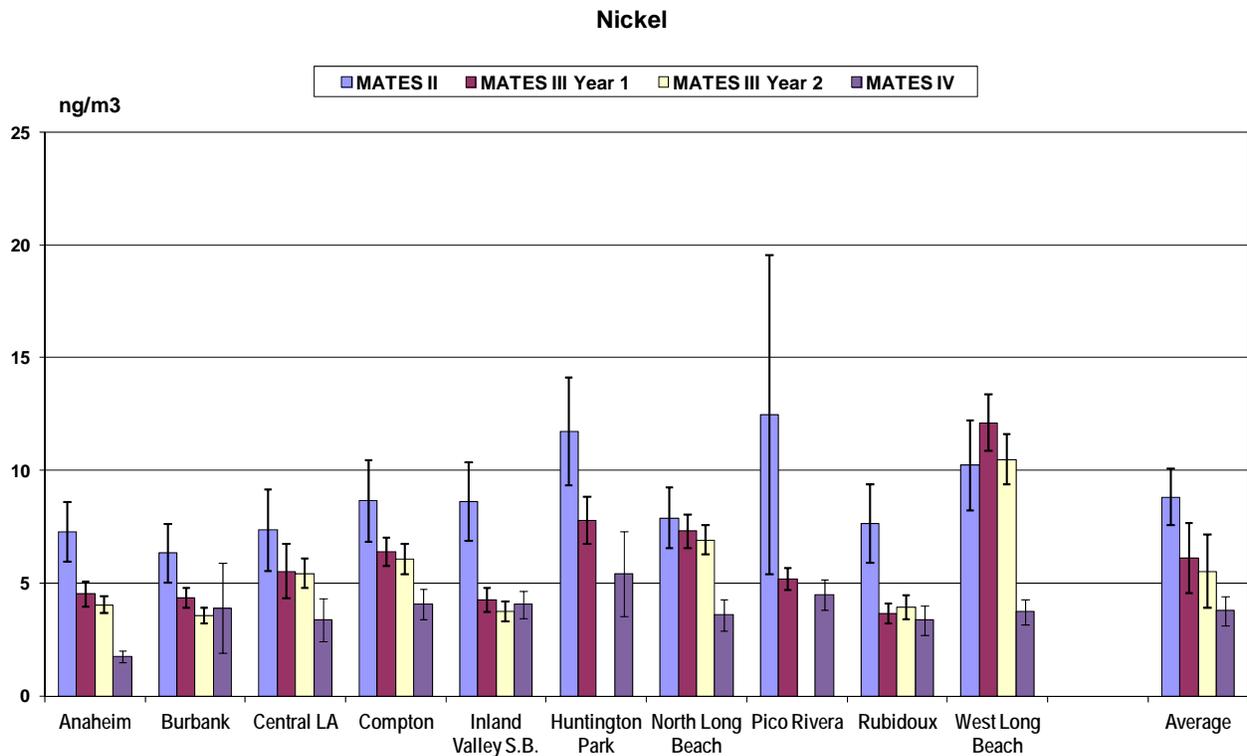
Nickel

Figure 2-11 Average Concentrations of Nickel in Total Suspended Particulate (TSP)

Hexavalent Chromium
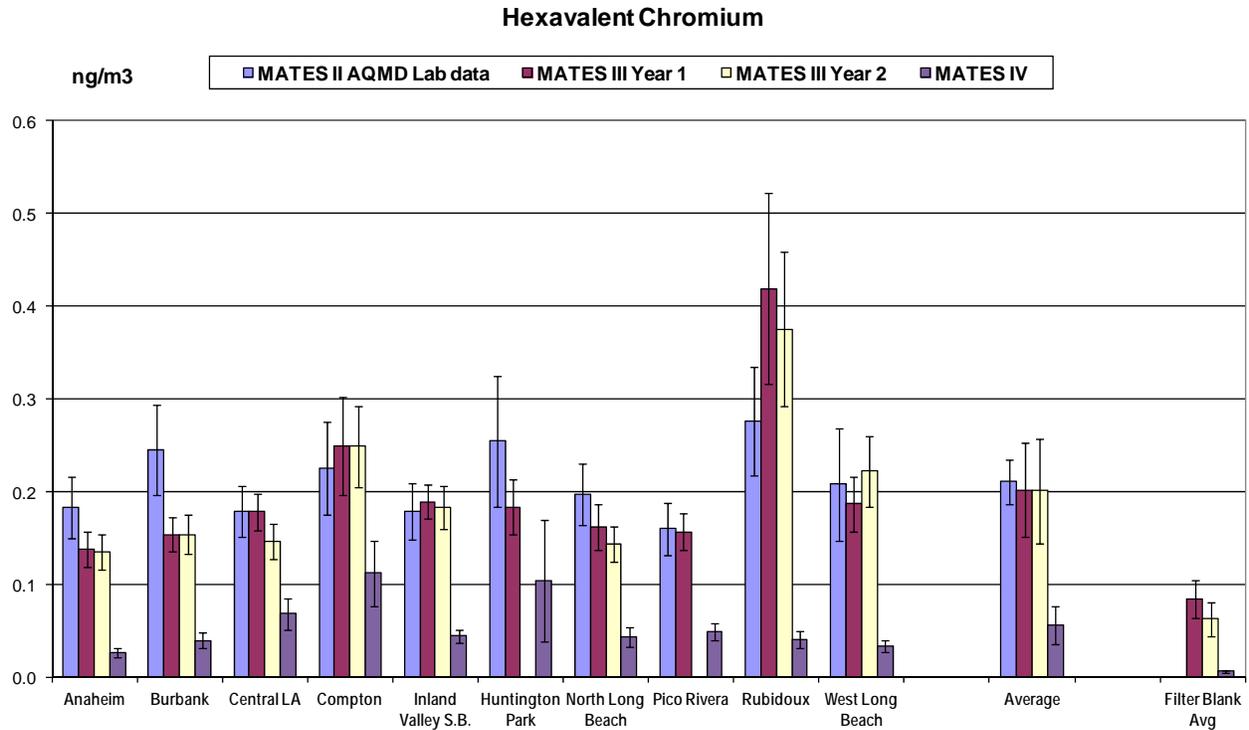
Figure 2-12 Average Concentrations of Hexavalent Chromium in Total Suspended Particulate (TSP)

Elemental Carbon - PM10
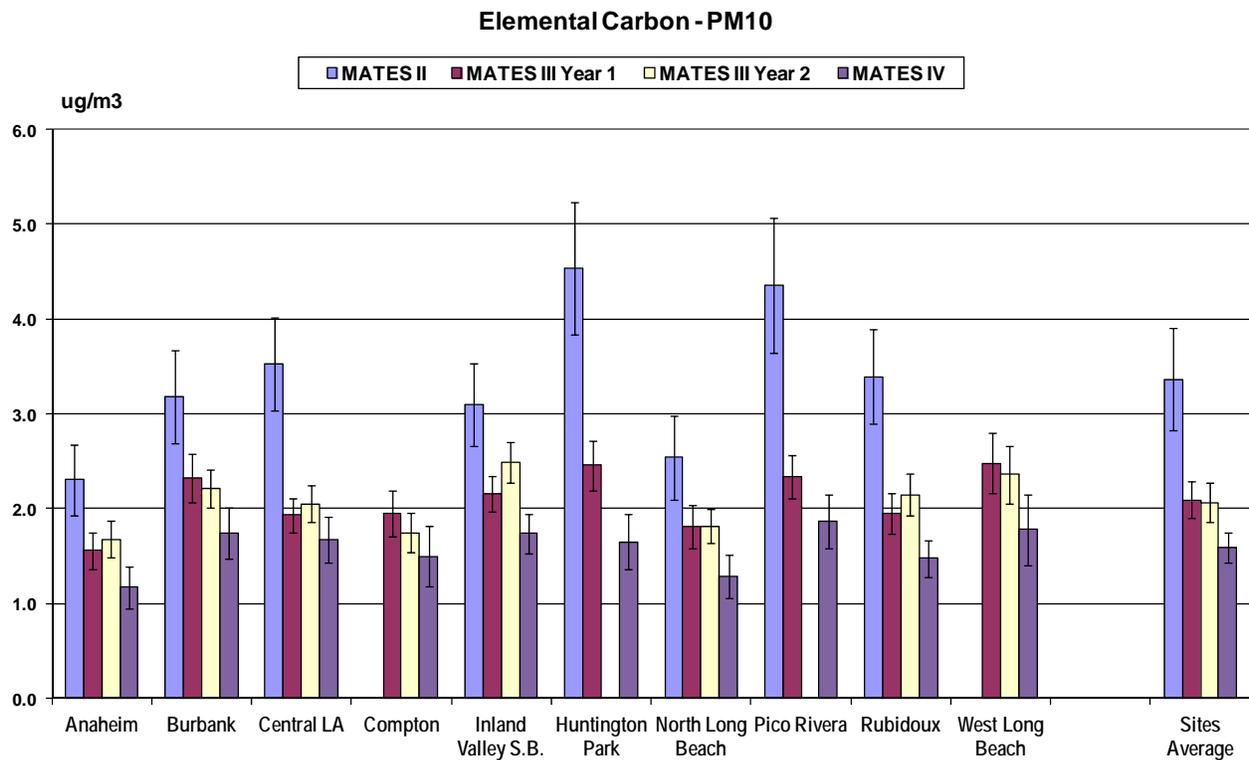
Figure 2-13 Average Concentrations of PM₁₀ Elemental Carbon (EC)

EC PM2.5
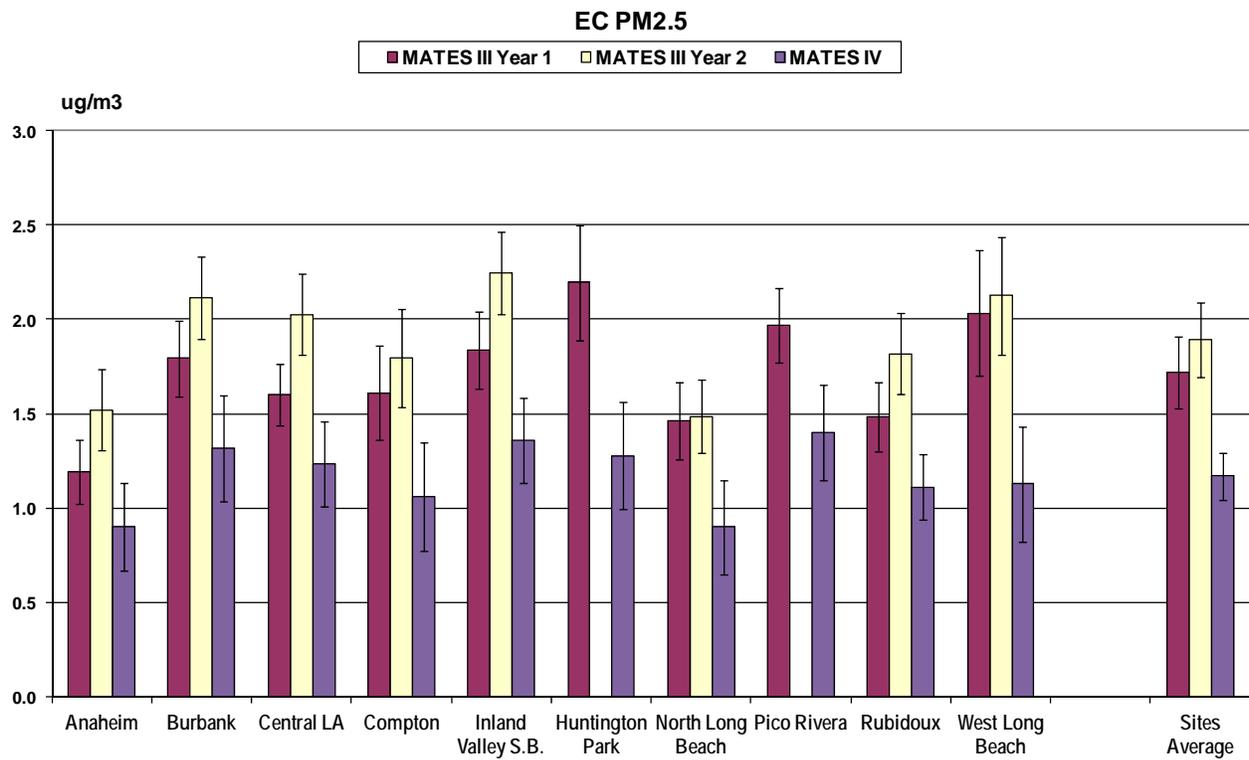
Figure 2-14 Average Concentrations of PM$_{2.5}$ Elemental Carbon (EC)

Diesel PM Estimates
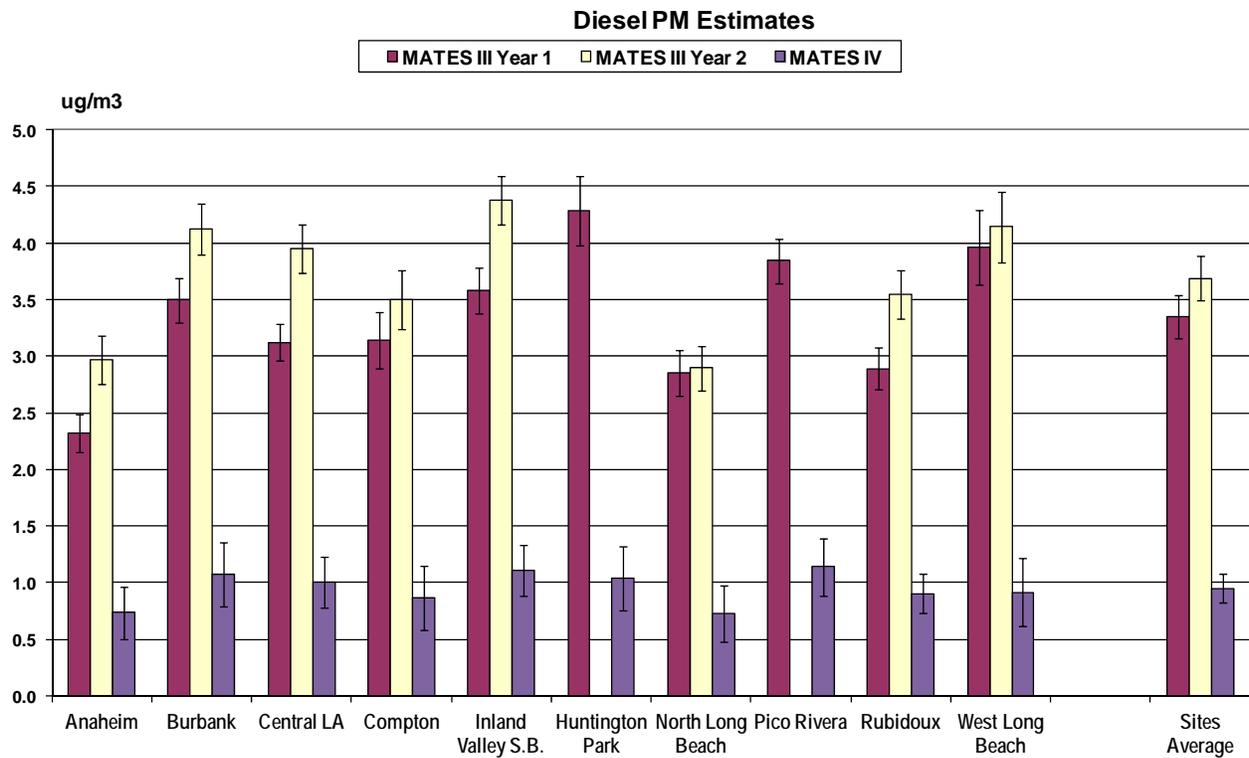
Figure 2-15 Average Concentrations for Diesel PM Based on Emissions Ratio Method

2-18
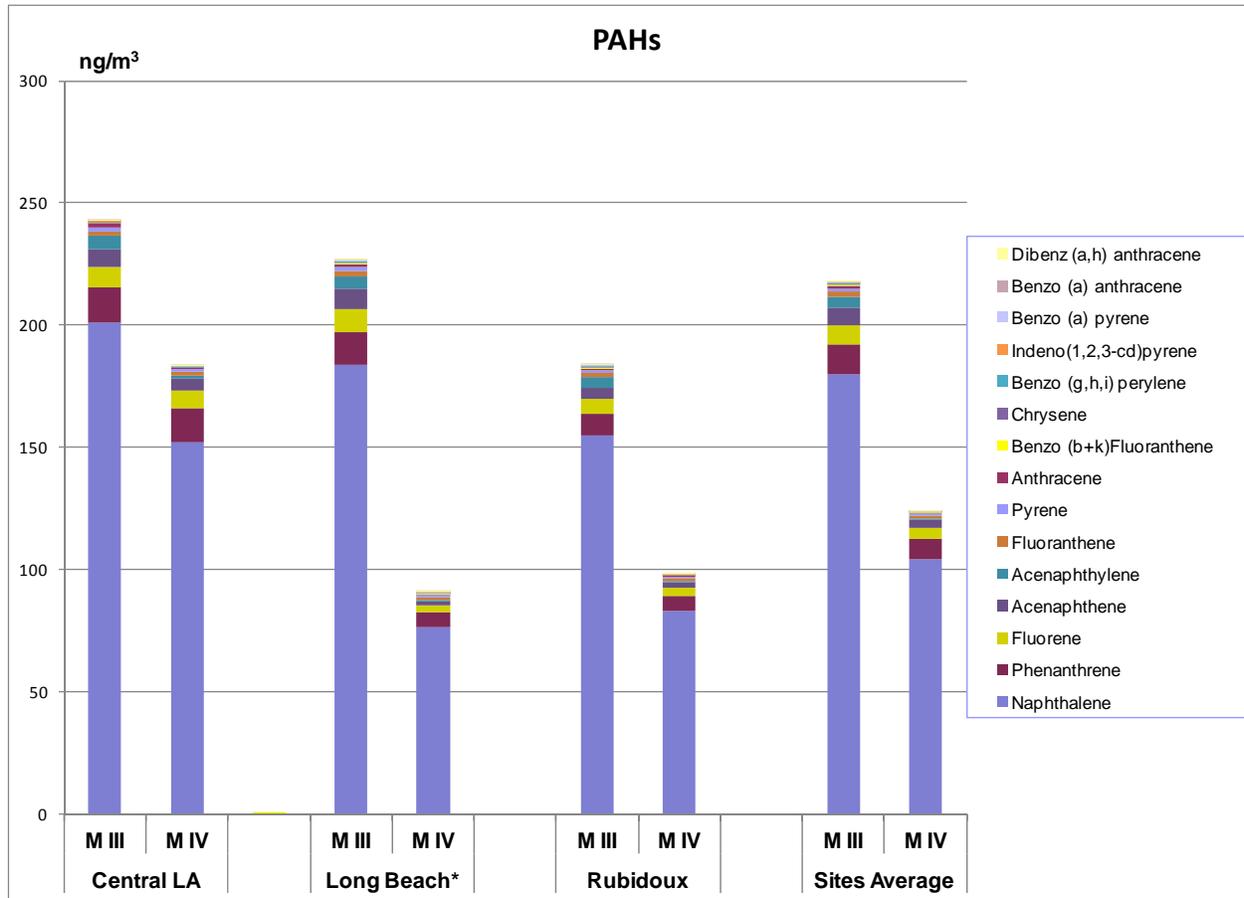
* MATES III site was at West Long Beach, and MATES IV site was at North Long Beach

Figure 2-16 Average Concentration of PAHs for MATES III and MATES IV
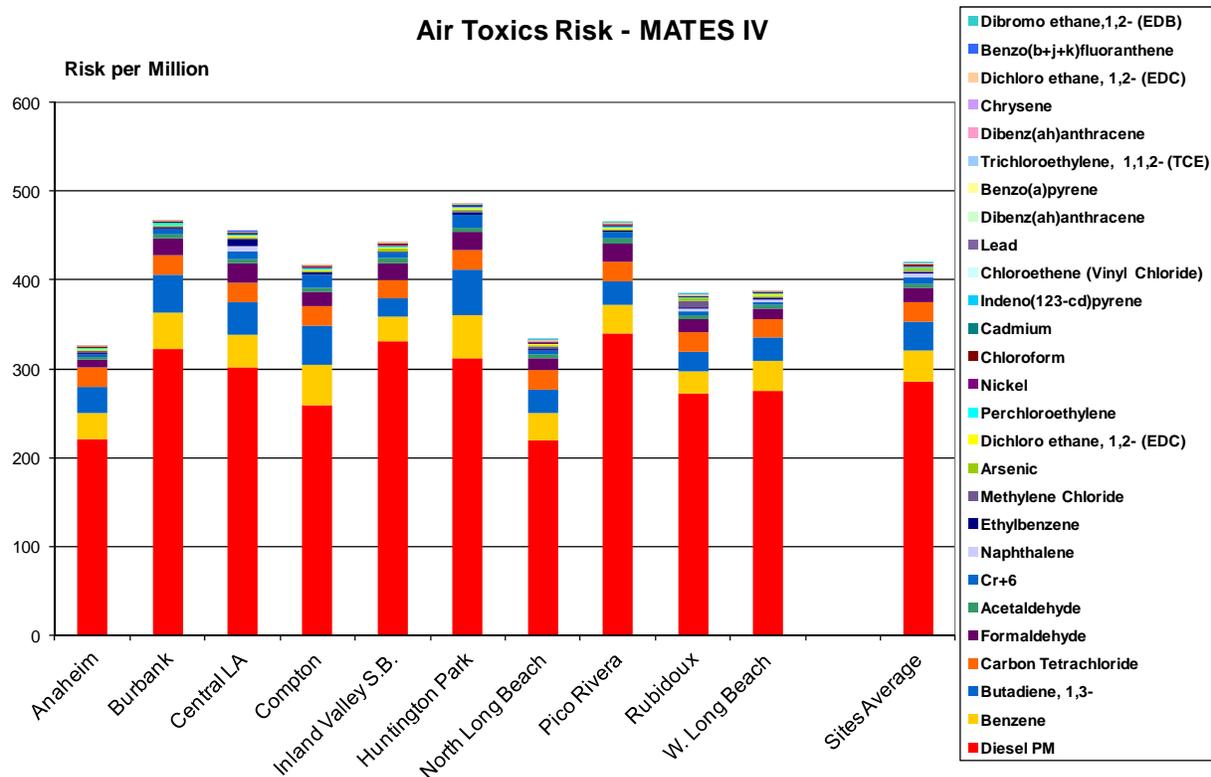
Figure 2-17 Estimated 70-Year Risk from MATES IV Monitoring Data
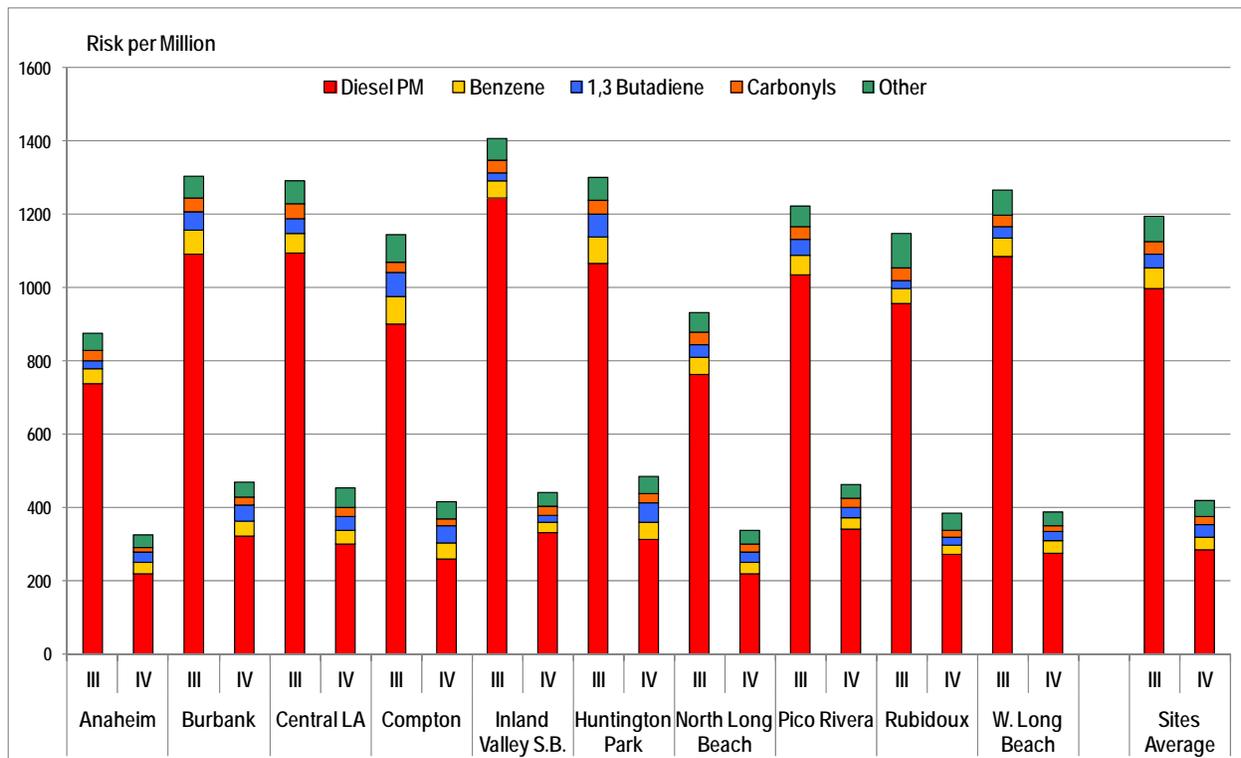
Figure 2-18 Comparison of Estimated 70-Year Risk from MATES III & IV Monitoring Data
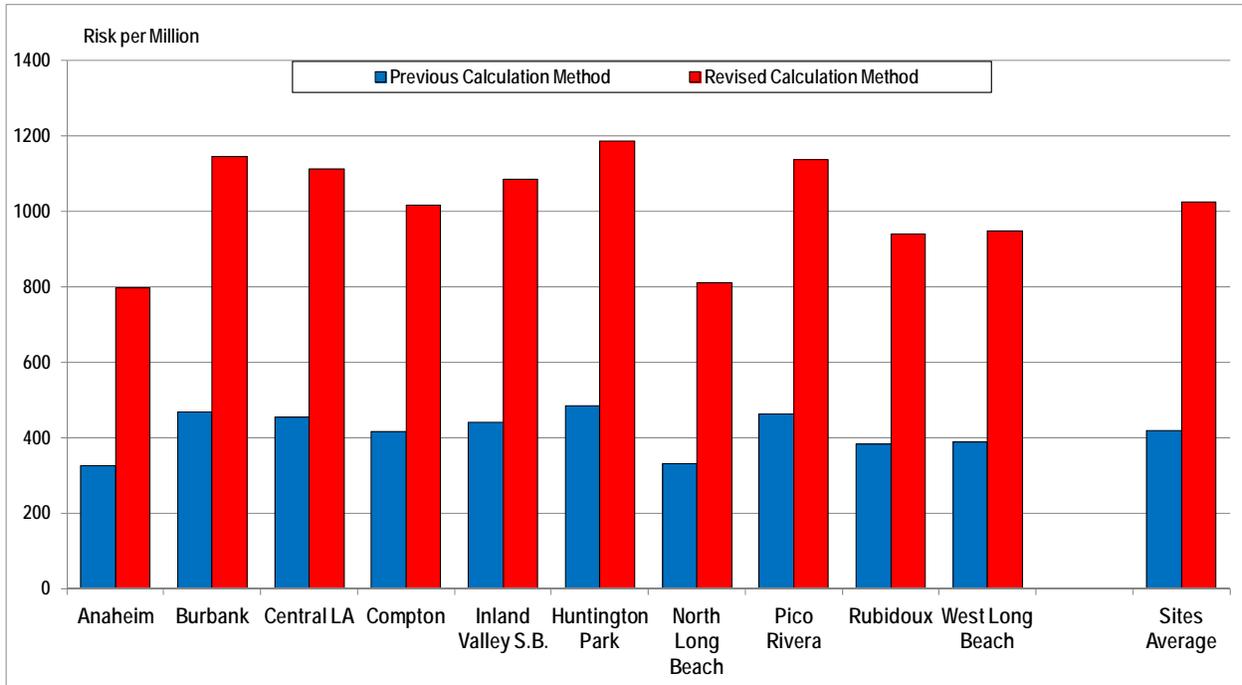
Figure 2-19. Comparison of Previous and Updated OEHHA Risk Calculation Methodologies

CHAPTER 3

DEVELOPMENT OF THE TOXICS EMISSIONS INVENTORY

Chapter 3.   Development of the Toxics Emissions Inventory

3.1 Introduction

An emissions inventory of air pollutants and their sources is essential to identify the major contributors of air contaminants and to develop strategies to improve air quality. The information necessary to develop a detailed emissions inventory for the Basin is obtained from SCAQMD data sources as well as other government agencies including California Air Resources Board (CARB), California Department of Transportation (Caltrans), and Southern California Association of Governments (SCAG).

Each of these agencies is responsible for collecting data (e.g., industry growth factors, socio-economic projections, travel activity levels, emission factors, emission speciation profiles, etc.) and developing methodologies (e.g., model and demographic forecast improvements) that are needed to generate a comprehensive emissions inventory. SCAQMD is solely responsible for developing the point source inventory, and the area source inventory is developed jointly by SCAQMD and CARB. CARB is the primary agency responsible for developing the emissions inventory for all mobile sources and provides on-road and off-road inventories from their EMFAC and OFF-ROAD Models, respectively. SCAG is the primary agency for projecting population and economic activity growth in the Basin. Caltrans provides SCAG with highway network, traffic counts, and road capacity data. SCAG incorporates these data into their Travel Demand Model for estimating and projecting vehicle miles traveled (VMT) and speed. CARB's on-road inventory also relies on SCAG's VMT estimates.

3.2 Overview

The toxic emissions inventory for MATES IV consists of four components: (1) point sources; (2) area sources; (3) on-road mobile sources; and (4) off-road (or other) mobile sources. Point source emissions are from facilities having one or more pieces of equipment registered and permitted with the SCAQMD with emissions above certain threshold levels. Area sources represent numerous small sources of emissions that can collectively have significant emissions (e.g., dry cleaners, retail gasoline stations, auto body shops, residential heating, etc.). On-road mobile sources include cars, trucks, buses, and motorcycles. All mobile sources not included in the on-road mobile source inventory are considered as "off-road" mobile sources, which include aircraft, ships, commercial boats, trains, recreational vehicles, construction and industrial equipment, etc.

The 2012 Air Quality Management Plan (AQMP)[1] is the basis for the toxics emissions inventory developed for MATES IV. The 2012 inventory used for the MATES IV modeling analysis is projected from the 2008 baseline emissions inventory in the 2012 AQMP. A "top-down" approach is used to develop the toxics inventory; that is, toxic emissions are calculated by applying the latest CARB speciation profiles[2] to the hydrocarbon and particulate matter emissions. Speciation profiles provide estimates of the emission's chemical composition. CARB maintains and updates the chemical composition and size fractions of particulate matter (PM) and the chemical composition and reactive fractions of total organic gases (TOG) for a

variety of emission source categories. The source type (e.g., equipment and fuel) is used to identify the appropriate speciation profile.

A top-down approach is preferable for a regional modeling risk analysis, for the following reasons:

- Speciating the VOC and PM inventory affords consistency with the 2012 AQMP;

- The photochemistry algorithms in the MATES IV modeling system require the complete speciation of the VOC emissions to ensure their correct application;

- The computer programs used to grow and control the VOC and PM emissions into the future for the 2012 AQMP can also be used for projecting the toxic emissions in MATES IV. Thus, the future cancer risk reductions resulting from the 2012 AQMP can be estimated.

3.3 Point Sources

A 2008 point source emissions inventory based on the emissions data reported by the point source facilities in the 2008 Annual Emissions Reporting (AER) Program is the basis for the 2012 inventory used for MATES IV modeling analysis. This program applies to facilities emitting four tons or more of VOC, NOx, SOx, or PM or emitting more than 100 tons of CO per year. Facilities subject to the AER Program calculate and report their emissions primarily based on their throughput data (e.g., fuel usage, material usage), appropriate emissions factors or source tests, and control efficiency, if applicable). Under the 2008 AER Program, approximately 1,800 facilities reported their annual emissions to the SCAQMD. Emissions from smaller industrial facilities not subject to the AER Program, which represent a small fraction of the overall stationary source inventory, are included as part of the area source inventory (see Section 3.4).

In order to prepare the point source inventory, emissions data for each facility are categorized based on U.S. EPA's Source Classification Codes (SCCs) for each emission source category. Since the AER collects emissions data on an aggregate basis (i.e., equipment and processes with the same emissions factor are grouped and reported together), facility's equipment permit data are used in conjunction with the reported data to assign the appropriate SCCs and develop the inventory at the SCC level. For modeling purposes, facility location specified in latitude/longitude coordinates is translated into the modeling coordinate system. The business operation activity profile is also recorded so that the annual emissions can be distributed temporally throughout the day, week, and year.

Toxic emissions are calculated by applying the latest CARB speciation profiles[2] to the hydrocarbon and particulate matter emissions. The SCC is used to identify the appropriate speciation profile for the source. The 2012 emissions used for MATES IV are based on the 2012 AQMP projections using 2008 as the base year.

3.4 Area Sources

The area source emissions developed for the 2012 AQMP, projected from 2008 to the year of interest (2012) are used for MATES IV. SCAQMD and CARB shared the responsibility for

developing the 2008 area source emissions inventory for approximately 350 area source categories. Specifically, SCAQMD developed the area source inventory for about 93 categories, and CARB developed the remaining area source categories (of which 239 categories are associated with consumer products, architectural coatings, and degreasing). For each area source category, a specific methodology is used for estimating emissions. Emissions are spatially allocated to 2 km by 2 km grids using spatial surrogates. Some commonly used spatial surrogates are listed in Table 3-1. As with the point source inventory, toxic emissions are calculated by applying the latest CARB speciation profiles to the hydrocarbon and particulate matter emissions.

3.5 On-Road Mobile Sources

On-road emissions are estimated by combining emission factors with vehicular activity. The 2012 on-road emissions were based on 2012 AQMP projections from the 2008 base year. For the 2012 AQMP, CARB's EMFAC2011 emission factors[3] were used and link-based traffic volumes and speeds were obtained from the SCAG regional transportation modeling. The Direct Travel Impact Model (DTIM) was used to link emission factors and transportation modeling results and generate hourly gridded emissions of criteria pollutants (i.e., TOG, NOx, PM, CO, and SOx). The DTIM emissions are adjusted based on the EMFAC2011 values. Toxic emissions are calculated by applying the latest CARB speciation profiles for mobile sources to the hydrocarbon and particulate matter emissions. A flow chart illustrating this process is provided in Figure 3-1. Some of the key steps in the process are discussed in more detail below.

EMFAC stands for EMission FACtor. In its current form, it is a suite of computer models that estimates the on-road emissions of hydrocarbons (HC), CO, NOx, PM, lead (Pb), SO_2, and CO_2 for calendar years 1970 to 2040. EMFAC considers 1965 and newer vehicles powered by gasoline, diesel, or electricity and reports for 13 broad vehicle classes as shown in Table 3-2. Over 100 different technology groups are accounted for within each class (e.g., catalyst, non-catalyst, three-way catalyst, carbureted, multiport fuel injection, LEV, TLEV, SULEV, etc.).

EMFAC currently considers the following county-specific information when calculating emissions:

- Ambient air temperature (denoted by T in Figure 3-1);
- Relative humidity (denoted by RH in Figure 3-1);
- Vehicle population;
- Fleet composition;
- Fleet growth rates;
- Mileage accrual rates;
- Vehicle age distribution;
- Distribution of VMT by speed;
- Smog check regulations;
- Fuel properties; and
- Altitude.

Selected on-road activity information for the four counties in the Basin is summarized in Table 3-3. Four of the top seven counties in California in terms of vehicle population, VMT, and trips are in the Basin.

One of the outputs of EMFAC summarizes HC, CO, NOx, PM, lead, SO_2, and CO_2 emission rates for a given calendar year for each vehicle class and for each county/air basin specified. Processing continues with the DTIM modeling system, which prepares gridded hourly on-road emissions for photochemical grid modeling.

The DTIM processing system consists of three Fortran program modules: CONVIRS4, IRS4, and DTIM4. The main function of CONVIRS4 is to re-format the emission rate file output from EMFAC into a form compatible with IRS4. IRS4 creates fleet average emission rates by ambient air temperature, relative humidity, and vehicle speed.

The DTIM4 module prepares gridded, hourly on-road emissions of HC, CO, NO_X, PM, lead, SO_2, and CO_2 link by link in the transportation network. SCAG's Travel Demand Model provides the following for each link in the transportation network: the number of vehicles, their average speed, and time on the link. Separate files containing hourly gridded temperature (T in Figure 3-1) and relative humidity (RH in Figure 3-1) are provided as input to DTIM4. Knowing the air temperature and relative humidity representative of the link and the average vehicle speed on the link, DTIM4 looks up the fleet average emission rate in the file prepared by IRS4, and multiplies these by the number of vehicles and the average time on the link.

Finally, CARB speciation profiles are used to speciate the on-road HC and PM emissions into its toxic components.

3.6 Off-Road Mobile Sources

The 2008 off-road emissions developed for the 2012 AQMP were projected to 2012 for MATES IV. For the 2012 AQMP, CARB's OFF-ROAD model[4] was used to estimate emissions for all off-road categories (100+ source categories) except commercial ships, aircraft, locomotive, and recreational vehicles. This model incorporates various aspects of off-road elements, such as the effects of various adopted regulations, technology types, and seasonal conditions on emissions. The model combines population, activity, horsepower, load factors, and emission factors to yield the annual equipment emissions by county, air basin, or state. Spatial and temporal features are incorporated to estimate seasonal emissions. Ship emissions were developed by CARB for the 2012 AQMP. Aircraft emissions for the 2012 AQMP were developed by SCAQMD. Emissions are spatially allocated to 2 km by 2 km grids using spatial surrogates while aircraft emissions are allocated to the airports. Toxic emissions are calculated by applying the latest CARB speciation profiles for off-road mobile sources to the hydrocarbon and particulate matter emissions.

3.7 Summary of Toxic Emissions

Table 3-4 presents the emissions of selected compounds apportioned by the on-road, off-road, point, and area source categories. Chemicals that are considered potential or known human carcinogens are denoted with a check mark. Toxic emissions by major source categories are provided in Appendix VIII.

Species and source apportionment are shown in Table 3-5 and Figure 3-2, respectively. In those

illustrations, the emissions of the carcinogenic pollutants in Table 3-4 are weighted by the ratio of their cancer potency to the cancer potency of diesel particulate matter (DPM). Thus, emissions from species less potent than DPM (e.g, benzene, perchloroethylene, etc.) are weighted less, while emissions from species more potent than DPM (e.g., hexavalent chromium, arsenic, etc.) are weighed more. DPM has a weighting factor of one.

As shown in Table 3-5, DPM emissions account for 80% of the overall cancer risk. The other significant compounds (i.e., contributions >1%) are hexavalent chromium, 1,3-butadiene, benzene, formaldehyde, and arsenic. On-road and off-road mobile sources contribute nearly 92% of the weighted carcinogenic risks and stationary (i.e., point and area) sources contribute about 8% of the risk (Figure 3-2).

Carcinogenic emissions have been continuously decreasing. The 2005 MATES III carcinogenic emissions inventory decreased by 11% from the corresponding 1998 MATES II inventory. A more dramatic 65% emissions decrease was noted from MATES III to MATES IV (2005 to 2012 inventory years), as shown in Figure 3-3. Carcinogenic emissions from area, point, off-road and on-road source categories decreased by 78%, 21%, 74% and 49%, respectively.

3.8 Selected Emissions and Air Quality Changes Since MATES III

Table 3-6 compares emissions and measured air quality changes since MATES III for selected toxics. The air quality change is comparing measured annual average ambient concentrations from 2005 and 2012 from eight sites with complete data. Emissions have decreased, and air quality has improved since MATES III.

Several caveats are appropriate when comparing the changes in inventory emissions and ambient measurements. For example, weather and dispersion of pollutants can influence the relationship between emissions and ambient concentrations. Also, the inventory is a regional estimate of total emissions throughout the Basin, whereas ambient measurements are from the eight fixed monitoring locations where there may be influences from local sources. Another difference is that secondary formation and degradation of substances in the atmosphere are not accounted for in the emissions comparisons, but are captured in the ambient measurements. Nonetheless, comparing emissions estimates with air quality measurements can provide information on whether expected emissions changes are reflected in actual ambient measurements, can be used to help calibrate emissions estimates, and may suggest where emissions inventory methods can be improved.

3.9 References

1. A copy of the 2012 AQMP can be viewed or downloaded at the following SCAQMD link: http://www.aqmd.gov/home/library/clean-air-plans/air-quality-mgt-plan/final-2012-air-quality-management-plan

2. CARB speciation profiles can be viewed or downloaded from the following CARB link: http://www.arb.ca.gov/ei/speciate/speciate.htm.

3. EMFAC2011 model and its documentation can be obtained at the following CARB link: http://www.arb.ca.gov/msei/modeling.htm.

4. The OFF-ROAD Model and its documentation can be obtained at the following CARB link: http://www.arb.ca.gov/msei/offroad/offroad.htm.

Table 3-1. Commonly Used Spatial Surrogates.

Population	Total employment
VMT	Industrial employment
Length of rail per grid cell	Retail employment
Locations of unpaved rural roads	Single dwelling units
Total housing	Rural land cover – forest
Agricultural land cover	Rural land cover – range land
National forest > 5000 ft	

Source: http://eos.arb.ca.gov/eos/projects/surrogates/

Table 3-2. Broad Vehicle Classes Considered by EMFAC.

Vehicle Class	Weight (lbs)	Vehicle Class	Weight (lbs)
Passenger cars	All	Heavy-Heavy-Duty Truck	33,001 – 60,000
Light Truck I	0 – 3,750	Motorcycle	All
Light Truck II	3,751 – 5,750	Urban Diesel Bus	All
Medium-Duty Truck	5,751 – 8,500	School Bus	All
Light-Heavy-Duty Truck I	8,501 – 10,000	Other bus	All
Light-Heavy-Duty Truck II	10,001 – 14,000	Motor Homes	All
Medium-Heavy-Duty Truck	14,001 – 33,000		

Source: Adopted from the User's Guide for EMFAC2011.

Table 3-3. Vehicle Activity Information for the Counties in the Basin.

County	Vehicle Population	VMT/day	Trips/day	Miles per Vehicle-Day
Los Angeles	6,278,704	217,899,000	40,271355	34.71
Orange	2,157,423	75,785,000	13,906,711	35.21
Riverside	1,342,704	45,651,000	8,704550	34.00
San Bernardino	988,717	38,912,000	6,372,705	39.36

Source: EMFAC2011 and SCAG 2012 RTP

Table 3-4. 2012 Annual Average Day Toxic Emissions for the South Coast Air Basin.

	Pollutant	Emissions (lbs/day)				
		On-road	Off-road	Point	Area	Total
√	Acetaldehyde*	2066.9	3083.1	108.1	1378.7	6636.9
	Acetone**	1796.1	2342.3	379.8	20569.3	25087.4
√	Benzene	5336.3	4477.1	711.8	1506.5	12031.7
√	1,3-Butadiene	1002.5	1028.7	435.2	107.2	2573.6
√	Carbon tetrachloride	0.0	0.0	6.6	0.1	6.7
√	Chloroform	0.0	0.0	12.7	0.8	13.5
√	1,1 Dichloroethane	0.0	0.0	0.3	65.3	65.5
√	1,4 Dioxane	0.0	0.0	0.1	0.0	0.1
√	Ethylene dibromide	0.0	0.0	0.1	0.0	0.1
√	Ethylene dichloride	0.0	0.0	53.8	11.4	65.2
√	Ethylene oxide	0.0	0.0	4.9	0.0	4.9
√	Formaldehyde*	5159.8	7530.0	1678.2	4517.8	18885.8
	Methyl ethyl ketone*	335.1	423.2	870.8	5425.6	7054.7
√	Methylene chloride	0.0	0.0	26.2	9874.3	9900.5
√	MTBE	0.0	1.1	0.1	0.0	1.2
√	Naphthalene	264.0	194.8	16.7	220.4	695.9
√	p-Dichlorobenzene	0.0	0.0	70.3	2945.1	3015.5
√	Perchloroethylene	0.0	0.0	805.0	5865.4	6670.4
√	Propylene oxide	0.0	0.0	0.5	0.2	0.7
	Styrene	271.2	174.2	1222.3	12.5	1680.1
	Toluene	15823.6	9233.1	4956.1	24497.6	54510.4
√	Trichloroethylene	0.0	0.0	735.3	886.1	1621.5
√	Vinyl chloride	0.0	0.0	37.9	128.6	166.5
√	Arsenic	0.4	0.0	18.6	5.3	24.3
√	Cadmium	0.3	0.3	5.0	3.0	8.6
	Chromium	44.0	3.7	34.5	24.8	107.0
√	Diesel particulate	10798.7	9180.9	411.8	80.6	20472.0
	Elemental carbon***	8873.4	6211.5	3286.8	11107.6	29479.3
√	Hexavalent chromium	2.2	0.5	0.4	0.0	3.1
√	Lead	4.8	8.7	30.9	73.1	117.5
√	Nickel	24.6	9.2	44.1	16.5	94.4
	Organic carbon	11675.2	7865.6	197.3	45202.9	64940.9
	Selenium	0.9	0.1	23.9	2.7	27.5
	Silicon**	2473.0	140.4	2498.8	87588.5	92700.7

√   Denotes potential or known human carcinogen.
*   Primarily emitted emissions. These materials are also formed in the atmosphere as a result of photochemical reactions.
**   Acetone and silicon are not toxic compounds. Their emissions are included here because they were measured in the sampling program.
*** Includes elemental carbon from all sources (including diesel particulate).

Table 3-5. Cancer Potency Weighted Species Apportionment for 2012 Emissions.

Toxic	Contribution (%)	Toxic	Contribution (%)
Diesel particulate	79.61	Methylene chloride	0.12
Hexavalent chromium	5.66	Trichloroethylene	0.04
1,3-butadiene	5.46	Lead	0.02
Benzene	4.25	Ethylene dichloride	0.02
Formaldehyde	1.40	Ethylene oxide	<0.01
Arsenic	1.03	Carbon tetrachloride	<0.01
Perchloroethylene	0.50	1,1-Dichloroethane	<0.01
Cadmium	0.46	Chloroform	<0.001
p-dichlorobenzene	0.43	Ethylene dibromide	<0.0001
Nickel	0.30	Propylene oxide	<0.0001
Naphthalene	0.30	1,3-Dioxane	<0.00001
Acetaldehyde	0.23	MTBE	<0.00001
Vinyl chloride	0.16		

Table 3-6. Selected Emissions and Air Quality Changes Since MATES III.

Toxic Gases	Change in Emissions	Change in Air Quality	Toxic Particulates	Change in Emissions	Change in Air Quality
Acetaldehyde	-53%	-56%	Arsenic	-43%	-35%
Benzene	-47%	-38%	Cadmium	-39%	-91%
1,3-butadiene	-50%	-18%	Elemental carbon	-24%	-35%
Formaldehyde	-46%	-49%	EC (PM$_{2.5}$)	-19%	-47%
Methylene chloride*	-29%	+44%	Hex. chromium**	+11%	-78%
Perchloroethylene	-37%	-50%	Lead	-42%	-56%
Trichloroethylene	+33%	-33%	Nickel	+6%	-45%

*   Measured concentrations at the Rubidoux site increased significantly since 2009.
**   High measured concentrations in MATES III due to nearby sources influencing the Rubidoux site. The emissions from these sources have since been controlled.
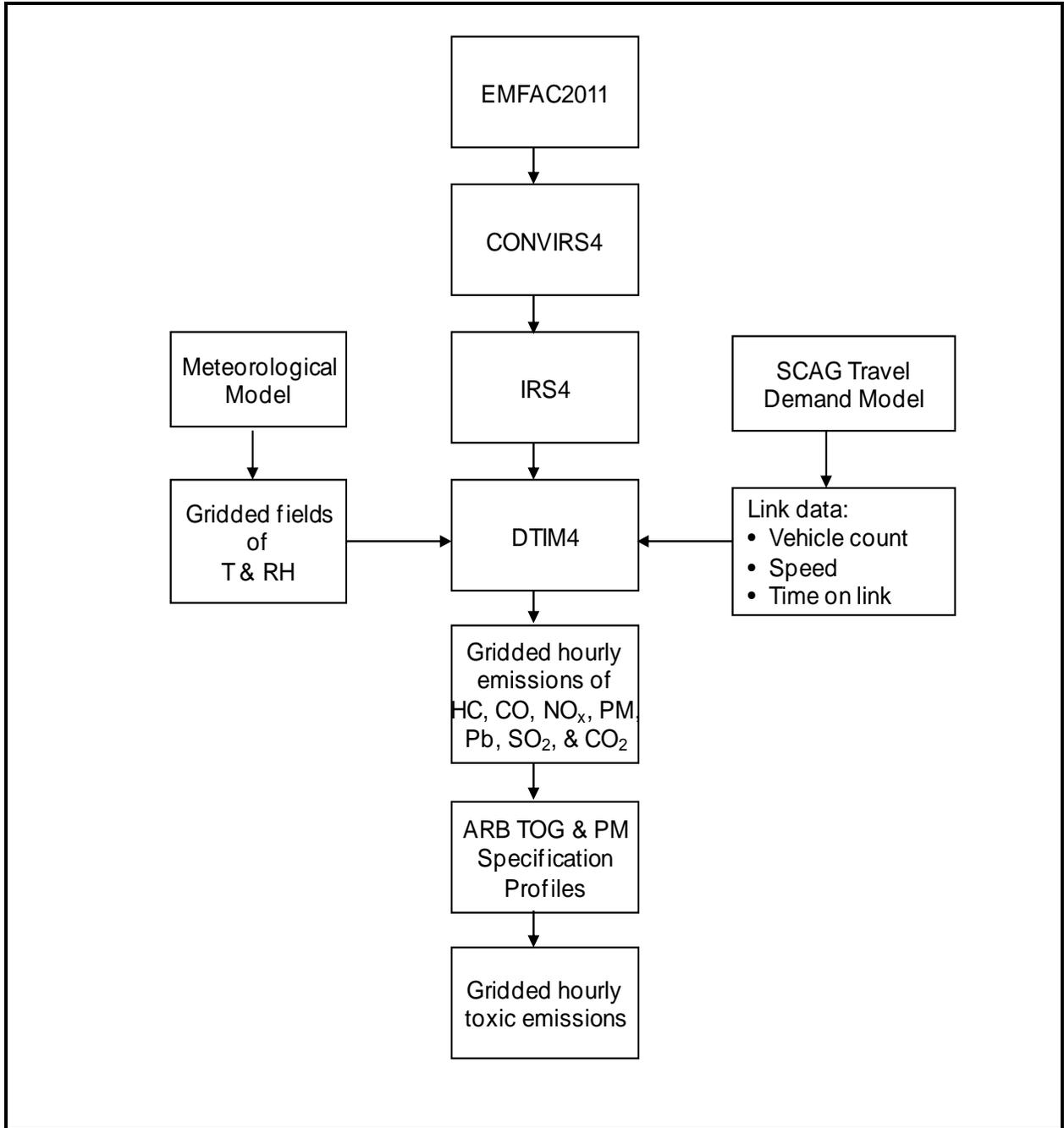
Figure 3-1. Flow Diagram for On-Road Emissions Processing.
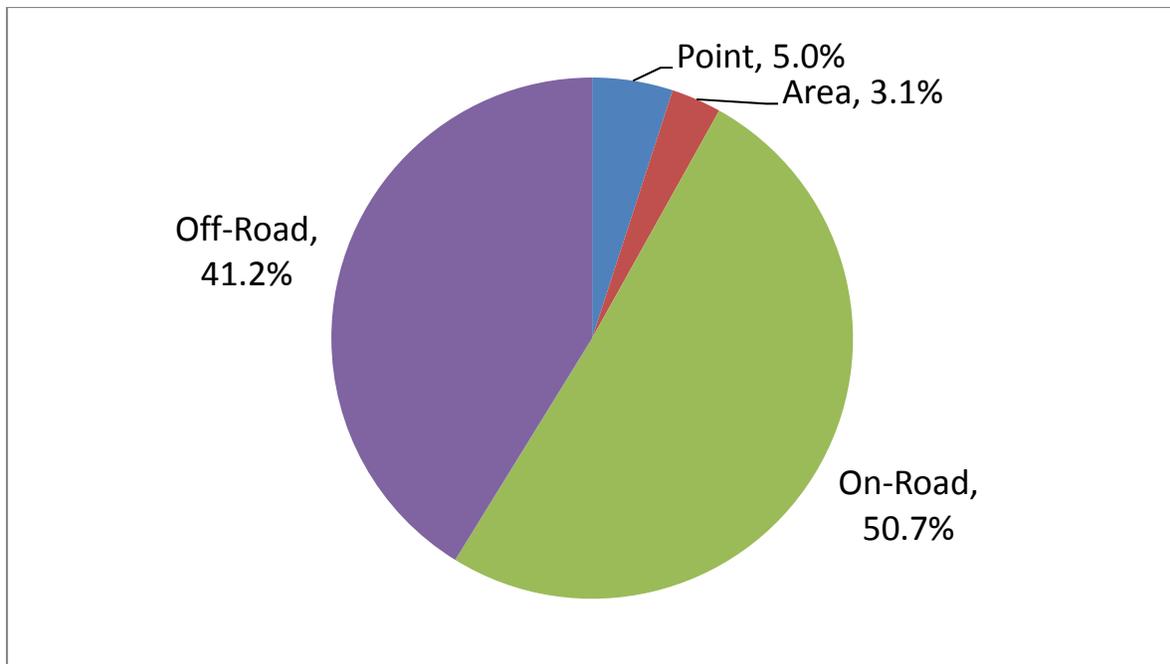
Figure 3-2. Cancer Potency Weighted Source Apportionment for 2012 Emissions.

Category	Change from MATES III (%)	Change from MATES II (%)
Area	-77.5	-87.0
Point	-20.8	-72.8
Off-road	-73.5	-73.2
On-road	-49.4	-55.7

Figure 3-3. Cancer Potency Weighted Emission Comparison of MATES II, MATES III and MATES IV.

CHAPTER 4
REGIONAL MODELING AND EVALUATION

Chapter 4. Regional Modeling and Evaluation

4.1   Background

Regional air quality modeling is used to estimate community exposure to air toxics as a function of both time and geography due to known toxic emissions sources. The model simulated concentrations of toxic compounds are translated into a spatial pattern of health risk based upon compound potency risk factors. The regional modeling provides a mechanism to predict the dispersion of emissions from a variety of source categories as well as individual sources to estimate risk throughout the modeling area. This analysis complements and is compared to the techniques used to assess concentration and risk from the data acquired at the fixed monitoring sites.

Since MATES II, the SCAQMD has used regional air quality models in air toxic risk analyses. In the MATES II analysis, the Urban Airshed Model with TOX (UAMTOX) chemistry was used to simulate the transport and accumulation of toxic compounds throughout the Basin. UAMTOX was simulated for a protracted 2 km by 2 km grid domain that overlaid the Basin.

Subsequent to MATES II, the SCAQMD transitioned to more technologically advanced tools that utilize updated chemistry modules, improved dispersion algorithms, and mass consistent meteorological data. In the 2007 AQMP and the subsequent MATES III analysis, the dispersion platform moved from UAM to CAMx and the diagnostic wind meteorological model was replaced by the Mesoscale Model version 5 (MM5, Grell et al 1994) prognostic model. CAMx, coupled with the MM5 input, using the "one atmosphere" gaseous and particulate chemistry, was used to simulate both episodic ozone and annual concentrations of $PM_{2.5}$ and air toxic pollutants. The modeling was performed based on the UTM coordinate systems.

In the 2012 AQMP, the SCAQMD transitioned from MM5 to a new mesoscale meteorological model, Weather Research Forecast (WRF; Skamarock 2008) and adopted a statewide Lambert Conformal coordinate system. Both CAMx and Community Multiscale Air Quality (CMAQ) models were used for air quality simulations. Within the South Coast Air Basin (SCAB), both models performed similarly. For MATES IV, the CAMx RTRAC with WRF was used to model air toxic concentrations of both particulate matter and gaseous species.
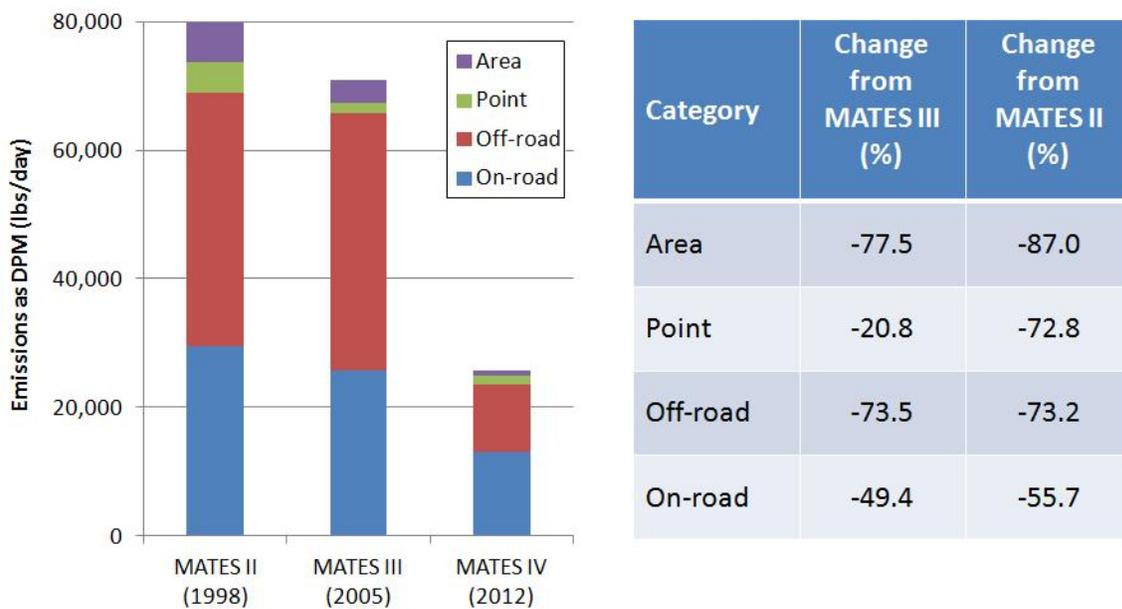
MATES IV Modeling was conducted over a domain that encompassed the Basin and the coastal shipping lanes located in the Southern California Bight portions of the Basin using a grid size of 2 km by 2 km. Compared to MATES III, the domain extends further eastward to include the Coachella Valley. Figure 4-1 depicts the MATES IV modeling domain. The unshaded portion of the grid area represents the extension of the domain beyond that used for MATES III. A projected emissions inventory for 2012 based on the 2012 AQMP emissions inventory for 2008, which included detailed source profiles of air toxic sources, provided the mobile and stationary source input for the MATES IV CAMx RTRAC simulations. Although the actual measurements and modeling for MATES IV spanned July 1, 2012, through June 30, 2013, for simplicity the MATES IV modeling used the 2012 emissions inventory.

Grid-based, hourly meteorological fields generated from WRF provided the wind patterns and atmospheric parameters for the simulations.
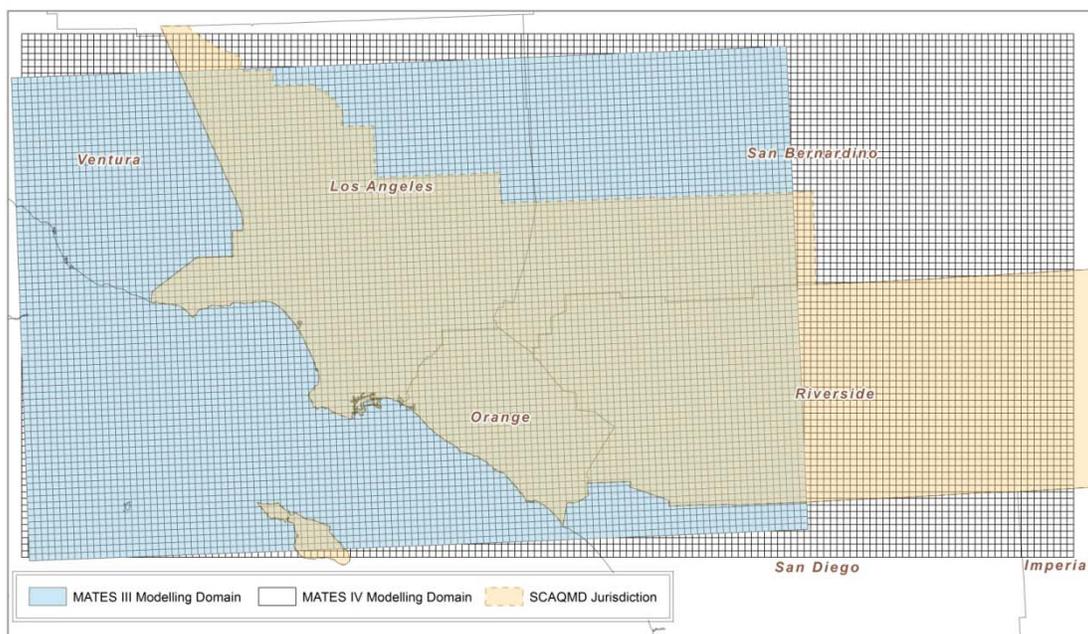
Figure 4-1.
MATES IV Modeling Domain. Shaded area highlights the grid extension to the
MATES III modeling domain.

4.2   MATES III vs. MATES IV: Key Modeling Assumptions

The MATES IV regional modeling analyses relied on the CAMx RTRAC model to simulate annual impacts of both gaseous and aerosol toxic compounds in the Basin. In the 2000 MATES II analysis, the Urban Airshed Model with TOX (UAMTOX) chemistry was used to simulate the advection and accumulation of toxic compound emissions throughout the Basin. UAMTOX was simulated for a 2 km by 2 km grid domain that overlaid the Basin. The analysis relied on the 1997-1998 emissions projection from the 1997 AQMP, and meteorological data fields for 1997-1998 were generated by objective analysis using a diagnostic wind model. These tools were consistent with those used in both the 1997 and 2003 AQMP attainment demonstrations.

MATES III employed CAMx RTRAC, which is identical to the modeling tool used in the current study. The meteorological data was generated using Mesoscale Meteorological model 5 (MM5), which was considered state-of-the-art at the time; however, MM5 was subsequently replaced by WRF as the most advanced and commonly used meteorological model.

The transition to CAMx and MM5 was made based on suggestions from peer review for the 2003 AQMP modeling efforts. A concern arising from the peer review was the need for better

state-of-the-science tools that utilize updated chemistry modules, improved dispersion algorithms, and mass consistent meteorological data. The recommendations were implemented for the 2007 AQMP where the dispersion platform moved from UAM to CAMx and the diagnostic wind meteorological model was replaced by the MM5 prognostic model. CAMx, coupled with MM5 input using the "one atmosphere" gaseous and particulate chemistry was used to simulate both episodic ozone and annual concentrations of $PM_{2.5}$.

MM5 simulated April 1998 through March 1999 and all days in 2005, which provided the dispersion profile for the CAMx simulations. As for emissions, an updated version of the 2007 AQMP inventory for model year 2005 was used. This included detailed source profiles of air toxics and mobile and stationary sources for CAMx RTRAC simulations. An additional back-cast of the 2007 AQMP emissions inventory was generated for 1998 to re-simulate the MATES II in a framework identical to the MATES III, which enabled a direct comparison of risk assessments of the two previous MATES studies.

The CAMx-MM5 modeling platform from MATES III was updated to the CAMx-WRF coupled system in MATES IV. The WRF, state-of-the-science meteorological modeling tool offers a variety of user options to cover atmospheric boundary layer parameterizations, turbulent diffusion, cumulus parameterizations, land surface-atmosphere interactions, etc., which can be customized to model specific geographical and climatological situations. The SCAQMD performed extensive sensitivity tests and further development to improve the WRF performance for the South Coast Basin, in which geographical and climatological characteristics impose great challenges in predicting the complex meteorological structures associated with air quality episodes. CAMx with RTRAC algorithms was employed as a chemical transport platform, given the importance of tracking chemically active toxic elements individually to assess the contribution of each source category. The RTRAC algorithm provides a flexible approach for tracking the emissions, dispersion, chemistry, and deposition of multiple gases and particles that are not otherwise included in the model's chemistry mechanisms.

Table 4-1 summarizes the major differences in the air toxics modeling between the MATES IV and MATES III analyses.

Table 4-1
Summary Comparison of Key Modeling Considerations Between
MATES IV and MATES III

Parameter	MATES IV	MATES III
Meteorological Modeling Year	July 2012 - June 2013	2005
Model Platform / Chemistry	CAMx RTRAC (5.30)	CAMx RTRAC (4.40)
Meteorology Model /Vertical Layers	WRF with30 layers/ CAMx: 16 layers	MM5 with 29 layers/ CAMx: 8 layers
On-Road Truck Emissions	Caltrans/SCAG Truck Model	Caltrans/SCAG Truck Model
Shipping Emissions Stack Height	Emissions spread through layers 1 and 2	Emissions spread through layers 1 and 2
Emissions Inventory	2012 Projection from 2008 (2012 AQMP)	2005 Projection from 2002 (2007 AQMP)
Mobile Emissions	EMFAC2011	EMFAC2007

4.3   Modeling Results

CAMx RTRAC regional modeling was conducted using WRF meteorological data and projected emissions data for 2012 to simulate annual average concentrations of 19 key compounds measured as part of the MATES IV monitoring program from July 1, 2012, to June 30, 2013. Simulated annual average concentration plots for the four toxic compounds that contributed the greatest risk throughout the domain (diesel particulate, benzene, 1,3-butadiene and formaldehyde) are depicted in Figures 4-2 through 4-5.

Figure 4-2 depicts the projected annual average concentration distribution of $PM_{2.5}$ diesel particulates in the Basin. The highest concentration (2.9 $\mu g/m^3$) was simulated to occur around the Ports of Los Angeles and Long Beach. In general, the distribution of diesel particulates is aligned with the transportation corridors including freeways, major arterials and rail right-of-ways. The peak diesel concentration is much lower than the previous MATES studies, due, in a large part, to emission reductions from ocean-going vessels at near coastal waters and at ports. Figures 4-3 and 4-4 provide the distributions of benzene and 1,3-butadiene respectively whereby the toxic compounds are almost uniformly distributed throughout the Basin, reflecting patterns of light-duty fuel consumption. As expected, the higher benzene concentrations appear in an area where refineries are located. However, benzene concentrations there are not significantly elevated relative to other areas. The modeled peak concentration of 0.5 ppb is comparable with measured values of 0.53 ppb at Huntington Park and 0.4 ppb at Los Angeles.

The ambient concentrations of formaldehyde in the SCAB are due to direct emissions, primarily from combustion sources, and secondary formation from anthropogenic and biogenic VOCs.

The formaldehyde concentrations shown in Figure 4-5 depict a spatial distribution indicative of its sources, with measurable concentrations in the heavily-traveled western and central Basin, with additional elevated levels in the downwind areas of the Basin that are impacted by higher levels of photochemistry and ozone formation. Due to continued reduction of primary combustion source emissions, the formaldehyde concentrations are dominated by secondary formation. The peak formaldehyde concentrations are now in the areas with high biogenic emissions.
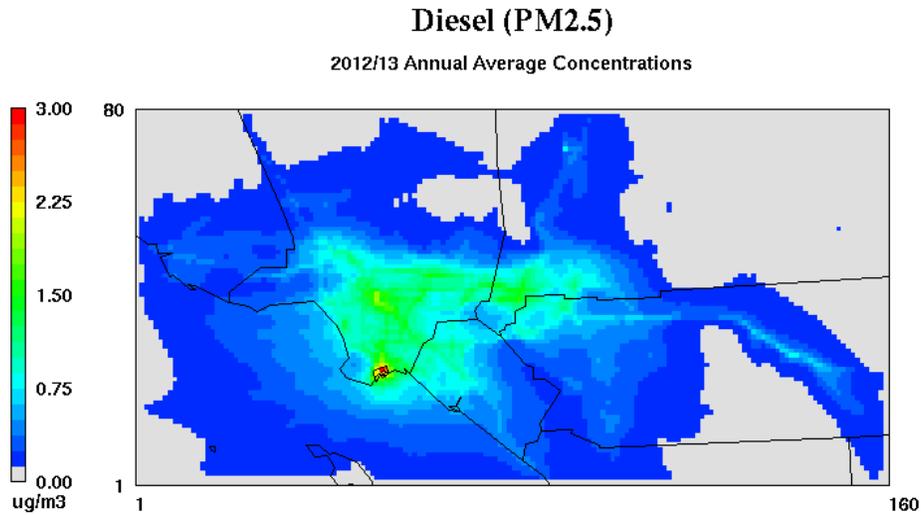
Figure 4-2
Annual Average Concentration Pattern for Diesel PM$_{2.5}$
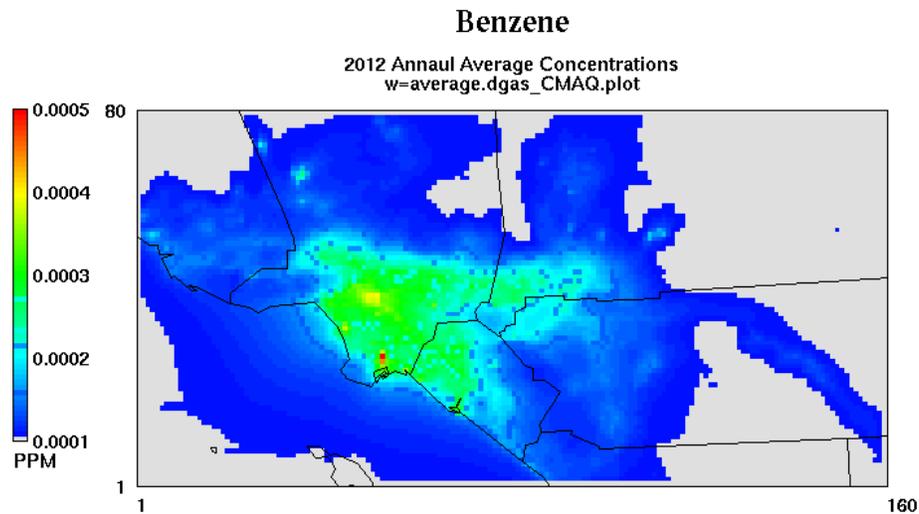
Figure 4-3
Annual Average Concentration Pattern for Benzene

1,3Butadiene

2012 Annaul Average Concentrations
w=average.dgas_CMAQ.plot
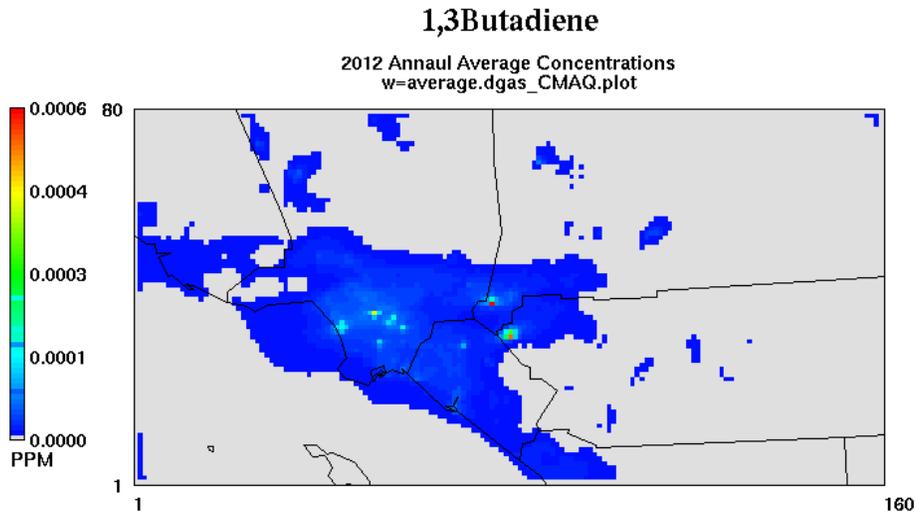
Figure 4-4
Annual Average Concentration Pattern for 1,3-Butadiene

Total Formaldehyde

2012 Annaul Average Concentrations
w=average.dgas_CMAQ.plot
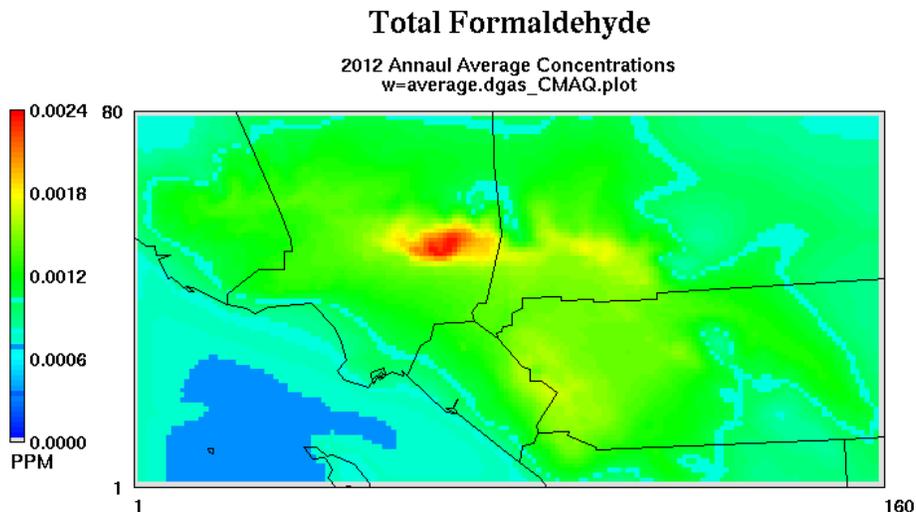
Figure 4-5
Annual Average Concentration Pattern for Total Formaldehyde

Table 4-2 provides a summary of the model performance relative to actual measured annual average concentrations. For this comparison, the monitored data for the 10 stations are combined to provide an estimate of average Basin-wide conditions for the 2012-2013 sampling period. CAMx RTRAC simulated concentrations at the monitoring sites were derived using the inverse distance-squared weighted surrounding nine-cell average. Since direct measurements of $PM_{2.5}$ diesel are not possible, no direct comparisons can be made with simulated annual average concentrations. However, if the factor of 0.82 derived from the emissions inventory is used (See Chapter 2), the estimated 10-site average diesel $PM_{2.5}$ concentration would be 0.96 μg/m^3 compared to the modeled average concentration of 1.23 μg/m^3. Naphthalene was measured only

at Long Beach, Central Los Angeles, and Rubidoux. For the rest of the species, each of the four counties within the SCAQMD is represented by at least one station.

Table 4-2
Measured and Simulated Annual Average Concentrations During 2012-2013 MATES IV

Compound	Units	2012-2013MATES IV	
		Measured Annual Average	Simulated Annual Average
$EC_{2.5}$	$\mu g/m^3$	1.17	1.41
EC_{10}	$\mu g/m^3$	1.58	1.70
Cr 6 (TSP)	ng/m^3	0.05	0.19
As (TSP)	ng/m^3	0.56	1.61
Cd (TSP)	ng/m^3	0.16	0.55
Ni (TSP)	ng/m^3	3.76	6.30
Pb (TSP)	ng/m^3	6.23	5.41
Benzene	ppb	0.38	0.29
Perchloroethylene	ppb	0.03	0.08
p-Dichlorobenzene	ppb	0.02	0.05
Methylene Chloride	ppb	0.42	0.25
Trichloroethylene	ppb	0.02	0.04
1,3-Butadiene	ppb	0.11	0.05
Formaldehyde	ppb	2.25	1.90
Acetaldehyde	ppb	0.90	0.96
Naphthalene	ppb	0.02*	0.01

* Three station average

For 2012-2013, the model simulated concentrations of particulate matter species, such as $EC_{2.5}$, EC_{10}, and TSP metals were biased high. The model performed better for gaseous species. Concentrations of perchloroethylene, p-dichloroebenzene, trichloroethylene have become so low such that the typical ambient concentrations are often below the detection limits of the measurements. Thus, model performances for those species are difficult to ascertain. Note that given their low concentrations, their respective contributions to the overall toxic cancer risk are less than one percent. For 1,3-butadiene, due to its highly reactive nature, large uncertainties exist in speciation profiles, measurements and decay parameters used in the modeling ; thus, good model performance for 1,3-butadiene is not typically expected. Information on speciation profiles for naphthalene is very limited. Both MATES III and MATES IV showed very low ambient concentrations of naphthalene and, hence, very low cancer risk contributions. Benzene, formaldehyde, and acetaldehyde showed good agreement between model simulations and measurements. Modeled and observed concentrations of methylene chloride compared very

well except for the Rubidoux site. This site experienced a dramatic increase in the average monitored methylene chloride concentrations since 2009, primarily due to a handful of days exhibiting elevated levels. Prior to 2009, the annual average concentration of methylene chloride had been in the range of 0.2-0.3 ppb. From 2009 onward, the measured annual average concentrations have been in the range of 1.4-2.4 ppb. The sources of this increase have not yet been determined and are being investigated. Based on experience and past MATES studies, it is likely a source or sources nearby the monitoring location. However, even at these elevated levels, methylene chloride has a negligible contribution to the overall air toxics cancer risk (~2 in a million).

Simulated annual average concentrations of $EC_{2.5}$ and EC_{10} were used to assess the overall model performance for the 2012-2013 MATES IV period. Tables 4-3a and 4-3b summarize the 2012-2013 MATES IV $EC_{2.5}$ and EC_{10} model performance, respectively.

EPA guidance (U.S. EPA, 2006) recommends evaluating particulate modeling performance using measures of prediction bias and error. Prediction Accuracy (PA), measured as the percentage difference between the mean annual observed and simulated $EC_{2.5}$ concentrations is another tool used in the performance evaluation. PA goals of ±20% for ozone and ±30% for individual components of $PM_{2.5}$ or PM_{10} have been used to assess simulation performance in previous modeling attainment demonstrations. In general, PM_{10} showed better agreement than $PM_{2.5}$. PA indicated that PM_{10} prediction meets the EPA performance criteria at nine out of 10 stations, while $PM_{2.5}$ meets only at five stations. Still, PM_{10} as well as $PM_{2.5}$ showed high bias in Long Beach.

Similar to the prior studies, including MATES III and 2012 AQMP, the CAMx model shows a tendency of high bias near the coastal area and low bias in the inland area. The areas showing the high bias (i.e. model overprediction) are Long Beach, Compton and Los Angeles; and the areas with underpredictions are Burbank and Rubidoux. A detailed discussion of the model performance is presented in Appendix IX).

Table 4-3a
MATES IV 2012-2013 EC$_{2.5}$ Model Performance

Location	Observed (µg/m³)	*Modeled (µg/m³)	Prediction Accuracy	Mean Bias (µg/m³)	Mean Error (µg/m³)	Normal-ized Mean Bias	Normal-ized Mean Error
Anaheim	0.90	1.10	22	0.20	0.56	1.08	1.24
Burbank	1.32	1.19	-9	-0.12	0.64	0.43	0.73
Compton	1.06	1.48	39	0.42	0.76	1.52	1.64
Inland Valley San Bernardino	1.38	1.13	-18	-0.25	0.46	-0.03	0.31
Huntington Park	1.30	1.70	31	0.40	0.67	0.85	0.93
Long Beach	0.91	1.45	59	0.53	0.80	2.18	2.27
Central L.A.	1.23	1.81	47	0.58	0.70	0.91	0.96
Pico Rivera	1.39	1.30	-6	-0.09	0.48	0.26	0.52
Rubidoux	1.11	0.98	-12	-0.13	0.40	0.12	0.44
West Long Beach	1.13	1.88	67	0.75	1.00	2.10	2.17
All Stations	1.17	1.40	20	0.23	0.65	0.95	1.13

* Included only sampling days

Table 4-3b
MATES IV 2012-2013 EC_{10} Model Performance

Location	Observed ($\mu g/m^3$)	*Modeled ($\mu g/m^3$)	Prediction Accuracy	Mean Bias ($\mu g/m^3$)	Mean Error ($\mu g/m^3$)	Normal-ized Mean Bias	Normal-ized Mean Error
Anaheim	1.17	1.39	18	0.22	0.49	0.44	0.54
Burbank	1.74	1.43	-18	-0.31	0.60	-0.03	0.34
Compton	1.50	1.81	21	0.32	0.66	0.58	0.68
Inland Valley San Bernardino	1.74	1.42	-18	-0.32	0.47	-0.08	0.27
Huntington Park	1.65	1.98	20	0.33	0.54	0.36	0.43
Long Beach	1.29	1.72	34	0.44	0.59	0.61	0.68
Central L.A.	1.67	2.17	30	0.50	0.61	0.46	0.51
Pico Rivera	1.87	1.69	-10	-0.18	0.44	-0.02	0.24
Rubidoux	1.48	1.26	-14	-0.22	0.44	-0.06	0.29
West Long Beach	1.78	2.15	21	0.37	0.86	0.53	0.69
All Stations	1.58	1.69	7	0.11	0.57	0.28	0.47

* Included sampling days only

4.4   Estimation of Cancer Risk

Figure 4-6 depicts the 2012-2013 MATES IV distribution of risk estimated from the predicted annual average concentrations of the key toxic compounds. Risk is calculated for each grid cell as follows:

$$\text{Risk}_{i,j} = \Sigma \; \text{Concentration}_{i,j,k} \; X \; \text{Risk Factor}_{i,j,k}$$

Where $_{i,j}$ is the grid cell (easting, northing) and k is the toxic compound.

The grid cell having the maximum simulated cancer risk of 1,057 in a million was located in the Ports of Los Angeles and Long Beach. In addition to the cluster of cells around the port area with high risk, a second cluster of high-risk area is centered around a railyard southeast of downtown Los Angeles. In general, as in the past studies, the higher-risk areas tend to be along transportation corridors.

Figure 4-7 provides the CAMx RTRAC simulated air toxics risk for the 2005 MATES III period, and Figure 4-8 depicts the changes in risk from 2005 to 2012-2013. The greatest decrease in risk occurred in the port area, reflecting the emission reductions from shipping and port operations. Overall, air toxics risk improved significantly, consistent with air toxic emissions reductions that occurred over the period.

The 2012-2013 Basin average population-weighted risk summed for all the toxic components yielded a cancer risk of 367 in a million. The average risk included all populated land cells that reside within the Basin portion of the modeling domain. The MATES III Basin average risk was 853 per million. Thus, between the MATES III and MATES IV periods, the simulated risk decreased by 57%. The 57% reduction in Basin risk can be attributed to several factors, most notably, changes in diesel emissions between 2005 and 2012. While weather profiles between the two monitoring periods varied, no appreciable difference was observed in the meteorological dispersion potential.

Regional risk from nondiesel sources (Figure 4-9) is also uniformly distributed throughout the Basin with values typically around 100 in one million, with only a few selected cells showing values in excess of 200.

Figure 4-10 provides a close-up plot of risk in the Ports area. Table 4-4 provides a summary risk estimated for the Basin, for the Ports area, and for the Basin excluding the Ports area. For this assessment, the Ports area includes the populated cells roughly bounded by the Interstate 405 to the north, San Pedro to the west, Balboa Harbor to the east, and Pt. Fermin to the south. The 2012-2013 average population-weighted air toxics risk in the Ports area (as defined above) was 480 in one million. The Basin average population-weighted air toxics risk, excluding the grid cells in the Ports area, was 359 in one million. It is important to note that the downwind impacts resulting from Port area activities are still reflected in the toxics risk estimates for the grid cells categorized as "Basin minus Ports." Similarly, the MATES III simulations for 2005 indicated that the Ports area air toxics risk was 1,415 in one million; and the Basin, minus the Ports area, was 816 in one million. Overall, the Ports area experienced an approximate 66% decrease in risk, while the average population-weighted risk in other areas of the Basin decreased by about 56%.
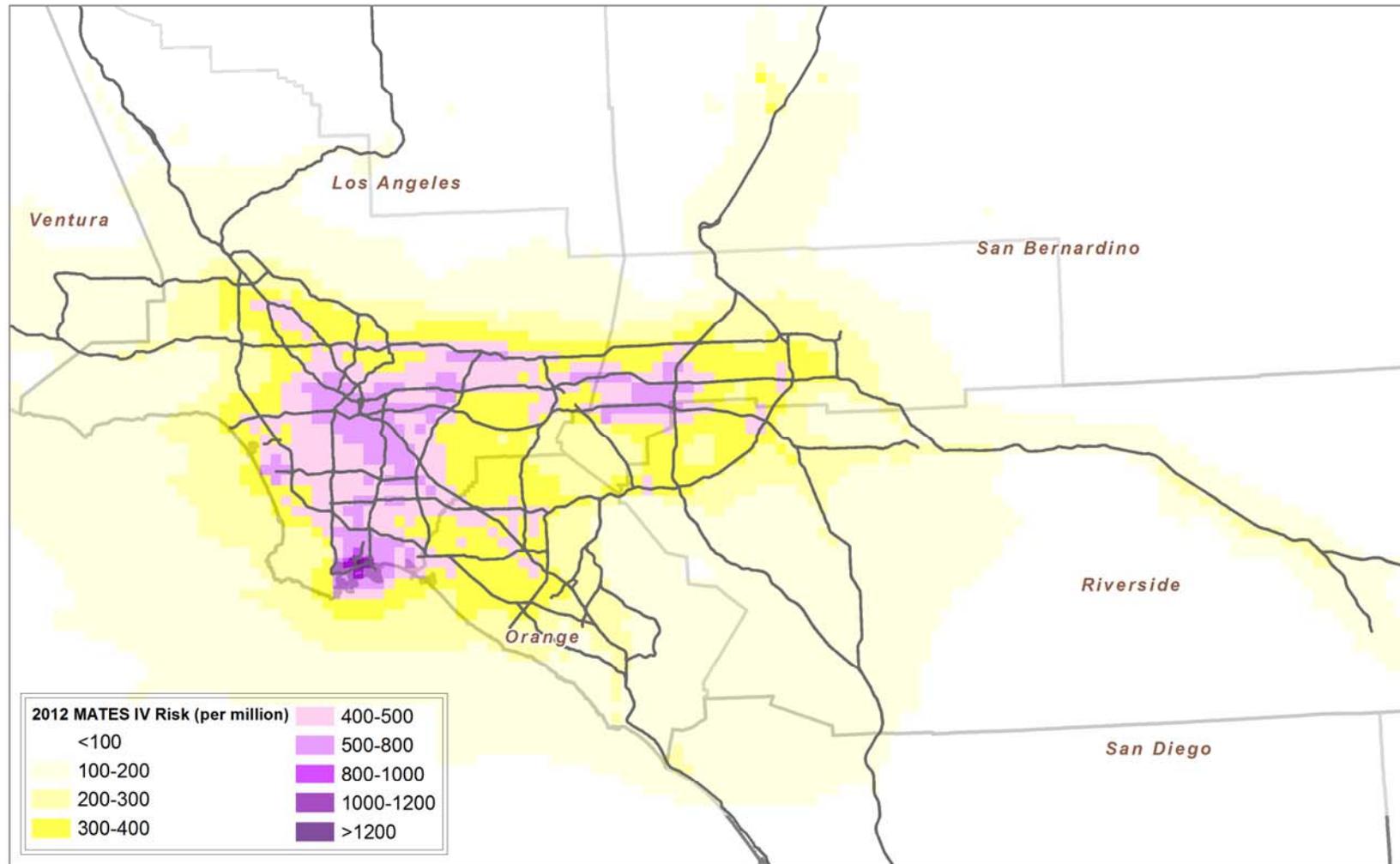
Figure 4-6
2012-2013 MATES IV CAMx RTRAC Simulated Air Toxic Cancer Risk
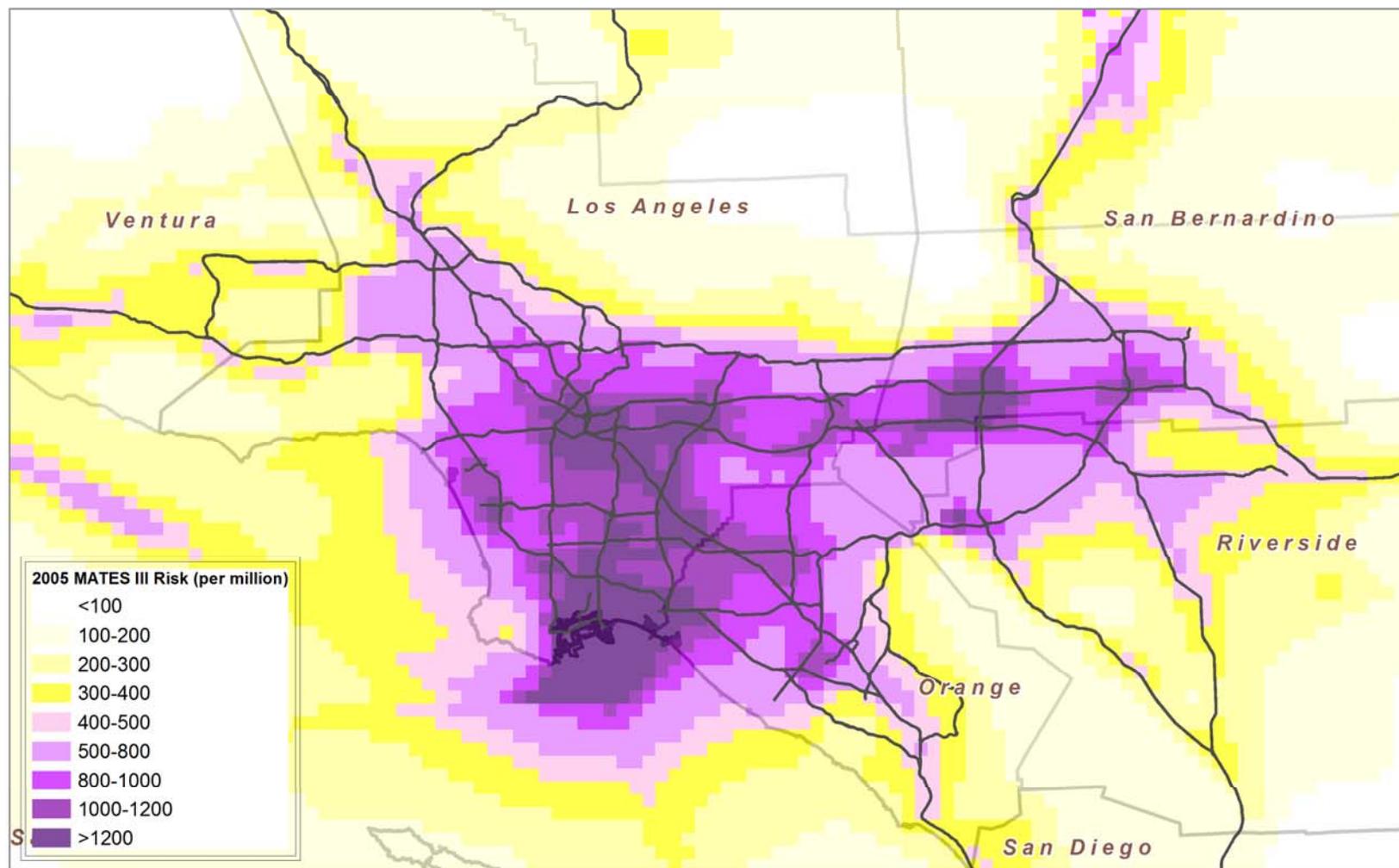
Figure 4-7
2005 MATES III CAMx RTRAC Simulated Air Toxic Cancer Risk
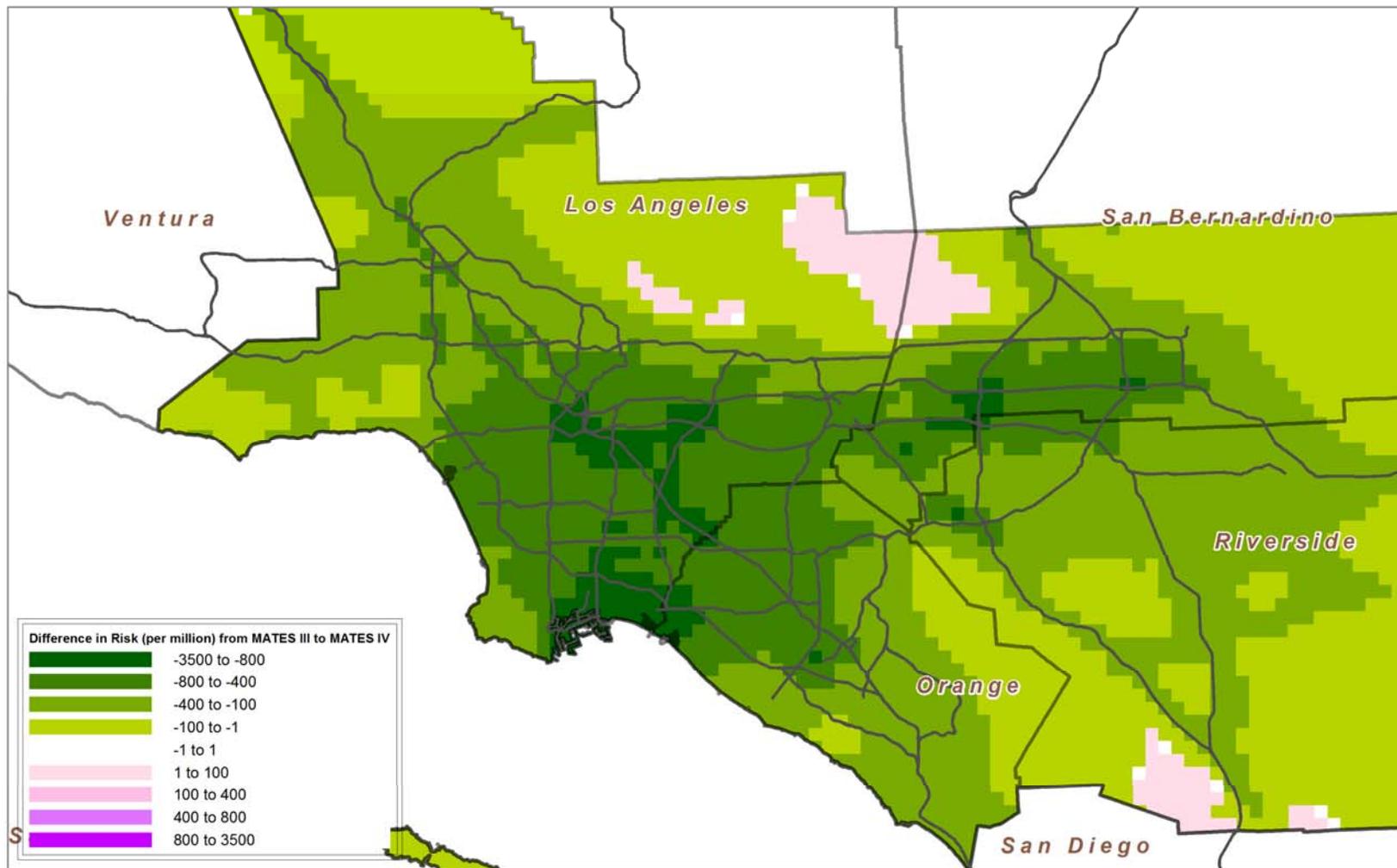
Figure 4-8
Change in CAMx RTRAC Simulated Air Toxics Cancer Risk (per million) from 2005 to 2012/2013
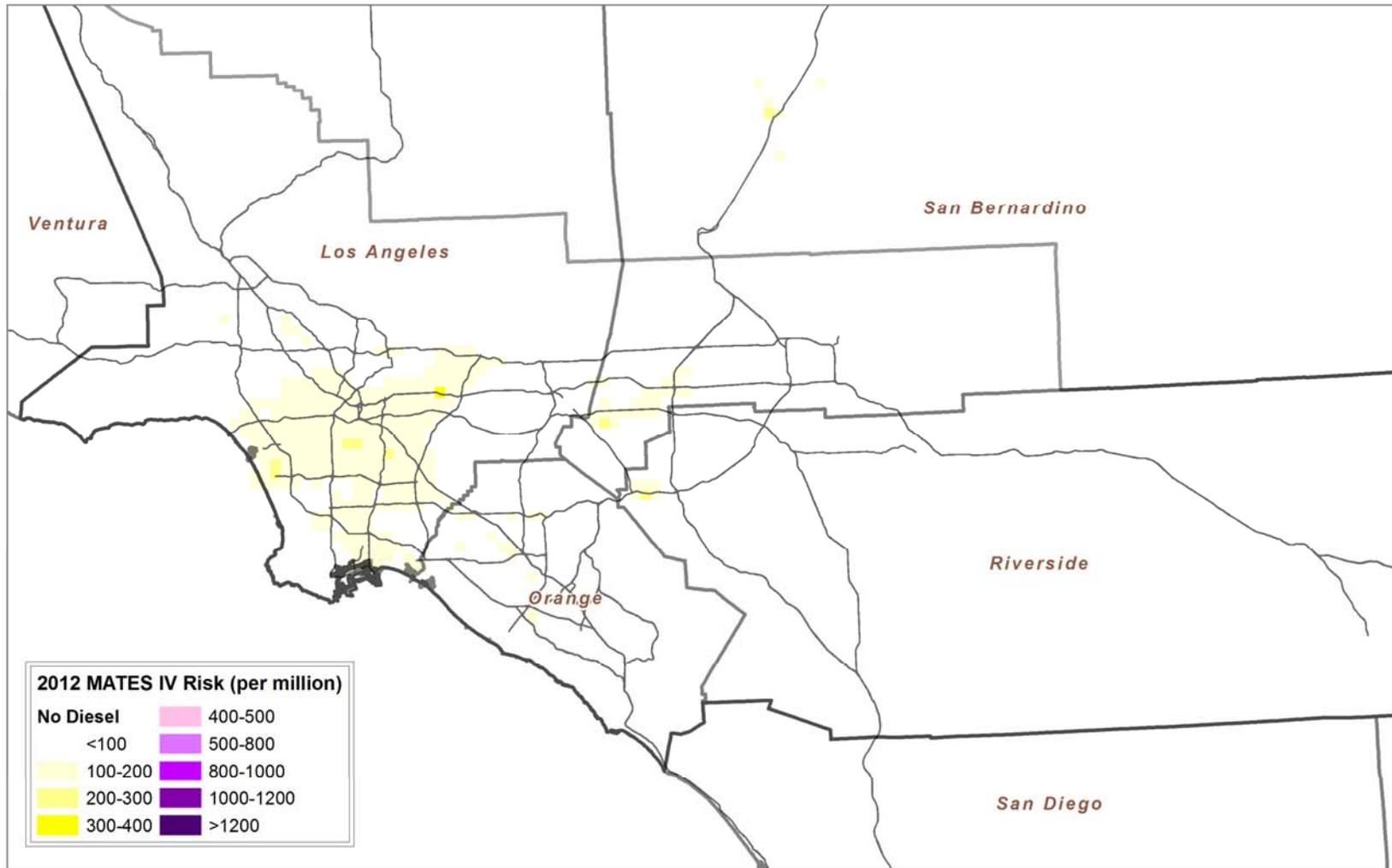
Figure 4-9
MATES IV Simulated Air Toxic Cancer Risk excluding Diesel PM
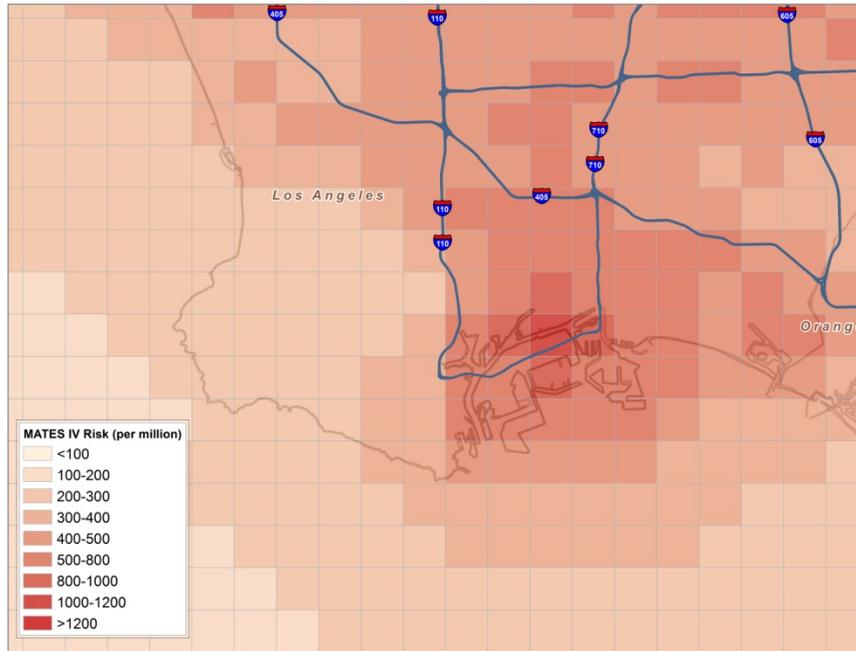
Figure 4-10
2012 Ports Area MATES IV Simulated Air Toxic Cancer Risk

Table 4-4
Basin and Port Area Population-Weighted Cancer Risk

Region	MATES IV		MATES III		Average Percentage Change in Risk
	2012 Population	Average Risk (Per Million)	2005 Population	Average Risk (Per Million)	
Basin	15,991,150	367	15,662,620	853	-57
Ports Area	998,745	480	959,761	1,415	-66
Basin Excluding Ports Area	14,992,806	359	14,702,859	816	-56

Figures 4-11 through 4-14 provide close-up depictions of risk in Central Los Angeles, Mira Loma, Colton, Central Orange County, and West Los Angeles areas, respectively.

Table 4-5 provides the county-by-county air toxics risk to the affected population. As presented in the spatial distribution, Los Angeles County bears the greatest average cancer risk at 415 per one million. The SCAB portion of San Bernardino County has the second highest projected risk at 339 per one million. The estimated risk for Orange County is 315 per million, and the SCAB portion of Riverside County was estimated to have the lowest population-weighted risk at 223 per million. As expected, the Coachella Valley portion of Riverside County, which is outside of SCAB, has the lowest toxic risk at 139 per million. It should be noted that these are county-wide averages, and individual communities could have higher risks than the average if they are near emissions sources, such as railyards or intermodal facilities.

Comparison of the county-wide population-weighted risk shows that the greatest reduction occurred in Orange County, but the amount of risk reduction among the counties is very similar. Reductions in emissions from mobile sources including benzene, 1,3-butadiene, and diesel particulate are the primary contributors to the improved county-wide risk. It is noteworthy that San Bernardino County now has higher population-weighted risk than Orange County. This is likely due to the port area having a proportionally larger impact in Orange County than in San Bernardino County.

Table 4-5
County-Wide Population-Weighted Cancer Risk

Region	MATES IV		MATES III		Average Percentage Change in Risk
	2012 Population	Average Risk (Per Million)	2005 Population	Average Risk (Per Million)	
Los Angeles*	9,578,586	415	9,887,127	951	-56
Orange	3,067,909	315	2,764,620	781	-60
Riverside*	1,784,872	223	1,548,031	485	-54
San Bernardino*	1,560,183	339	1,462,842	712	-52
SCAB	15,991,550	367	15,662,620	853	-57
Coachella Valley	465,064	139	N/A	N/A	N/A

*   Including the SCAB portion only
N/A - MATES III modeling did not include the Coachella Valley

Figure 4-11
2012/2013 Central Los Angeles MATES IV Simulated Air Toxic Cancer Risk

Figure 4-12
2012/2013 Mira Loma/Colton MATES IV Simulated Air Toxic Cancer Risk

Figure 4-13
2012/2013 Central Orange County MATES IV Simulated Air Toxic Cancer Risk

Figure 4-14
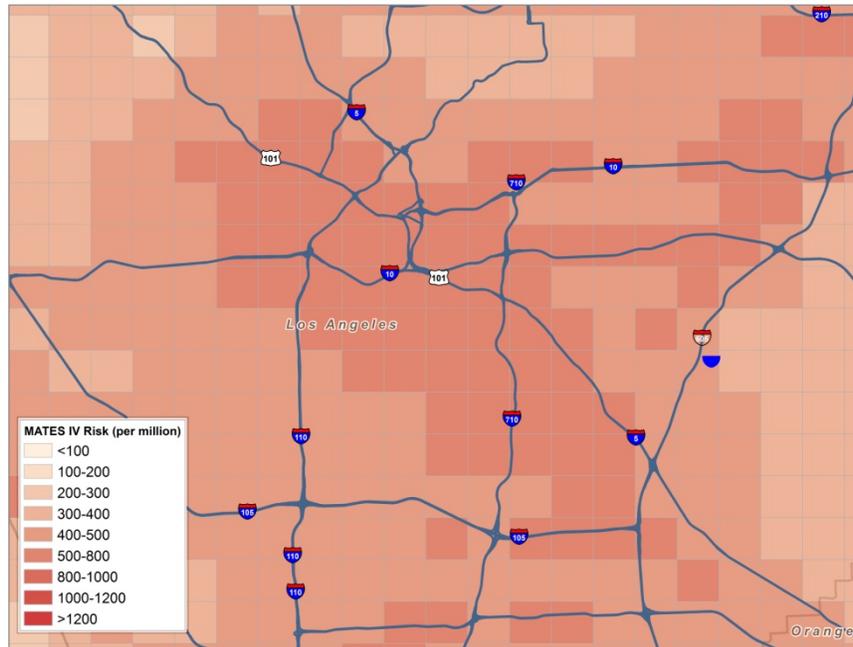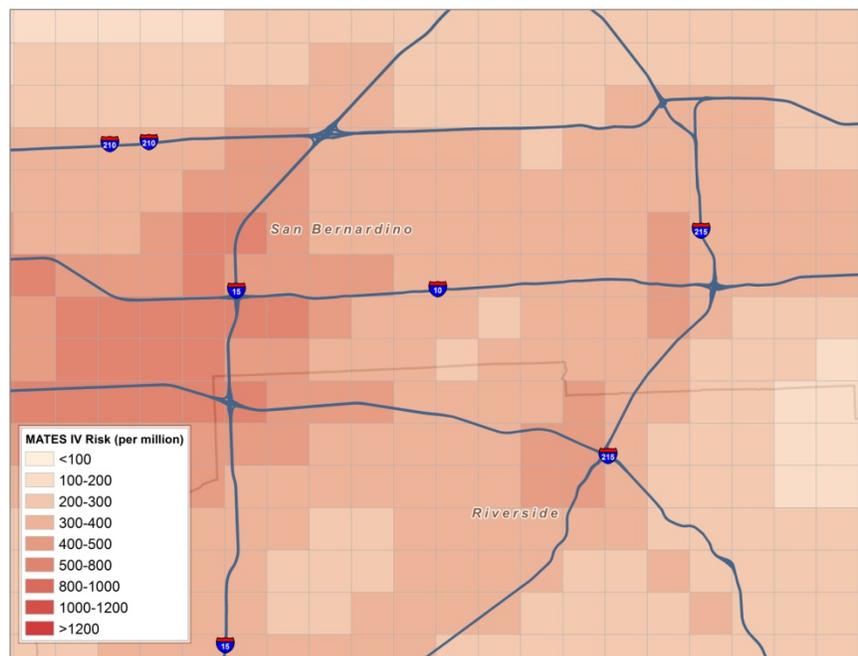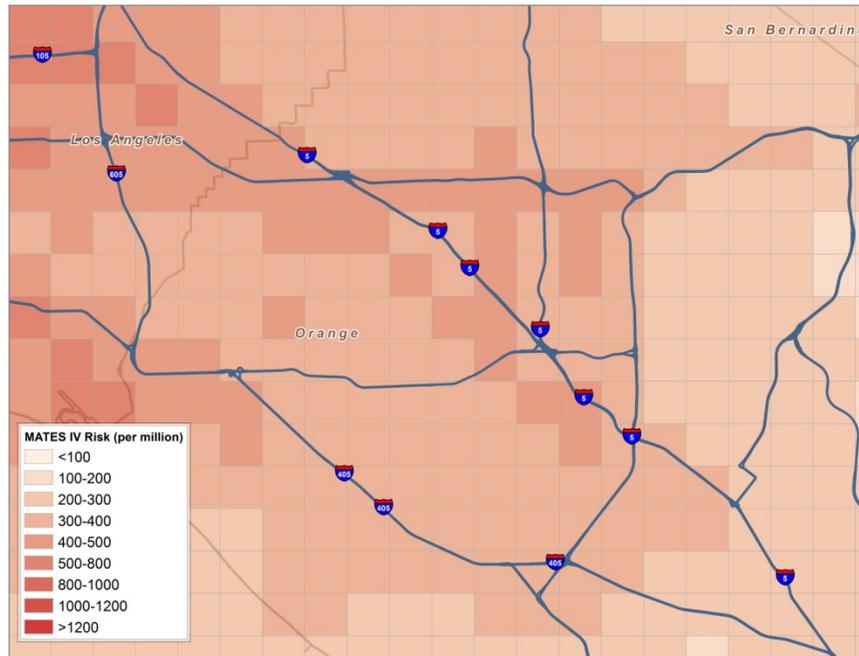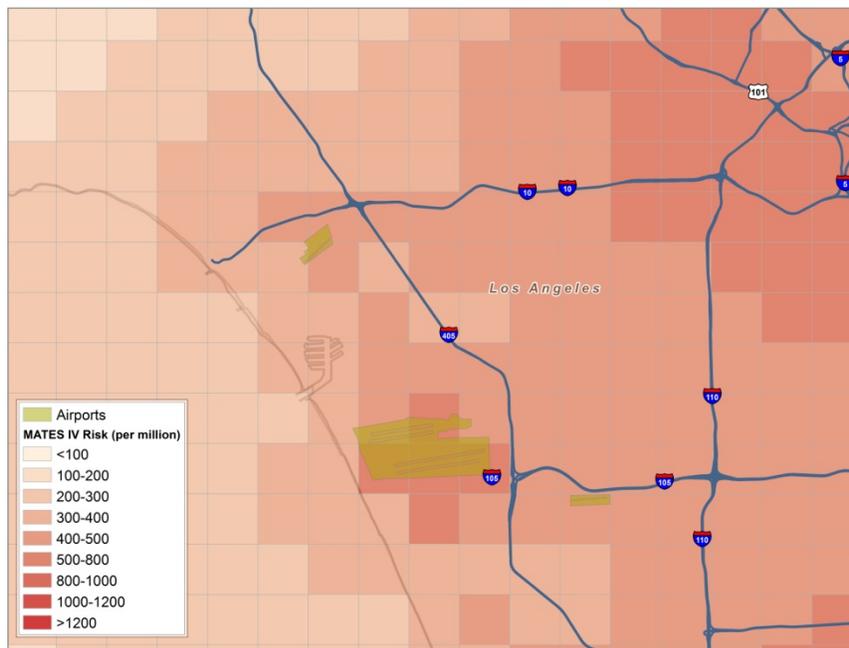2012/2013 West Los Angeles MATES IV Simulated Air Toxic Cancer Risk

Table 4-6 provides the Basin-wide average risk associated with each of the key air toxics simulated in the analysis. Diesel particulate was responsible for the largest contribution to cancer risk from air toxics. The next three highest contributors included benzene, hexavalent chromium, and 1,3-butadiene.

Table 4-6
2012/2013 MATES IV Cancer Risk from Simulated Individual Toxic Air Contaminants

Toxic Compound	Risk Factor ($\mu g/m^3$)	Peak Annual Average Concentration	Population Weighted Annual Average Concentration	Units	Cumulative Risk (per million)	% Contribution
Diesel	3.00E-04	3.1	0.93	$\mu g/m^3$	279.67	76.2
Benzene	2.90E-05	0.51	0.25	ppb	22.82	6.2
Hexavalent Chromium	1.50E-01	0.001	1.37E-04	$\mu g/m^3$	20.52	5.6
1,3- Butadiene	1.70E-04	0.58	0.03	ppb	12.54	3.4
Secondary Formaldehyde	6.00E-06	2.35	1.24	ppb	9.12	2.5
Primary Formaldehyde	6.00E-06	2.71	0.50	ppb	3.7	1.0
Secondary Acetaldehyde	2.70E-06	0.93	0.73	ppb	3.56	1.0
Arsenic	3.30E-03	0.043	9.97E-04	$\mu g/m^3$	3.29	0.9
p-Dichlorobenzene	1.10E-05	0.11	4.38E-02	ppb	2.90	0.8
Perchloroethylene	5.90E-06	0.356	0.07	ppb	2.71	0.7
Naphthalene	3.40E-05	0.03	9.87E-03	ppb	1.76	0.5
Cadmium	4.20E-03	0.014	3.29E-04	$\mu g/m^3$	1.38	0.4
Nickel	2.60E-04	0.11	3.69E-03	$\mu g/m^3$	0.96	0.3
Primary Acetaldehyde	2.70E-06	0.67	0.16	ppb	0.80	0.2
Methylene Chloride	1.00E-06	0.59	0.21	ppb	0.74	0.2
Trichloroethylene	2.00E-06	0.39	3.08E-02	ppb	0.33	0.1
Lead	1.20E-05	0.065	4.17E-03	$\mu g/m^3$	0.05	<0.1

Table 4-7 provides the simulated air toxics risk at each of the 10 stations for the three main toxic compounds and the remaining aggregate based on the regional modeling. Risk is calculated using the predicted concentrations of each toxic component for the specific monitoring station location (based on a nine-cell weighted average concentration). The summary also provides the comparison between simulated average risk for the 10 stations combined and the average risk calculated using the annual toxic compound measurements and the estimated diesel concentrations at those sites.

Table 4-7
Comparison of Network Averaged CAMx RTRAC 2012-2013 Modeled Cancer Risk to Measured Risk at the 10 MATES IV Sites

Location	2012/2013 MATES IV CAMX RTRAC Simulation				
	Benzene	1,3-Butadiene	Diesel	Others	Total
Anaheim	26	14	301	54	395
Burbank	27	13	333	59	431
Central Los Angeles	33	19	516	78	646
Compton	26	17	383	63	489
Inland Valley San Bernardino	21	9	309	61	400
Huntington Park	30	62	389	96	576
North Long Beach	27	16	395	65	503
Pico Rivera	25	13	358	62	459
Rubidoux	20	7	296	46	369
West Long Beach	32	15	662	69	778
10-Station Average Modeled	27	18	394	65	505
10-Station MATES IV Average Measured (EC$_{2.5}$ x 0.82 for Diesel)	35	33	287	47*	402

*Including modeled species only, Risk from some measured species, such as carbon tetrachloride, chloroform and PAHs are excluded.

Among the monitored areas, the highest simulated risk was estimated for West Long Beach followed by Central Los Angeles, Huntington Park, North Long Beach, and Compton. The lowest modeled risk was simulated at Anaheim. As previously discussed, simulation performances at those high risk sites showed a tendency for overprediction relative to measurements.

Cancer risk averaged over the 10 stations was simulated as 505 in a million, which is approximately 25% higher than the estimate from the measurements. This includes the

contribution of diesel particulates. An emission based conversion factor of 0.82 was applied to the $EC_{2.5}$ measurements in order to estimate the diesel PM contributions (See Chapter 2).

The nondiesel portion of the simulated cancer risk can be directly compared to risk calculated from the toxic compound measurements. Figure 4-15 presents a comparison of the model simulated and measurement estimated nondiesel risk at each monitoring site, as well as the 10-station average. Simulated nondiesel risk is within 30% of measurements at all stations. The simulated 10-station average cancer risk agrees very well with the risk estimated from the measurements.
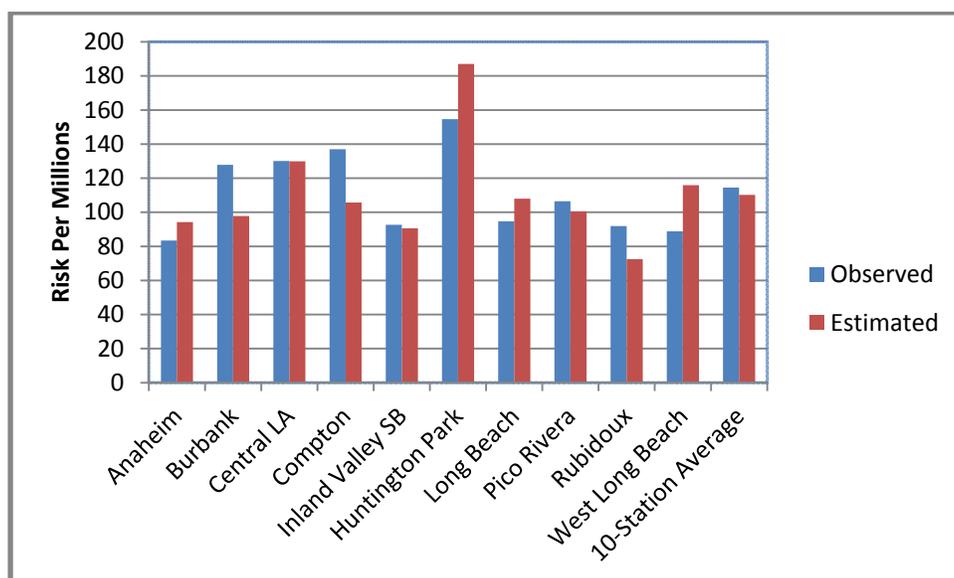

Figure 4-15
2012/2013 MATES IV Simulated vs. Measured NonDiesel Air Toxics Risk

4.5   Evaluation

The population-weighted average Basin air toxics risk (367 per million) simulated using CAMx RTRAC for the 2012-2013 MATES IV period was estimated to be 57% lower than that estimated (853 in a million) for the MATES III period. The areas of the Basin that are exposed to the most risk continue to be the Ports of Los Angeles and Long Beach with a secondary maximum occurring in an area around a railyard in Los Angeles.

A majority of the risk reduction was due to a 66% reduction in diesel emissions from 2005 to 2012. The emissions reductions of benzene (11%), 1,3-butadiene (50%), arsenic (43%) and other air toxics also contribute to the overall reduction in 2012/2013 simulated risk. A general assessment of the observed meteorological conditions for the two simulated years suggests that the two monitoring periods had comparable potentials for pollutant dispersion.

4.6   Updates to Cancer Risk Estimation Methods

The California Environmental Protection Agency Office of Environmental Health Hazard Assessment (OEHHA) has adopted revised methods for estimating cancer risks (CalEPA, 2015). The proposed new method includes utilizing higher estimates of cancer potency during early life exposures. There are also differences in the assumptions on breathing rates and length of residential exposures. When combined together, staff estimates that risks for the same inhalation exposure level will be about 2.5 times higher using the proposed updated methods. This would be reflected in the average lifetime air toxics risk estimated from the monitoring sites data going from 418 per million to an 1023 per million. While the previous method is used to compare results with past studies, staff notes that using the updated method would give the same percentage change in risks for previous MATES study estimates.

Under the revised risk assessment methodology, OEHHA has made refinements to be more health protective of children. Among other things, age sensitivity factors (ASFs) are now included in the risk calculations. These factors increase the carcinogenic potency by a factor of 10 for exposures occurring between 0 and 2 years of age, and increase the potency by a factor of 3 for exposures between ages 2 and 16.   Refinements have also been made to the intake rates (e.g., breathing and ingestion rates) for the various exposures pathways (inhalation, soil, dermal, etc.) by age as well. For example, instead of using a single estimate of lifetime breathing rate for a point estimate of risk, point estimates of breathing rate for various age groups are applied. These latter two changes increase the estimate of dose at a given exposure concentration. An additional change is using 30 years as the time of residence at a given receptor rather than the current 70 years. This latter change decreases the estimate of dose at a given concentration. Applying these changes in age specific potency factors, age specific breathing rates and time of residence gives the overall estimate of the change in risk from inhalation exposures of about a 2.5 fold increase. [1] Unit Risk Factors were calculated based on the revised methodology and are show in Appendix I.

Applying the calculated Unit Risk Factors based on the update methodology to the modeled ambient levels gives a higher estimated risk across the SCAB as depicted in Figure 4-16. As shown, the revised risk levels based on the revised methodology are similar to those originally calculated for the MATES III study using the then current risk assessment methodology.

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[1] In the October, 2014 Draft MATES IV Report, the increased in risk estimates was given as a 2.7 fold increase. This was based on using the 90th percentile of breathing rate distribution. In anticipation of CARB guidance for risk management, we have used the 80th percentile of the breathing rate distribution for ages greater than 2 years. This resulted in a 2.45 fold change in the estimate of risk.
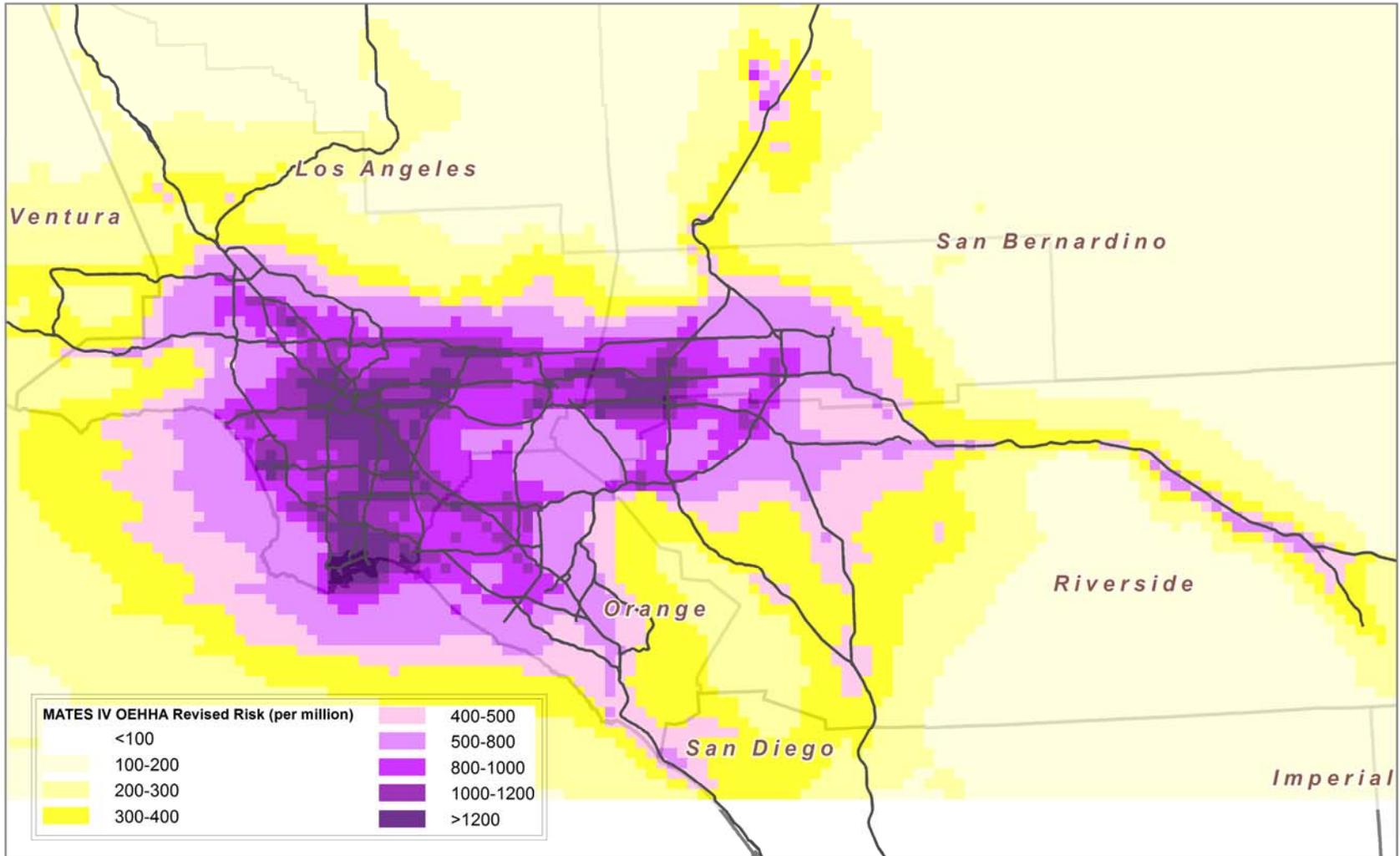
Figure 4-16
MATES IV Modeled Air Toxics Risks Estimates using OEHHA Updated Method

4.7   Comparison with Another Pollution Impacts Mapping Tool (CalEnviroScreen)

Below is a comparison of the MATES IV estimated diesel PM emissions with that of another analysis that estimated emissions of this substance, the California Communities Environmental Health Screening Tool (CalEnviroScreen).

The California Communities Environmental Health Screening Tool (CalEnviroScreen) has been developed by the Office of Environmental Health Hazard Assessment (OEHHA) and California Environmental Protection Agency (CalEPA). It is a science-based guidance and screening tool aiming to assess the cumulative impacts of environmental pollution in California communities. It is primarily designed to identify disadvantaged communities and is used to assist planning and decision-making such as administering environmental justice grants, prioritizing cleanup activities and guiding environmental community programs. Unlike MATES, which is a quantitative health risk assessment, CalEnviroScreen is a screening methodology that provides a relative ranking of impacted communities, and is not intended to be comparable to full risk assessments.

In August 2014, CalEnviroScreen version 2.0 (CES 2.0) was released. CES 2.0 produces results at the census tract level with approximately 8,000 census tracts in California and approximately 3,600 tracts within the jurisdiction of SCAQMD. The CES 2.0 model consists of two component groups – pollution burden and population characteristics. A set of statewide indicators (Table 4-8), selected based on existing environmental, health, demographic and socioeconomic data, is used to characterize pollution burden and population characteristics. Note that up to three pollution burden exposure indicators (diesel PM emissions, traffic density, and toxic releases) have potential to correspond to the emissions data that was used for MATES IV analysis.

Table 4-8
Indicators used to Represent Pollution Burden and Population Characteristics in
CalEnviroScreen 2.0

Component Group 1: Pollution Burden		Component Group 2: Population Characteristics	
Exposures	Environmental Effects	Sensitive Populations	Socioeconomic Factors
PM 2.5 concentrations	Cleanup sites	Children and elderly	Educational attainment
Ozone concentrations	Groundwater threats	Asthma emergency department	Linguistic isolation
Diesel PM emissions	Impaired water bodies	Low birth weight births	Poverty
Pesticide use	Solid waste sites and facilities		Unemployment
Toxic releases from facilities	Hazardous waste		
Traffic density			
Drinking water quality			

For each indicator, a value is assigned for each census tract. Among the areas with an indicator value, the values are ranked from highest to lowest and a statewide percentile score is created for each indicator in each census tract. The percentile score for all individual indicators is averaged in each component group and then divided by the maximum value observed in the State. In the pollution burden component group, environmental effects indicators are weighted half as much as the exposure indicators. The component group scores are both scaled to a maximum of 10 with a possible range of zero to 10. Finally, the overall CES score is calculated by multiplying the scaled component group score for pollution burden by the scaled component group score for population characteristics. The highest possible CES percentile score is 100 with an equal contribution from the two component groups. An area with a high score would be expected to have higher pollution burdens and vulnerabilities than other areas with low scores. More details

about the indicator selection and scoring, model characteristics and methodology can be found in the CES 2.0 documentation.

Figure 4-17 depicts the CES 2.0 score in SCAQMD highlighting the census tracts scoring in the highest percentiles across the state. Most urbanized areas are in the top 30% score, indicating these tracts have relatively high pollution burdens and population sensitivities compared to other communities in the State. In particular, a significant fraction of census tracts in the Los Angeles, Riverside and San Bernardino counties are in the top 10% of the relative statewide scoring.
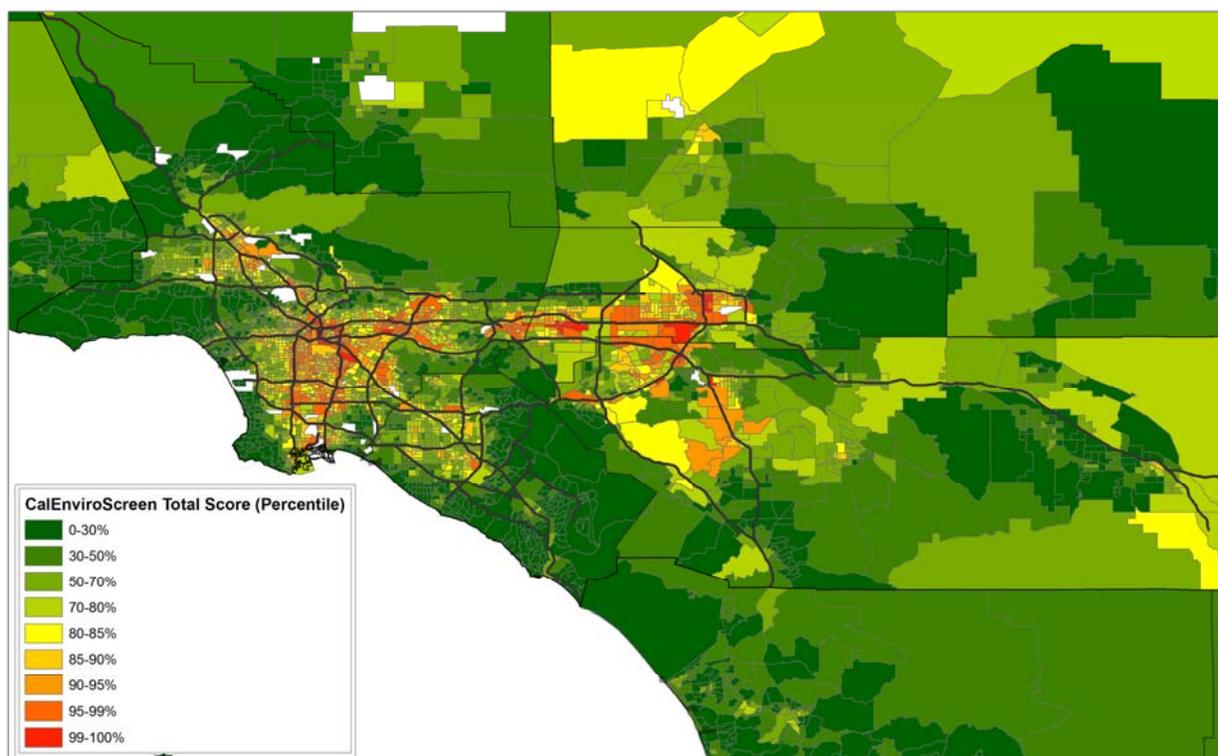

Figure 4-17
CalEnviroScreen 2.0 Overall Scores. *Data retrieved from OEHHA in September 2014.*

Within the pollution burden component, five out of the 12 indicators (PM$_{2.5}$ concentrations, ozone concentrations, diesel PM emissions, toxic releases from facilities and traffic density) are utilized to fully or partially characterize air pollution exposure. CES 2.0 estimates diesel PM emissions based on emission inventories and models similar to those used in MATES IV. On-road diesel PM emissions are calculated using California Air Resources Board (CARB)'s EMFAC 2013 for a 2010 summer day in July, and non-road diesel PM emissions are estimated from CARB's emission inventory forecasting system (CEPAM). County-wide estimates are distributed to 4 km grid cells and allocated to census tracts. Figure 4-18 shows the statewide percentile score of diesel PM emissions. Central Los Angeles and the Long Beach Port area score the highest (top 1%, shown as red color) in the State.

The diesel PM emissions in the MATES IV period (July 2012 to June 2013) are shown in Figure 4-19. Despite different study time period and geographical units, the spatial distribution of diesel PM emissions in MATES IV is similar to the diesel PM emission pattern in CES 2.0. Both

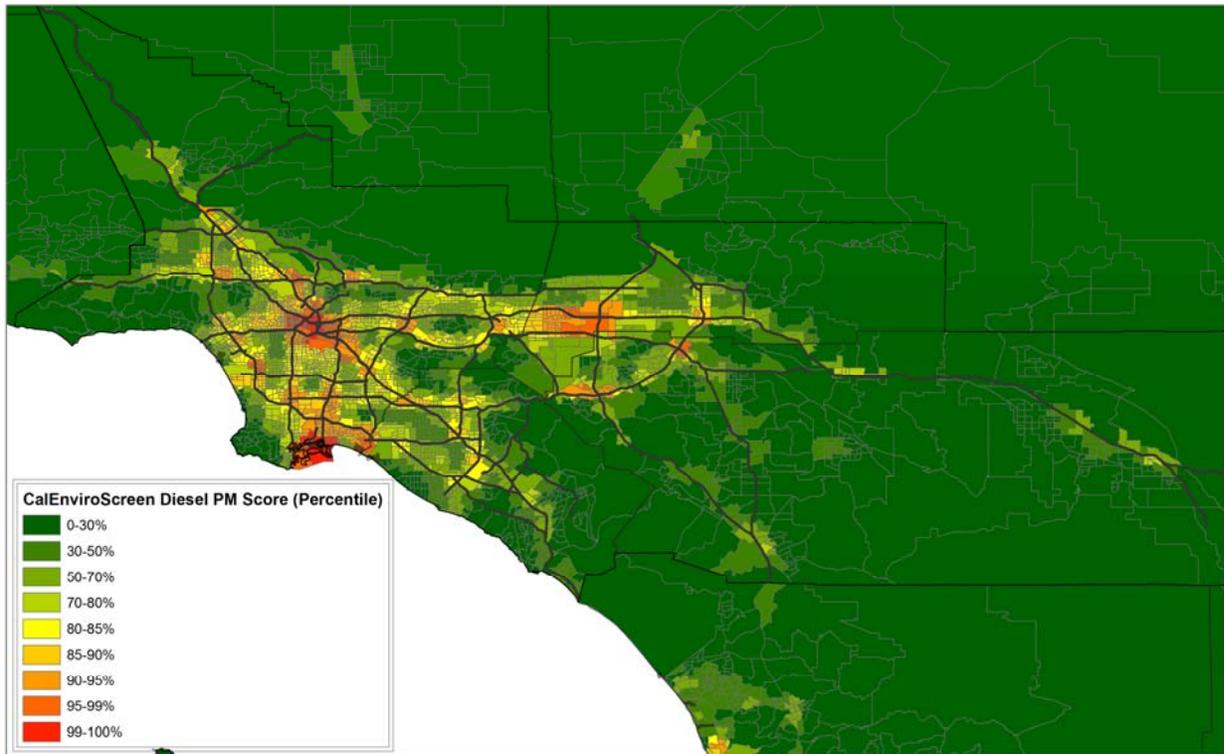models yield the highest diesel PM emissions in Central Los Angeles and in the area near the Ports.

Figure 4-18
CalEnviroScreen 2.0 Diesel PM Scores. *Data retrieved from OEHHA in September 2014.*
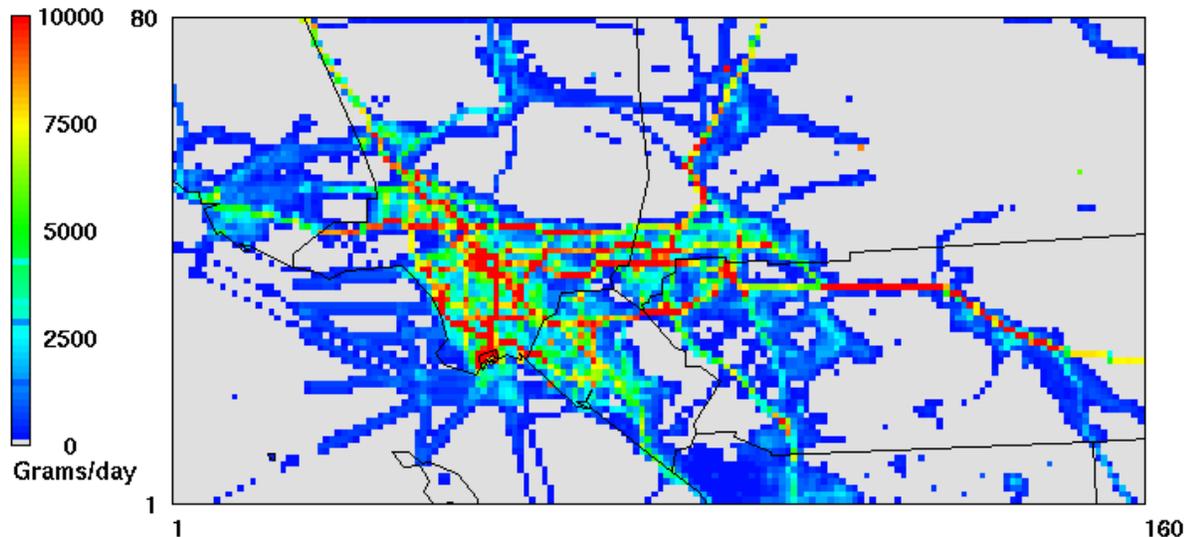
Diesel Emissions (PM2.5)

Figure 4-19
Weekday average emissions pattern for Total Diesel PM$_{2.5.}$

While CalEnviroScreen can assist CalEPA in prioritizing resources and helping promote greater compliance with environmental laws, it is important to note some of its limitations. The tool's output provides a relative ranking of communities based on a selected group of available datasets, through the use of a summary score. Unlike MATES, the CalEnviroScreen score is not an expression of health risk, and does not provide quantitative information on increases in cumulative impacts for specific sites or projects. Further, as a comparative screening tool, the results do not provide a basis for determining when differences between scores are significant in relation to public health or the environment. Accordingly, CalEnviroScreen is not intended to be used as a health or ecological risk assessment for a specific area or site.

4.8   References

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CHAPTER 5

ULTRAFINE PARTICLES AND BLACK CARBON MEASUREMENTS

Chapter 5   Ultrafine Particles and Black Carbon Measurements

5.1 Introduction

One of the key findings of the MATES III Study was that diesel particulate matter (DPM) accounts for over 80% of the total carcinogenic risk due to exposure to air toxics in the South Coast Air Basin (SCAB) (MATES III; SCAQMD, 2008). DPM is mostly comprised of impure carbon particles (soot) resulting from the incomplete combustion of diesel-type fuels and is often emitted along with ultrafine particles (UFP) and other combustion products. Soot is often referred to as black carbon (BC) or elemental carbon (EC) depending on the measurement method used (see Chapter 2 for details). In urban areas, EC and BC are often considered good surrogates for DPM. Although EC and BC are currently unregulated, the implementation of national, state and local regulations and programs to mitigate fine PM (i.e. $PM_{2.5}$) and diesel emissions often results in the control of EC and BC.

While substantial effort has been made to characterize the health risks associated with exposure to $PM_{2.5}$ in general and DPM in particular, the health impact caused by exposure to UFPs is still not well-understood. These very small particles have a diameter of 100 nm or less, consist of organic material, soot, trace metals, and are likely to be more toxic than larger PM fractions. Because of their small size, UFPs can penetrate deeply into the respiratory tract, into the bloodstream, and can be transported to other critical organs such as the heart and the brain. Thus, exposure to UFPs can potentially cause adverse health effects (both acute and chronic) in humans (HEI, 2010).

In an attempt to better characterize their spatial and temporal variations in the SCAB, potential sources and mechanism of formation, and their potential impact on public health, continuous measurements of UFP and BC concentrations were taken at all 10 MATES IV fixed sites, using state-of-the-art methods and techniques that were not mature at the time of MATES III.

BC measurements (i.e. 1- to 5-min. time resolution) were carried out using two different types of Aethalometers (AE22; Magee Scientific, Berkeley, CA; and AE33; Teledyne API, San Diego, CA). These are instruments that continuously measure the light transmission through particulate matter (PM) collected on a sampling filter. Specifically, they utilize the light-absorbing properties of BC-containing particles at a wavelength of 880 nm in order to gain a light absorption coefficient, which is related to the particulate BC mass concentration. Aethalometers are small, reliable, easy to operate, provide continuous real-time data, and are the most common instruments used to measure ambient BC. The principle of operation of both types of Aethalometers used during MATES IV is described in detail in Appendix III.

Ultrafine particle number concentration data was collected continuously (i.e. 1-min. time resolution) using water-based condensation particle counters (CPC Model 651; Teledyne API, San Diego, CA). This instrument provides the total number concentration of particles above 7 nm in real-time. UFPs are grown through condensation in a controlled super-saturation environment to larger sizes that can be detected and counted using a photodetector. The particular model used during MATES IV was specifically designed for routine ambient air quality monitoring in network applications (See Appendix VII for details).

Continuous BC and UFP measurements were conducted at all 10 fixed MATES IV locations (i.e. West Long Beach, North Long Beach, Compton, Huntington Park, Pico Rivera, Central Los Angeles, Burbank, Inland Valley San Bernardino, Rubidoux, and Anaheim) for a period of at least 12 months from July 2012 until the end of June 2013, or beyond. Only data collected from July 1, 2012, through June 30, 2013 have been included for the present report. The SCAQMD is committed to achieving the highest possible data quality level. A comprehensive summary of the data review and validation procedures is provided in Chapter 2 and Appendix III.

5.2 Measurement Results

The spatial and temporal variations in BC and UFP concentrations discussed below provide invaluable information regarding daily and seasonal patterns and, more importantly, potential source contributions of these two air pollutants throughout the SCAB.

5.2.1 Spatial Variations

Figure 5-1 shows the study average BC concentration at each of the 10 fixed sites, along with the overall Basin average BC concentration [MATES IV (AVG)] and the Basin average EC concentration for both MATES III and MATES IV [MATES III (EC) and MATES IV (EC), respectively][1]. Typically, the highest BC levels were observed at the more urban sites located near major roadways (i.e. Burbank, Central Los Angeles, Pico Rivera and Huntington Park) and at inland/receptor sites such as Inland Valley San Bernardino and Rubidoux. While BC was not measured during MATES III, the average EC levels decreased substantially (about 35% reduction) from MATES III to MATES IV (See Chapter 2).

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[1] BC and EC both refer to impure carbon particles resulting from combustion processes. While these terms are often used interchangeably, they are two methodologically-defined species that are measured using optical and thermal-optical methods, respectively. A comprehensive comparison between BC and EC measurements is available in Appendix VI.
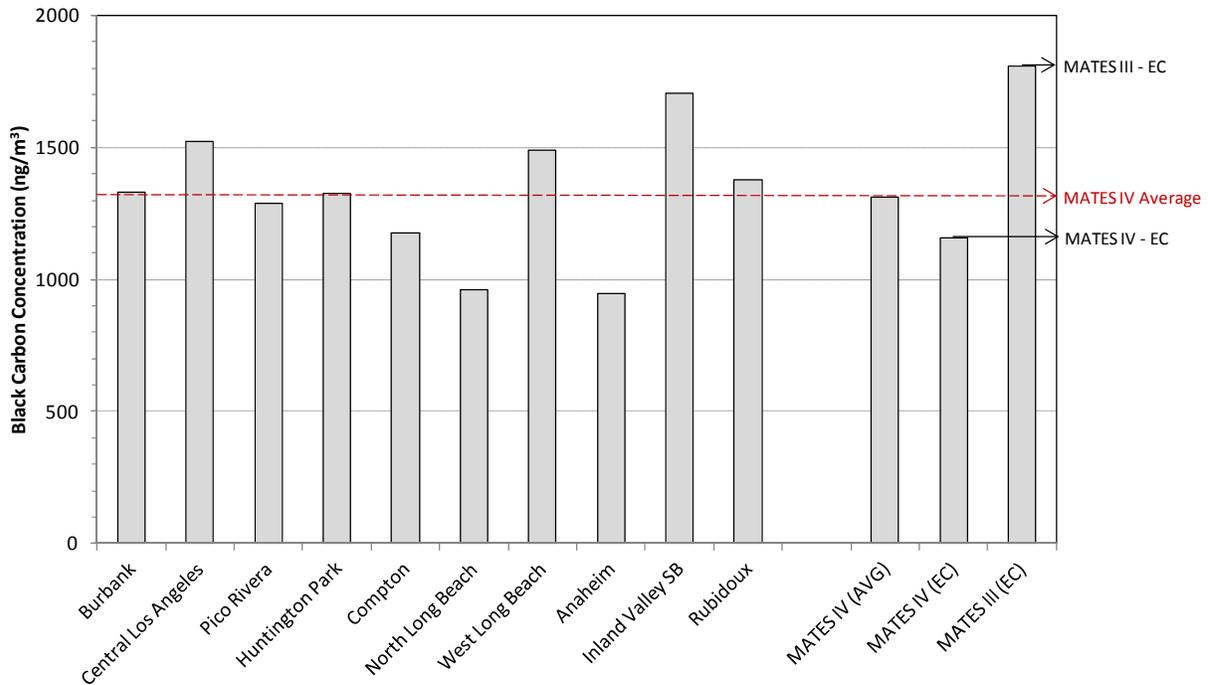
Figure 5-1 – Spatial Distribution of Average Black Carbon (BC) Concentrations during MATES IV and Comparison with MATES IV and MATES III Elemental Carbon (EC) Averages.

Sampling sites located near heavily-trafficked freeways are usually characterized by increased levels of UFPs compared to more rural sites. For this reason the West Long Beach site (located in a highly industrial area near the San Pedro Bay Port complex) exhibited the highest study average UFP concentration during MATES IV (Figure 5-2).

In particular, BC and UFP levels in West Long Beach are probably affected by emissions from the Terminal Island Freeway 103 located upwind of the sampling station, where vehicular traffic from goods movement associated with the San Pedro Bay Ports is particularly pronounced. Similarly, emissions from railroads and goods movement are likely to contribute to the elevated study average UFP concentration observed at the Huntington Park site (Figure 5-2).
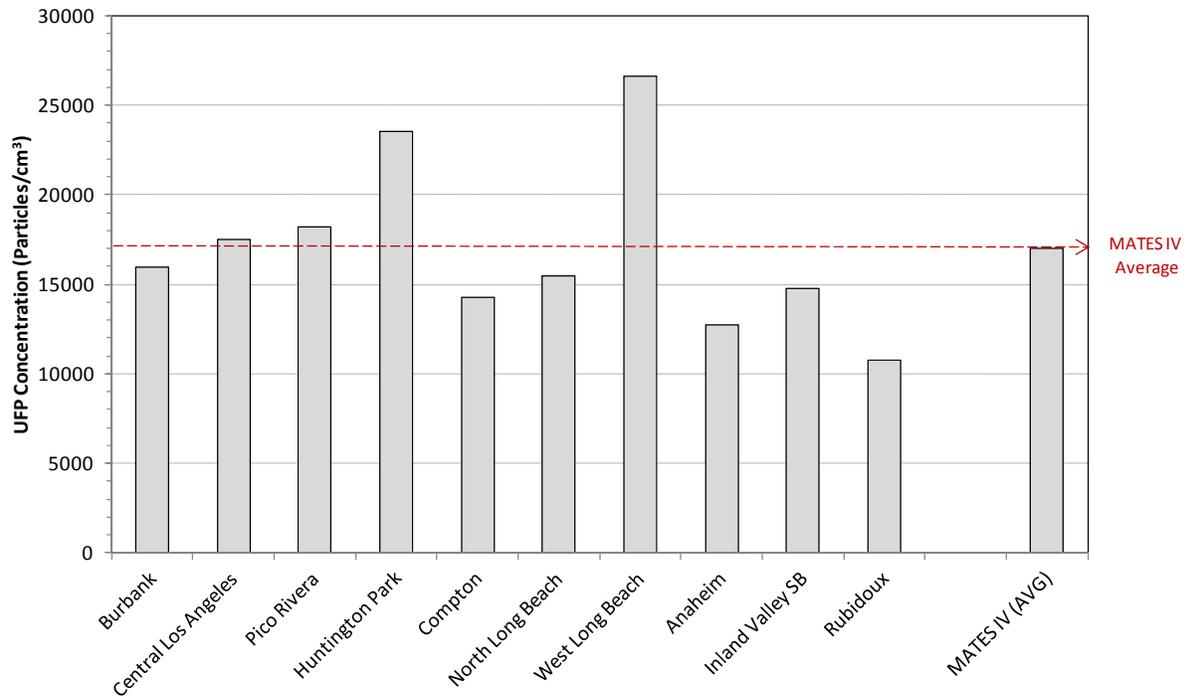
Figure 5-2 – Spatial Distribution of Average Ultrafine Particle (UFP) Concentrations during MATES IV.

5.2.2 Temporal Variations

Both BC and UFP exhibited considerable daily, monthly, and seasonal variations. Studying these variations can yield insights into potential contributions from local and regional sources. Hourly average measurements (discussed in Appendix VI and VII) can also provide estimates of the frequencies and magnitudes of high concentrations to which the SCAB population might have been exposed.

5.2.2.1 Monthly Trends

Occurrences of high daily mean BC and UFP concentrations were observed mostly during the colder months (November to February), as shown in Figures 5-3 to 5-5. Conversely, concentrations during the spring and summer months (April to August) were distinctly lower.

As mentioned earlier, vehicular diesel exhaust often contributes to increasing the ambient concentration of BC at most sites. Other potential sources may include industrial emissions (particularly diesel-powered), meat charbroiling, biomass burning, and heavy fuel oil combustion (ship emissions). Emissions from these sources often show some seasonality and may impact the spatial distribution of BC within the Basin (Magliano, 1999; Reinhart, 2006). For instance, the higher BC concentrations observed during the winter season can be partly attributed to enhanced BC emissions from increased usage of wood burning for space heating (Jordan, 2006; Fine, 2004). Variations in meteorological conditions are another important contributing factor. The boundary layer in the winter is much shallower than in the summer; this causes a lowering of the "mixing height," less atmospheric transport and dilution, and thus a consequent increase in atmospheric BC concentrations.
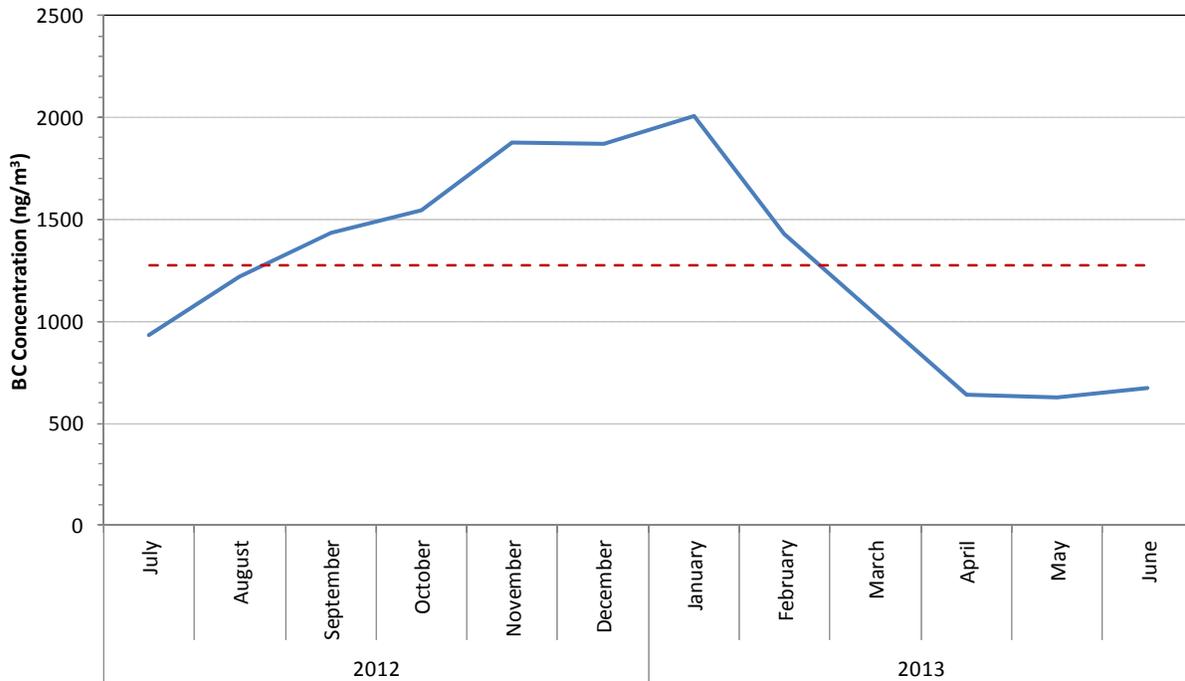
Figure 5-3- Monthly Average Black Carbon (BC) Concentration Trends in the South Coast Air Basin During MATES IV. The Red Line Represents the Study Average BC Concentration During MATES IV.

These seasonal trends are further highlighted in Figure 5-4, where BC concentrations for each site were averaged over a period of three months (i.e. summer: June, July and August; fall: September, October and November; winter: December, January and February; and spring: March, April and May).
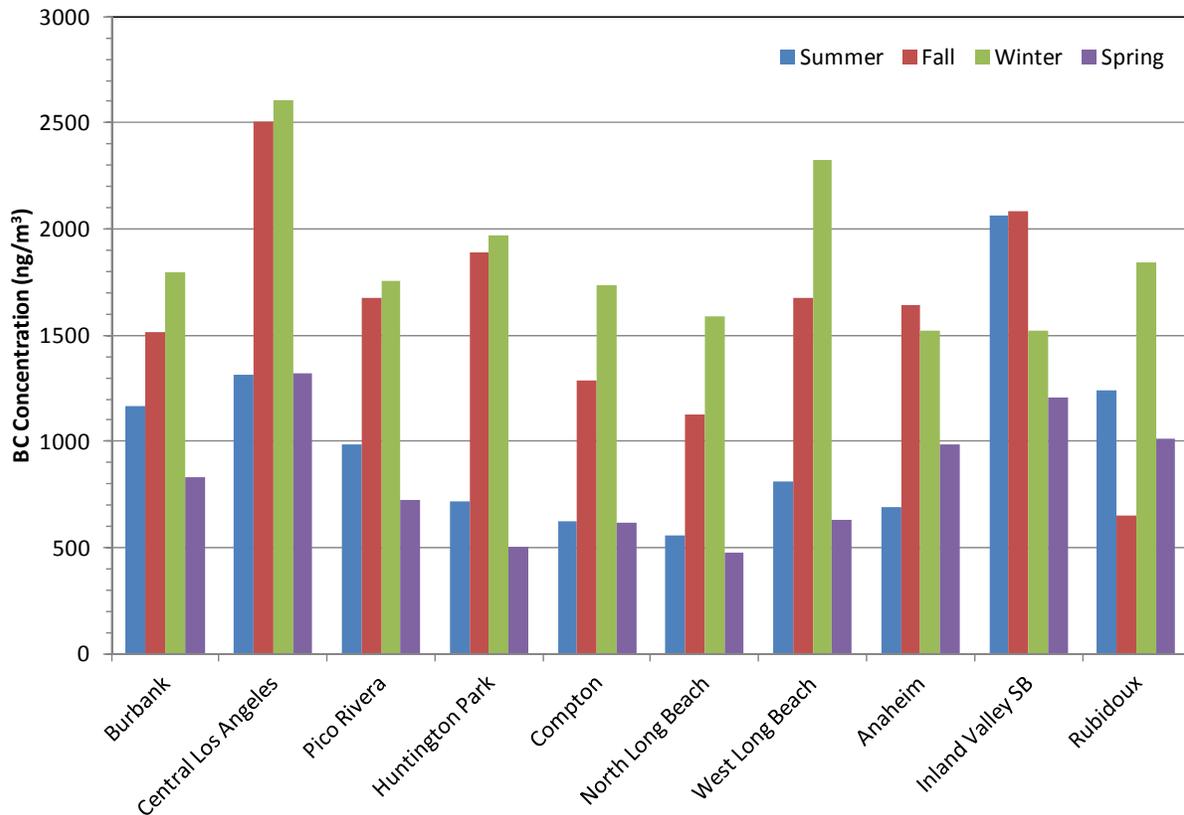
Figure 5-4 - Seasonal Variations of Black Carbon (BC) Concentrations at Each MATES IV Site.

Figure 5-5 displays the seasonal variation in UFP concentration for all 10 fixed monitoring sites. In most instances, the winter months were characterized by increased UFP levels. This is because, in the winter, decreased ambient temperatures and lower mixing heights led to less atmospheric particle dilution and favor the formation of a larger number of small UFP particles (Kittleson 1998, Wang et al. 2013).
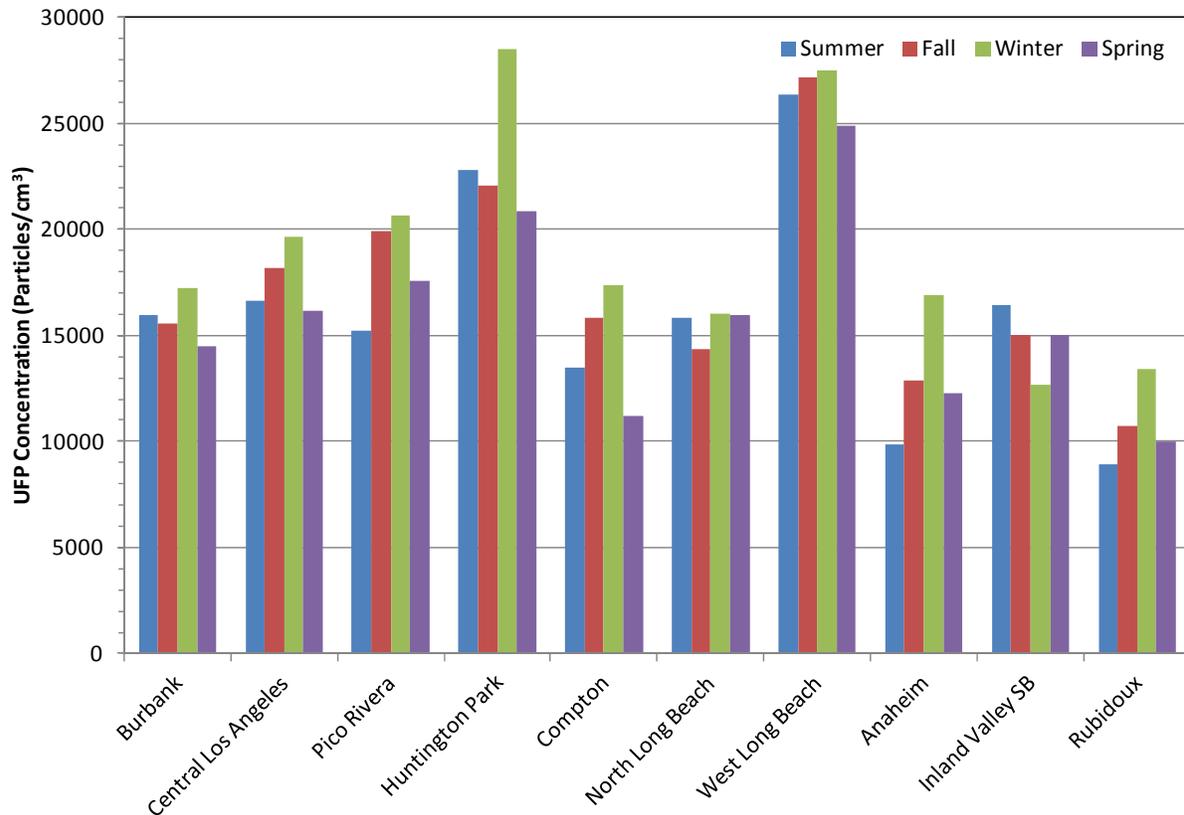
Figure 5-5 - Seasonal Variations of Ultrafine Particle (UFP) Concentrations at Each MATES IV Site.

5.2.2.2 Diurnal Trends

Typically, BC and UFP exhibit distinct diurnal profiles. BC is associated with primary combustion activities and is widely considered as one of the best indicators of mobile source emissions (diesel vehicles in particular) in urban environments. BC and UFP concentrations in urban environments have been shown to closely follow the temporal variation in traffic density, with the highest levels observed on weekdays during rush hours (Hussein et al., 2004; Morawska et al., 2008; AQMD, 2012). UFPs can also be formed by photochemical reactions in the atmosphere, particularly in photochemically-active, sunnier seasons. This is often reflected in a mid-day peak associated with secondary particles.

The 10-site average diurnal variation of BC (indicative of the typical diurnal BC trend in the South Coast Air Basin) is shown in Figure 5-6. Typically, the BC mass concentration peaked in the morning between 0600 and 0900 PST because of rush-hour traffic and decreased throughout the day due to decreased traffic volume, increased wind speeds and subsequent dispersion of ambient pollutants. Early in the evening, evening rush hour, lower wind speeds and a shallow inversion layer led to a slight increase in BC concentration and stable conditions until the early morning.
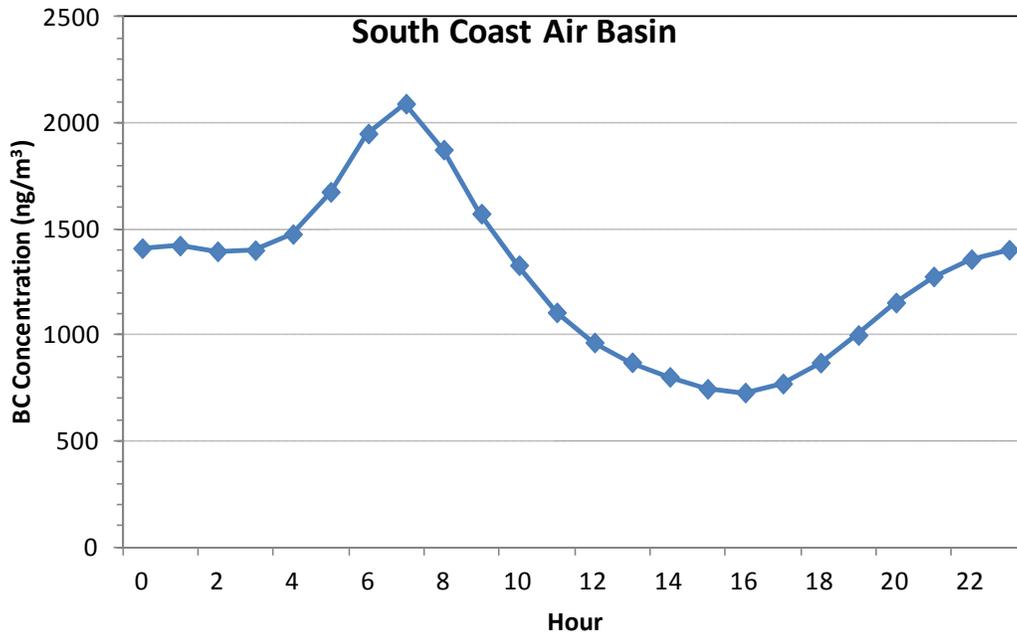
Figure 5-6 - Diurnal Variation in Black Carbon (BC) Concentration in the South Coast Air Basin During MATES IV

The effect of the meteorology on the diurnal trend of BC is more evident when comparing diurnal patterns in different seasons (Figure 5-7). As expected, diurnal variations are more pronounced in the winter and fall because of more stable atmospheric conditions, as explained in previous sections.
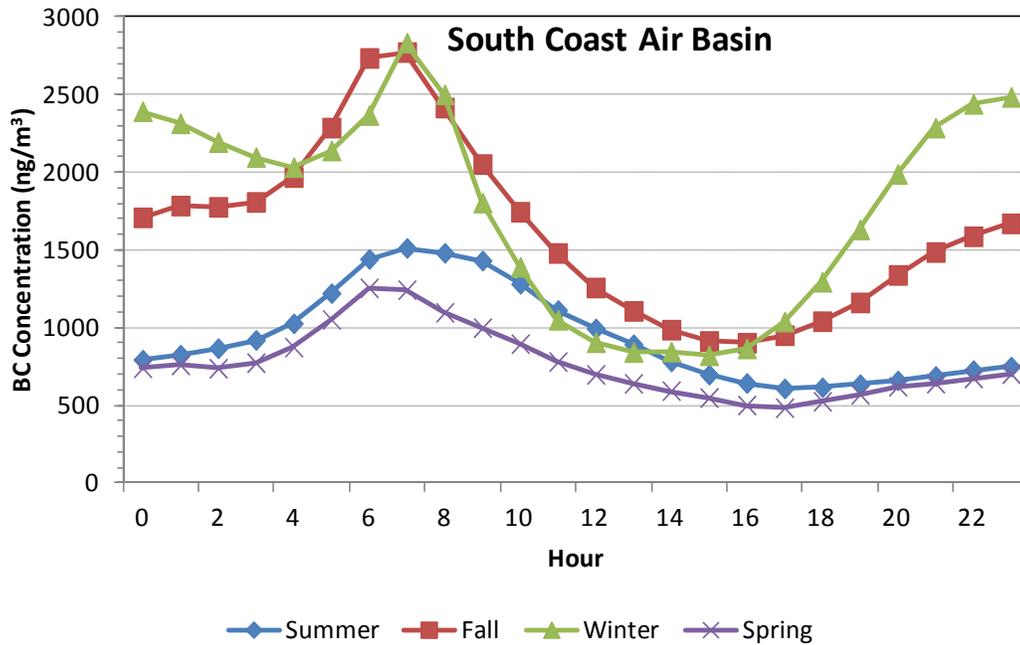
Figure 5-7 - Diurnal Variation in Black Carbon (BC) Concentration in the South Coast Air Basin During MATES IV

Unlike what was observed for BC, the study average diurnal trend for UFP is characterized by three distinct peaks, one early in the morning coinciding with rush hour traffic, followed by a wider mid-day peak which is probably related to photochemical particle formation, and a less pronounced peak in the late afternoon, mostly caused by evening rush hour and a lower mixing height (Figure 5-8).
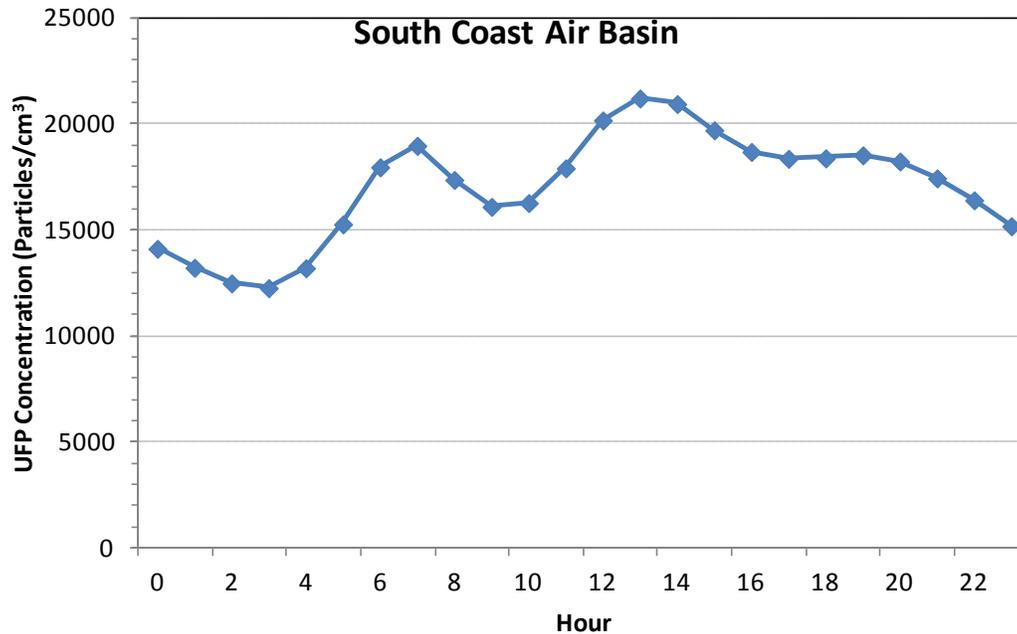
Figure 5-8 - Diurnal Variation in Ultrafine Particle (UFP) Concentration in the South Coast Air Basin During MATES IV

The effect of meteorology on UFP concentration is more evident when comparing average diurnal patterns for different seasons (Figure 5-9). Several factors contribute to the seasonal variability of UFPs. Winters, characterized by stable atmospheric conditions and lower mixing heights, result in elevated UFP levels during morning rush hours and at night (Singh et al. 2006, Wang et al. 2012). Moreover, lower temperatures favor the nucleation/condensation of volatile components of combustion exhaust and, in turn, led to an increase in UFPs. Summer months are typically characterized by a distinct mid-day peak due to increased photochemical activity, which favors particle formation.
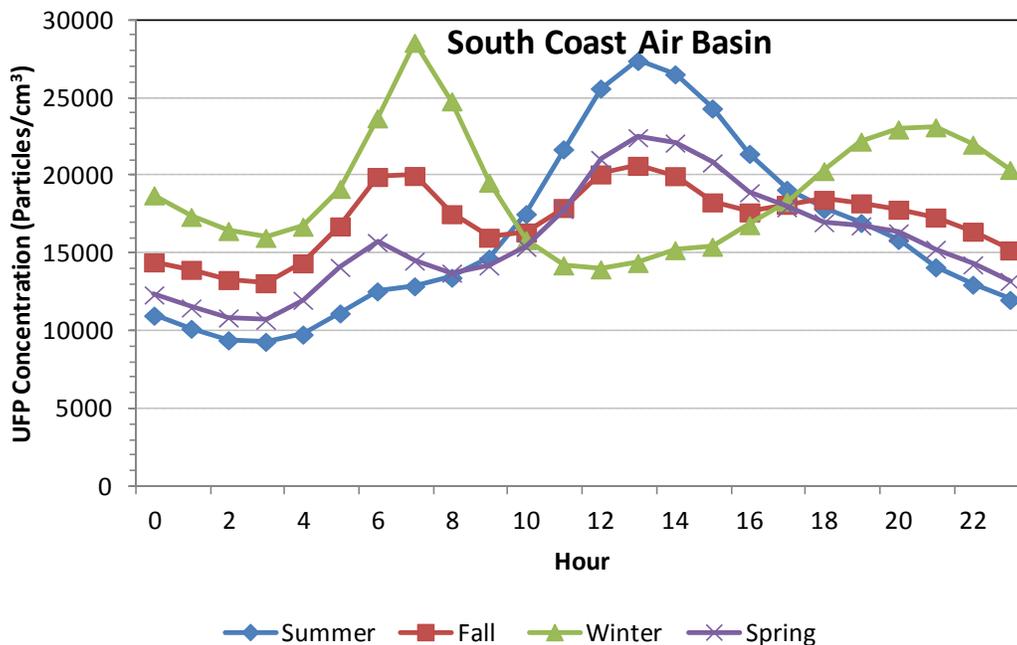
Figure 5-9 - Diurnal Variation of Ultrafine Particle (UFP) Concentration in the South Coast Air Basin During MATES IV.

5.3 Summary for Fixed Sites

Long-term BC and UFP measurements were carried out over a period of one year from July 2012 to June 2013 in a network of 10 sampling sites located in the SCAB. This data was used to characterize the spatial and temporal variations in BC and UFP concentrations and their association with meteorology and local sources.

The morning peak in BC and UFP concentrations observed at most MATES IV sites was probably associated with increased traffic density during rush hours. This effect is particularly pronounced during the colder months, when higher traffic density is coupled with a shallower mixing height. UFPs also exhibit a mid-day peak during the warmer season which is likely to be associated with generation of secondary particles through photochemical processes in the atmosphere.

Seasonal variations in BC and UFP concentrations are mostly related to changes in meteorology. For example, in the wintertime biomass burning smoke may contribute to the observed elevated BC concentrations, and lower temperatures can promote condensation of volatile species and subsequent formation of UFPs.

Various existing regulations and emission reduction strategies are designed to control the atmospheric concentration of BC, either directly by reducing diesel emissions, or indirectly by reducing total PM emissions. Some examples include: (a) promoting regular vehicle emissions testing and retrofitting older diesel powered vehicles and equipment; (b) controlling ship emissions by regulating idling at terminals and mandating fuel standards for ships seeking to dock at port; (c) requiring the use of cleaner fuels; (d) controlling and limiting biomass burning;

(e) requiring permits for operation of industrial, power-generating and oil refining facilities; and (f) promoting filtering and aftertreatment technologies. In most cases, measures to mitigate BC will probably also reduce UFP emissions.

5.4 Local-Scale Studies

Programs such as MATES are designed to monitor and characterize toxic emissions over the entire Basin. However, ambient monitoring is necessarily conducted at a limited number of locations, and modeling is limited to a spatial resolution of 2km. For this reason, communities located very near industrial sources or large mobile source facilities (such as marine ports, railyards and commercial airports) can be affected by higher air contaminant levels than cannot be captured in the typical MATES analysis. Near-road monitoring studies and dispersion modeling results for point sources indicate that exposure can vary greatly over distances much shorter than 2 km. The local-scale monitoring program of MATES IV aims to characterize the impacts of large sources on nearby communities by utilizing portable platforms designed to sample for a period of several weeks at selected locations with an emphasis on diesel particulate matter (DPM) and ultrafine particle (UFP) emissions. The studies are designed to assess gradients in ambient pollutant levels within communities as well as provide a comparison to the fixed MATES monitoring sites. The communities chosen for sampling were selected based on proximity to potential sources as well as environmental justice concerns.

To complete these short-term studies, the SCAQMD employed two mobile monitoring platforms (MMP) and/or up to six environmental enclosures (EE) that were specifically designed for fast-response deployment in communities of the Basin. The MMPs integrate multiple monitoring technologies on a mobile platform and are capable of characterizing the atmospheric concentrations of a wide array of particle and gaseous pollutants in real time, including UFPs and BC (measured using a water-based particle counter and a portable Aethalometer, respectively). Similarly, each EE consists of a water-based condensation particle counter (for continuous UFP measurements) and a micro-Aethalometer (for measuring BC in real-time), powered by a portable battery and enclosed inside a rigid synthetic case.

5.4.1 Los Angeles International Airport (LAX)

SCAQMD conducted a series of air quality measurements at the Los Angeles International Airport (LAX) to characterize the atmospheric levels of UFPs and BC downwind of the main runways. Specifically, these local-scale studies were conducted to: (a) delineate local air toxic concentration gradients that might be driven by proximity to the airport; (b) establish if airport-related emissions are distinguishable from those of other potential sources such as nearby traffic from the I-405. These objectives are consistent with the community-scale air monitoring grant program goals of the EPA, which partially funded this deployment.

5.4.1.1 Gradient Study

On 09/11/2012 between 08:00 and 17:00 (PST), UFP and BC measurements were taken at eight different sites east (downwind) of and at different distances from runway 25R (typically used for aircraft take-off) and runway 25L (usually used for landing), as shown in Figure 5-10. Since most sites were located in highly restricted areas where access was only possible under LAX

personnel supervision, only a limited number of measurements were collected for this part of MATES IV. However, the highly resolved one-minute UFP and BC data provided useful information on the local gradients, short-term variations, and potential impacts on local communities. It should be noted that sites 4 and 8 were located 100 and 250 m downwind of the I-405 to evaluate the potential relative contributions of airport and freeway emissions. Lastly, BC measurements were also conducted at a "Community" site, in a highly populated residential area further away from LAX and the I-405. However, all data collected at this last location were invalidated because of unexpected construction activities occurring near this site.

Figure 5-10 - SCAQMD monitoring sites used for the Los Angeles International Airport (LAX) gradient study.

The study average UFP concentrations at sites 1 through 8 were substantially more elevated than the corresponding MATES IV Basin average measured at the 10 fixed sites (Figure 5-10). As expected, the average UFP level peaked at site 1 immediately downwind of runway 25R (where aircraft take-off) and decreased exponentially away from the runway. Interestingly, the average UFP concentrations downwind of runway 25 L (used for landing) followed the opposite trend and increased with increasing distance from the runway (Figure 5-11). This suggests that aircraft landing may also impact the atmospheric levels of UFPs in the area (and possibly communities) east of LAX. Given the short duration of these measurements, it is difficult to assess the full extent of this impact.

It should be noted that motor-vehicle emissions from the I-405 Freeway may have contributed to increasing the ambient UFP concentrations at site 8. The relative contribution of freeway emissions to the measured UFP levels is difficult to assess with this limited dataset. More information regarding the potential impacts of airport-related emissions on ambient air quality of communities adjacent to the airport is available in the Los Angeles International Airport (LAX) Air Quality and Source Apportionment Study (AQSAS).
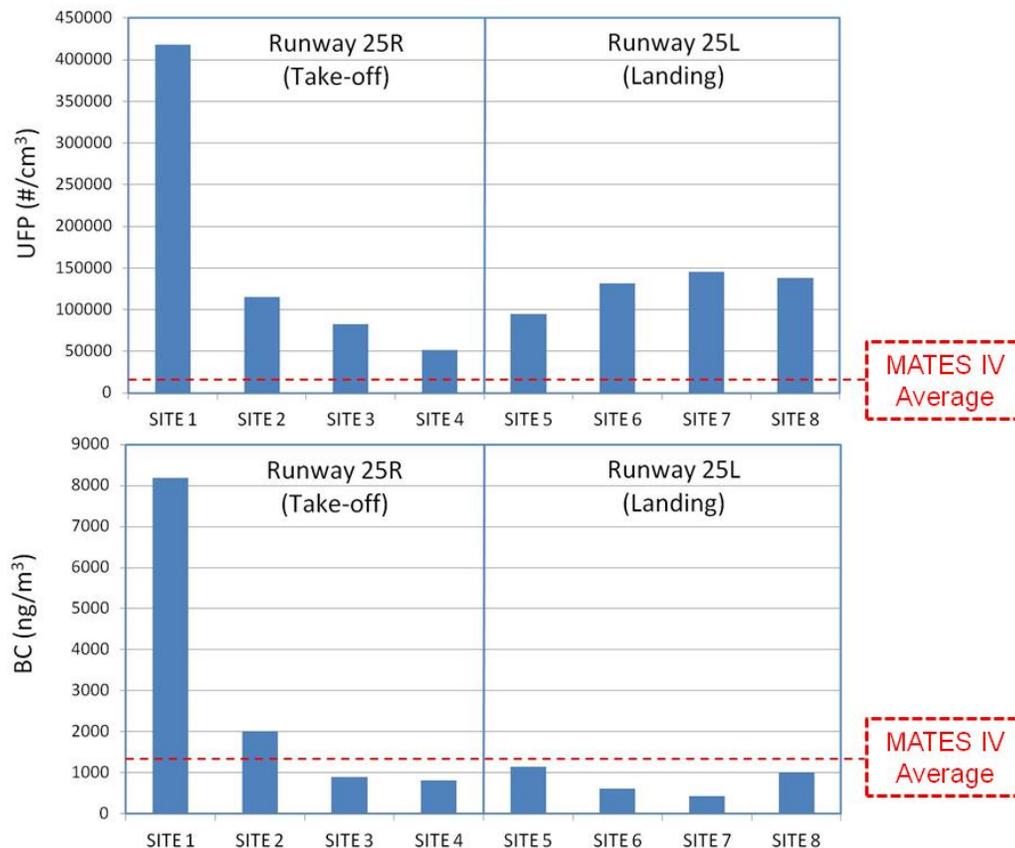

Figure 5-11 - Average UFP and BC levels measured at the eight temporary sites downwind of runway 25R (where aircraft take-off) and runway 25L (typically used for landing).

Similarly, the average concentration of BC downwind of runway 25R peaked at site 1 because of aircraft take-off and decreased steeply moving away from the airport (Figure 5-11). However, while the average BC level at site 1 (8188 ng/m^3) was well above what is typically found in urban areas, the ambient concentrations at the remaining downwind sites were close or below the MATES IV BC study average (1313 ng/m^3). No evidence of a significant contribution of BC emissions from aircraft landing was found from the data collected downwind of runway 25L.

Site 8 showed slightly higher BC concentrations than those measured closer to the airport, probably because of contributions from the I-405. However, since the traffic volume on this

freeway is dominated by light-duty gasoline vehicles, these contributions are probably not very significant, as confirmed by previous studies conducted in Los Angeles.

5.4.2 San Bernardino Railyard

The San Bernardino Railyard (located in the city of San Bernardino) was selected to further characterize ambient air pollutant levels in the communities surrounding this facility. Railyards are a complex mix of many source types including trains, stationary equipment, terminal operations and on-road vehicles, particularly heavy-duty diesel trucks. A unique set of rapidly deployable mobile air toxics monitoring platforms using the latest technologies for continuous measurements, including both MMPs and EEs, were utilized. A combination of continuous air monitoring and meteorological data is extremely valuable in determining source locations, emission profiles, and exposure variability.

The MMPs were equipped with a condensation particle counter (CPC, model 3785; TSI, Inc.) which measures the number concentration of particles larger than 5 nm in size and up to 10,000,000 particles per cubic centimeter (#/cm^3). A portable Aethalometer (AE22; Magee, Inc.) for real-time measurements of BC was also installed in MMP as an indicator of DPM. EEs were equipped with a condensation particle counter (CPC, model 3781; TSI, Inc.), which monitors number concentrations of particles down to 6 nm in size and up to concentrations of 500,000 (#/cm^3), while BC was measured using micro-Aethalometers (AethLabs). The MMPs and EEs were placed around the San Bernardino Railyard facility as shown in Figure 5-12, to assess potential gradients in exposure as a function of distance from the railyard activities. Measurements were taken between 09/06/2013 to 09/19/2013.
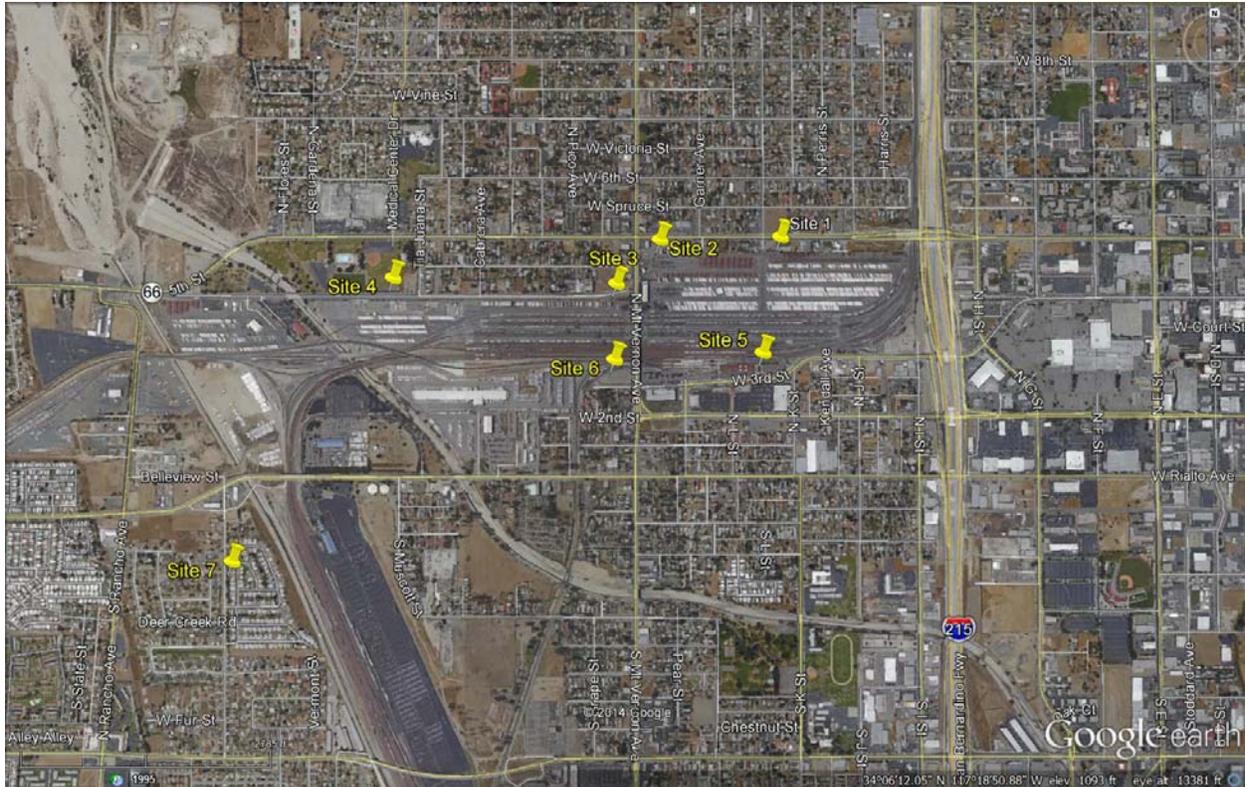
Figure 5-12 - SCAQMD Monitoring Sites for MATES IV San Bernardino Railyard Microscale Study.

Comparing the levels measured at these local-scale sampling sites to those collected from other fixed MATES IV locations can yield insights as to the magnitude of local impacts. Both BC and UFP concentrations were elevated compared to the MATES IV Basin averages, the annual levels measured at the fixed Inland Valley San Bernardino site, as well as the levels measured at this fixed site during the same period when the local-scale measurements were conducted. Particularly, the study average BC concentrations at sites 1 through 7 were substantially elevated relative to the corresponding MATES IV Basin average measured at the 10 fixed sites (Figure 5-13). Elevated BC concentrations are expected in vicinity of a railyard facility due to high traffic activity of heavy-duty vehicles. It should be noted that sites 1, 2 and 3 that are located close to the intersection between Highway 66 and the I-215 Freeway may experience relatively higher heavy-duty diesel traffic. The BC levels were also significantly higher than the annual average BC concentration at the Inland Valley San Bernardino site (1703 ng/m^3), as well as those recorded at the Inland Valley San Bernardino site during the same period as the local-scale study (1564 ng/m^3 between 09/06/2013 and 09/19/2013).

Compared to BC, UFP concentrations are only slightly higher than the MATES IV Basin average concentration (Figure 5-13). Relatively higher UFP concentrations at sites 1, 2 and 3 close to Highway 66 and the I-215 Freeway suggest that the motor-vehicle emissions may have contributed to higher ambient UFP concentrations.
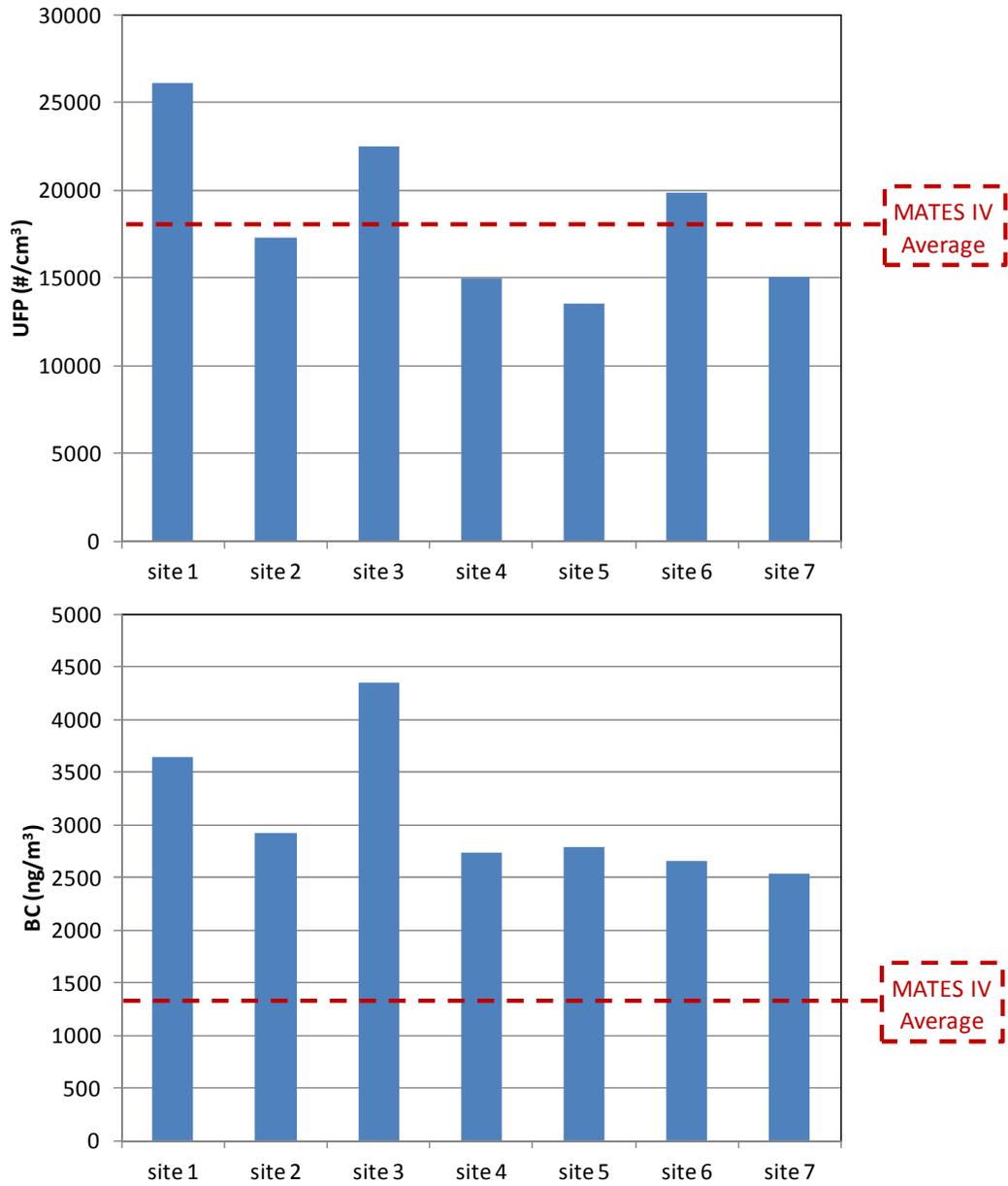
Figure 5-13 - Average UFP and BC levels measured at the seven temporary sites surrounding San Bernardino Railyard.

5.4.3 Mira Loma/CA-60 Freeway

This location was selected to assess the impact of motor-vehicle emissions from the CA-60 Freeway and Etiwanda Ave on a local community. As for the LAX and San Bernardino Railyard studies, each EE contained a micro-Aethalometers (AethLabs) and a portable CPC (Model 3781), and each MMP included a Magee portable Aethalometer and a CPC model 3785. Sampling was conducted at six different sites on seven different dates from mid January to early March, 2013. Each sampling period started before pre-morning rush-hour traffic and concluded in mid afternoon. Sites were selected to capture the potential gradients of BC and UFP concentrations in this residential neighborhood. Sites 1, 3 and 4 were located in the residential area, downwind and away from major roads. Site 2 was located at the intersection of two roadways, while sites 5 and 6 were closest to the 60 Freeway (Figure 5-14).
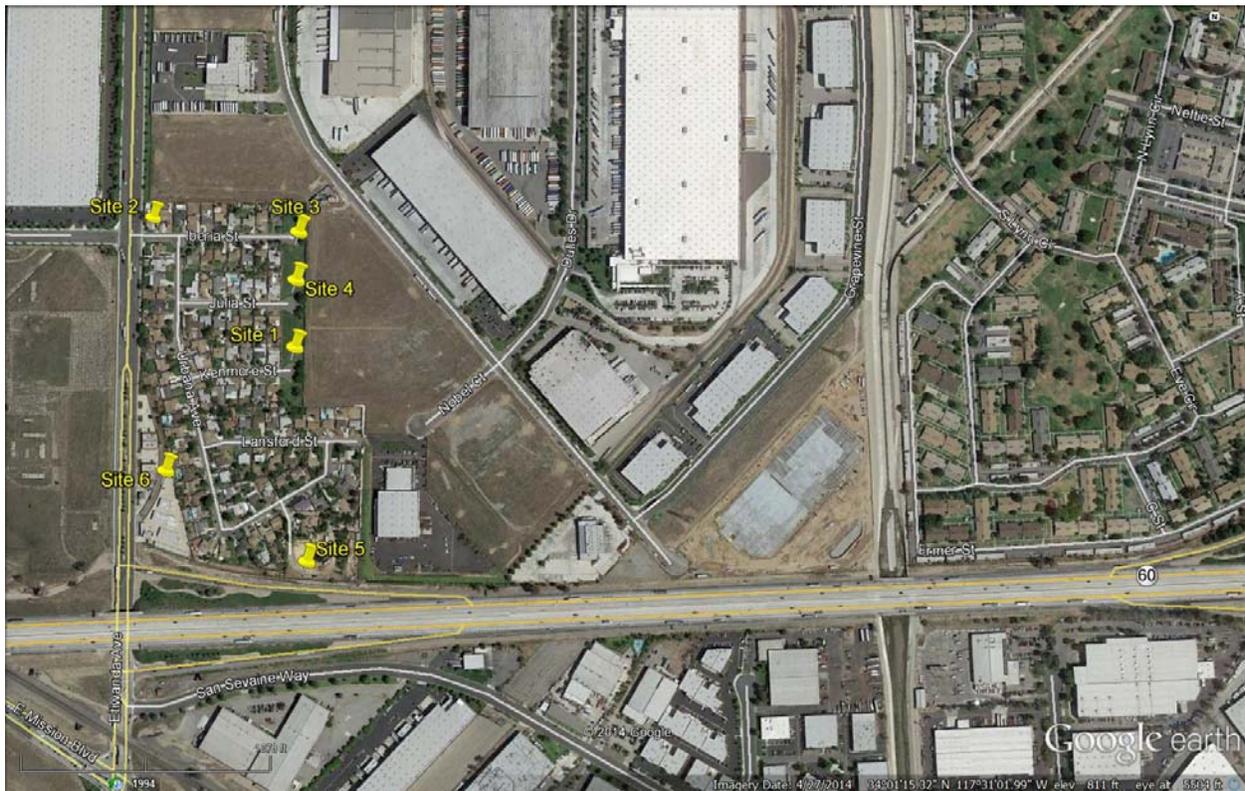

Figure 5-14 - SCAQMD monitoring sites used for the Mira Loma study.

The study average BC and UFP concentrations at all sites was close to or exceeded the corresponding MATES IV Basin average (Figure 5-15), probably due to the intense traffic activity in this industrial area, and the relatively high contributions from heavy- duty diesel trucks. As expected, the average BC and UFP concentrations peaked at sites closer to the 60 Freeway and to major roads (e.g. sites 2, 5 and 6) and decreased substantially away from the freeway (as observed at sites 1, 3 and 4).
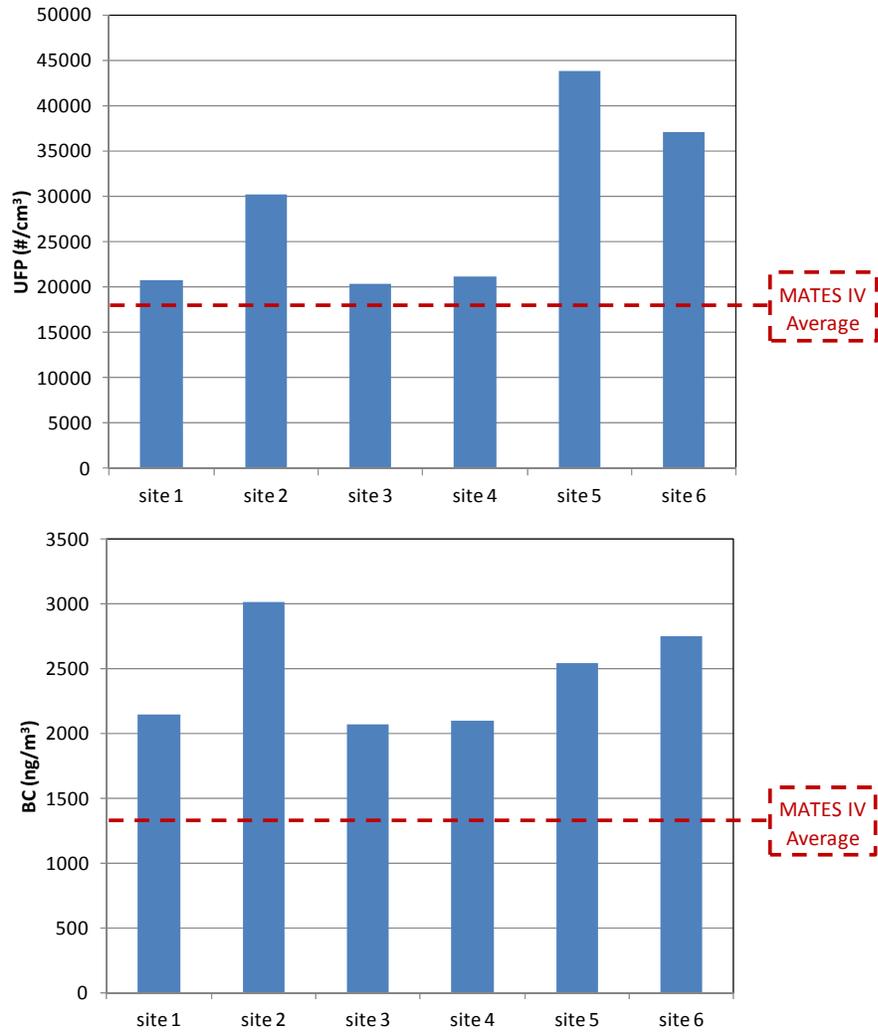
Figure 5-15 - Average UFP and BC levels measured at the six temporary sites in Mira Loma.

CHAPTER 6

FINDINGS AND DISCUSSION

Chapter 6.   Findings and Discussion

The MATES IV Study incorporates several updates and improved methodologies compared to previous air toxics studies in the Basin to measure and model ambient levels of air toxics and their associated risks. Key elements and findings are listed below.

6.1. Ambient Monitoring

- Air toxics samples were taken at 10 fixed sites, once every six days, from July, 2012 through July, 2013.

6.2. Air Toxics Modeling

- Updated emissions inventories based on the 2012 year were used, as well as meteorology for 2012.

- An air quality modeling platform, CAMx, was used to estimate levels of air toxics throughout the Basin using the 2012 emissions inventory. The estimates were allocated to a 2 km x 2 km regional grid scale.

6.3. Key Findings

- During the study period, the average Basin cancer risk from air toxics based on the annual average levels calculated from the 10 monitoring sites data was approximately 418 per million. This is about 65% lower than the estimated risk from the 2004-2006 time period.

- Diesel exhaust was the key driver for air toxics risk, accounting for 68% of the total estimated air toxics risk estimated from monitoring.

- None of the annual averages of pollutants measured were above the chronic reference exposure levels (RELs) for noncancer health effects developed by OEHHA.

- Ambient levels of most substances measured were lower compared to that of the MATES III Study, which was conducted in 2004-2006, reflecting the success of various control strategies to reduce exposure to air toxics.

- Diesel PM showed the most dramatic reductions, with the levels found about 70% lower compared to MATES III.

- Benzene and 1,3-butadiene average levels, pollutants mainly from vehicles, were down 35% and 11%, respectively.

- Stationary source-related pollutants, perchloroethylene (an industrial solvent) also showed declines of 53%.

- Hexavalent chromium, which is from mobile as well as stationary sources, was lower by 70%.

- Regional modeling analysis shows the highest risks from air toxics surrounding the port areas, with the highest grid cell risk about 1,000 per million, followed by Central Los Angeles, where there is a major transportation corridor, with grid cell modeled risks

ranging from about 700 to 750 per million.

- Model estimated air toxics risk showed an overall Basin-wide reduction, with the greatest reductions occurring near the ports.

- The Basin-wide estimated population-weighted risk was 57% lower in MATES IV compared to MATES III.

- The spatial distribution of diesel $PM_{2.5}$ emission in MATES IV is similar to the diesel PM emission pattern derived in CalEnviroScreen 2.0, both showing the highest diesel PM emission in Central Los Angeles and area around the Ports.

- Risk estimates in this study do not include mortality from particulate exposure. This was done in the recent update to the AQMP.

- Ultrafine particle measurements at the ten fixed sites revealed that regional ultrafine levels are higher in western areas of the Basin with greater population and traffic density.

- Consistent with previous studies, short-term, local-scale measurements near a rail yard, an airport, and a busy freeway intersection showed higher diesel PM and ultrafine concentrations than the nearest fixed site monitor.

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6.4. Discussion and Policy Implications

- Although there are uncertainties in the ambient estimates, diesel particulate continues to be the dominant toxic air pollutant based on cancer risk. The study findings therefore clearly indicate a continued focus in reducing diesel emissions.

- Additionally, application of the updated risk estimation methods recently adopted by OEHHA result in about a 2.5-fold increase in inhalation risks from air toxics. Using the updated methods yields estimated lifetime risks near the ports of over 2,500 per million from air toxics.

- Goods movement is a significant source of diesel emissions. With the projected future growth in goods movement, diesel source activity may increase. The interplay between (a) the increase in goods movement and (b) projected emission reduction strategies will be crucial in further decreasing diesel exposures in the future.

- There are several uncertainties in estimating air toxics risks. These include uncertainties in the cancer potencies of the substances, in the estimates of population exposure, and uncertainty in estimating the level of diesel particulate.

- Since the time frame of the MATES III Study, there have been numerous regulations and initiatives to reduce diesel exhaust emissions by local, state and national authorities. These efforts along with those of the ports and private sector organizations have been successful in reducing actual risks from air toxics exposure.

- Although the estimated Basin-wide risks declined from the MATES III period, areas near the ports and near transportation corridors continue to show the highest air toxics risk.

- Many current and future measures designed to meet Air Quality Management Plan goals for $PM_{2.5}$ and ozone will have the additional benefits of reducing air toxic emissions as well as greenhouse gas emissions.   The opportunities to achieve co-benefits towards multiple objectives should be maximized in future air quality policies and strategies